



Full length article

## PrEP awareness, eligibility, and interest among people who inject drugs in Baltimore, Maryland

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### ABSTRACT

**Background:** Limited research has examined pre-exposure prophylaxis (PrEP) interest among people who inject drugs (PWID). To date, few studies have examined the relationship between PrEP eligibility and PrEP interest among PWID.

**Methods:** Data were from an anonymous, cross-sectional survey of Baltimore Syringe Services Program (SSP) clients and non-client peers, restricted to HIV-uninfected participants (N = 265). Participants were classified as PrEP eligible/ineligible based on injection related criteria outlined in the CDC's PrEP guidelines. Participants were asked if they were previously aware of PrEP, would be interested in taking PrEP, and the ease of taking PrEP daily. Participants self-reported their sociodemographic characteristics, health diagnoses, and recent drug use, overdose, and drug treatment history. We estimated bivariate and multivariate logistic regression models to test for significant predictors of interest in PrEP.

**Results:** One-quarter of PWID had previously heard of PrEP and 63% of the sample was interested in taking PrEP. Only two respondents were currently taking PrEP. The majority (89%) thought taking PrEP every day would be easy. In the presence of other variables, PrEP interest was associated with PrEP eligibility (adjusted odds ratio [aOR] = 2.46; 95% Confidence Interval [CI]:1.34,4.50) and the number of medical diagnoses (aOR = 1.16; 95% CI:1.01,1.33)

**Conclusions:** Most PWID were unaware of PrEP but interested in taking it. PWID who were eligible for PrEP are more likely to be interested in taking it. Having co-morbid conditions was an important correlate of PrEP interest. These results underscore the importance of providers across the healthcare sector engaging PWID in discussions about PrEP.

### 1. Introduction

People who inject drugs (PWID) have been central to the HIV/AIDS epidemic for over 30 years, with the World Health Organization estimating that about 19% are living with HIV globally (Mathers et al., 2008). In 2015, the Centers for Disease Control and Prevention (CDC) determined that 6% of HIV diagnoses in the U.S. were attributable to injection drug use (IDU) and another 3% to male-to-male sexual contact and IDU (Centers for Disease Control and Prevention (CDC), 2016). The most successful, evidence-based HIV prevention effort targeting PWID is syringe service programs (SSPs), which have significantly reduced the

incidence of HIV and HCV infections among PWID over the past 30 years (Fernandes et al., 2017; Gibson et al., 2001; MacDonald et al., 2003). The ongoing opioid epidemic threatens to reverse the progress that has been made on HIV prevention. Rates of heroin injection have dramatically increased in recent years, as non-medical use of prescription opioids increased drug tolerance and lead to a shift towards opioid injection in populations with previously low rates of injection drug use (Compton et al., 2016). The opioid crisis has also brought the issue of injection drug use to previously unaffected regions. In particular, the CDC has identified over two hundred primarily rural, low-resource counties that are at high-risk for HIV outbreaks (Van Handel

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et al., 2016). Despite the effectiveness of SSPs, they alone are not sufficient to fully combat HIV among PWID. Given the potential for future HIV outbreaks, scaling up other prevention services for PWID is essential to avert a future HIV crisis.

Pre-exposure prophylaxis (PrEP) is a potentially valuable tool for preventing HIV amongst PWID, and is currently underutilized. Oral PrEP is a combination of tenofovir and emtricitabine taken daily to prevent individuals exposed to HIV from developing infections (Food and Drug Administration (FDA), 2014). Other modalities of PrEP are currently being developed, including injectable and other long-acting forms of PrEP (Meyers and Golub, 2015). PrEP has significantly changed the landscape of HIV prevention among other populations at high risk for HIV, like men who have sex with men (Grant et al., 2010). Research on PrEP has often excluded PWID given doubts of their ability to adhere to daily drug regimens, in spite of their ability to adhere to their own regimens (Guise et al., 2017). A seminal PrEP trial amongst PWID in Bangkok demonstrated adherence to and efficacy of PrEP for both male and female PWID (Choopanya et al., 2013). This randomized, placebo-controlled trial found that PrEP use was associated with a 49% decrease in the incidence of HIV among PWID, without a significant increase in other serious adverse events (Choopanya et al., 2013). The protective effect of PrEP increased among PWID in this trial as regimen compliance increased to 56% effective when taken 74% of the time or more. Other literature has also supported the ability of PWID to engage in behaviors to protect against HIV, including reducing sharing of injection equipment, peer outreach, and altruism within social networks (Abdul-Quader et al., 2013; Booth and Wiebel, 1992; Friedman et al., 1999; Latkin et al., 2003). The CDC recommends PrEP for PWID based on individual HIV risk behaviors, including having an injection partner with HIV infection, sharing injection equipment, and still injecting despite recently receiving drug treatment (Centers for Disease Control and Prevention (CDC), 2014). These CDC eligibility criteria are the standard guidance used for physicians prescribing PrEP and interventions that engage at risk populations into PrEP treatment.

Despite the initial evidence that PrEP is in fact effective for preventing HIV among PWID, there is substantial debate around whether broad PrEP engagement makes good public health sense in this population (Centers for Disease Control and Prevention (CDC), 2014). A recent cost-effectiveness evaluation of broad PrEP engagement among PWID determined that the cost per quality-adjusted life year gained exceeds \$250,000 (Bernard et al., 2016). This high cost is due, in part, to the success of other harm reduction strategies suppressing the rate of HIV transmission. However, many PWID in the rural areas at risk for HIV outbreaks do not have access to other prevention efforts, such as SSPs (Canary et al., 2017; Des Jarlais et al., 2015). In these settings, PrEP may be the only option for preventing HIV among many PWID.

While the cost effectiveness concerns surrounding broad PrEP implementation are legitimate, they can be overcome through effective targeting of interventions. The authors who raised these concerns acknowledge that innovative strategies for targeting PrEP delivery to high-risk individuals or locales can improve the cost effectiveness for PWID (Bernard et al., 2016). Similarly, the broader literature indicates that PrEP implementation must be undertaken with careful consideration of the unique needs and interests of the target population (Cáceres et al., 2015). Two key factors that should inform PrEP delivery efforts are the risk level for HIV transmission and individuals' interest in taking PrEP (Cáceres et al., 2015).

Only a few studies have previously explored interest in PrEP among PWID. One study in the U.S. found that PWID were less likely than other at-risk groups to be aware of PrEP (Walters et al., 2017b). Others found that few PWID in Vancouver were willing to use PrEP, but being at high risk for HIV was associated with increased interest in PrEP (Escudero et al., 2015). Similarly, another study in New York found that sex work and syringe exchange based social networks increased awareness of PrEP among PWID (Walters et al., 2017a). Researchers in Massachusetts found that only 7% of PWID in detoxification treatment were aware of

PrEP and less than half were willing to take it (Stein et al., 2014). Alternatively, a Ukraine study found that the majority of PWID would be interested in taking PrEP (Eisingerich et al., 2012). Similarly, one study in Washington D.C. found that only 13% of older PWID had heard of PrEP and none had ever known someone who used PrEP, but most would be willing to use PrEP if it was available for free (Kuo et al., 2016). These results were further replicated in a study of PWID in a Connecticut methadone program, where 18 percent of individuals were aware of PrEP but 63 percent were willing to take it (Shrestha et al., 2017). Overall, studies agree that PrEP awareness is low among PWID, but the evidence on PrEP interest is mixed. More research is needed to fully understand the level of interest in PrEP among PWID and factors associated with interest in PrEP.

### 1.1. The current study

We seek to examine PrEP awareness and interest, exploring the role of PrEP eligibility as a predictor of interest in PrEP among PWID in Baltimore, MD. We further aim to identify key correlates of PrEP interest among PWID, in order to identify important opportunities to engage PWID in PrEP care. Such research is needed in order to inform effective scale up of PrEP interventions in this population.

## 2. Methods

### 2.1. Study design and recruitment

The current analysis is part of a larger study that examined the impact of a change in syringe distribution practices of the Baltimore City Health Department Syringe Service Program (SSP) from a one-for-one (i.e., return one used syringe per new one received) to a needs-based (i.e., can receive as many new syringes as needed regardless of the number of used syringes returned) distribution model. Data were collected through a cross-sectional survey conducted from April–November 2016. Participants were sampled from all 16 Baltimore SSP sites. The number of participants sampled from each site was weighted to account for the total number of clients per site. Study staff approached potential participants after they exited the SSP van, explained the study, and screened participants for eligibility. Eligible individuals were invited to participate in an anonymous, 30-minute interview administered via a Computer Assisted Personal Interview (CAPI) survey. The study team also recruited non-client peers of SSP clients through referrals from previously-interviewed SSP clients. Both clients and non-clients were eligible to participate if they were at least 18 years old and able to provide consent in English. Participants gave informed consent orally. Participants were compensated with a pre-paid \$25 Visa card. This study was approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

### 2.2. Measures

#### 2.2.1. PrEP variables

We examined four PrEP variables: awareness, interest, eligibility, and ease of use. Awareness was measured by asking if participants had heard of PrEP before the interview (yes/no) (“Have you heard of HIV PrEP before today?”). Interest was measured by asking if individuals were interested in taking a pill every day to help prevent HIV (“How interested would you be in taking a pill every day to help prevent HIV infection?”). Participants who responded that they were very or somewhat interested were categorized as “interested,” and those who responded somewhat or very disinterested were considered “not interested.” Eligibility was based on CDC criteria for PrEP eligibility relating to injection behaviors (Centers for Disease Control and Prevention (CDC), 2014). Individuals who reported sharing any injection equipment (i.e., cotton, cookers, or needles) in the past 30 days were classified as PrEP eligible. Ease of use was measured by asking participants reported

how easy they thought taking a pill every day to help prevent HIV would be (“How easy would it be for you to take a pill each day, to prevent HIV infection?”). Participants who responded that it would be very or somewhat easy were categorized as “easy,” and those who responded somewhat or very difficult were considered “not easy.”

### 2.2.2. Sociodemographic characteristics

Sociodemographic characteristics included sex (male/female), race (White/Black/other), education (< high school, 12<sup>th</sup> grade/GED, some college or more), marital status (single/other), age (18–34, 35–44, 45–54, 55+), sexual orientation (heterosexual, gay/lesbian/bisexual/queer), employment status (full-time, part-time, not employed), and homelessness (yes/no, based on participants’ report of their usual sleeping place). SSP client status was ascertained at recruitment (client/non-client). The “other” race category combined Hispanic, Asian, Native American, and ‘other race’ individuals, as the samples sizes in each of these groups were too small to proceed with.

### 2.2.3. Drug use and overdose

Participants reported the use of four injection (heroin, cocaine, speedball, and prescription opioids) and seven non-injection drugs (marijuana, crack cocaine, heroin, prescription opioids, cocaine, buprenorphine/suboxone, tranquilizers) in the past 6 months (yes/no). Participants reported their most frequent location of injection, which we categorized as private (own or other’s home), semi-public (public bathroom, abandoned building, vehicle), or public (street, park, stairwell, shooting gallery). Four binary overdose variables were included: any lifetime overdose, any overdose in the past 12 months, received naloxone during their last overdose (among those experiencing overdose), and went to the emergency room for their last overdose (among those experiencing overdose).

### 2.2.4. Drug treatment

Participants self-reported what types of substance use treatment they attended in the past year from a list of options. We then created three binary variables to indicate whether the participant reported receiving inpatient treatment in a hospital, inpatient treatment in a rehabilitation facility, or any outpatient treatment in the past 12 months.

### 2.2.5. Health variables

Health care access was measured by health insurance type (no insurance/Medicaid only/other). Participants reported their physical health diagnoses by selecting from a list of 18 conditions (hypertension, high cholesterol, coronary heart disease, myocardial infarction, endocarditis, stroke, emphysema, COPD, asthma, cancer, diabetes, sepsis, arthritis, cirrhosis, chronic pain condition, acute persistent pain, abscess, seizure disorder), which we totaled to create a count variable. The physical health questions were adapted from the National Health Interview Survey (Parsons et al., 2014).

## 2.3. Analysis

The original sample included 299 participants. The analytic sample was restricted to participants who had a history of injecting drugs (1 excluded), did not self-report having HIV (31 excluded), and were not currently taking PrEP (2 excluded). This yielded a final analytic sample of 265 participants. We examined the concordance between being aware of, interested in, and eligible for PrEP using chi-square tests. We then compared sociodemographic characteristics and drug use behaviors among our sample by PrEP eligibility and interest using Pearson’s chi-square tests. We used bivariate logistic regression models to examine the associations between the health care access and key demographic variables on PrEP interest. Finally, we estimated a multivariate logistic regression model for the effects of sociodemographic variables, PrEP eligibility, and measures of health problems and care access on interest in PrEP. Variables were included in this model based on our

priori theoretical hypotheses that HIV risk behavior, measured through PrEP eligibility, and access to medical care would be associated with more interest in PrEP. Drug treatment was not included in this model, as it is part of the CDC PrEP eligibility criteria and was addressed in our sensitivity analyses. We used the ‘vif’ and ‘collin’ commands in STATA to check for multi-collinearity and identified no issues with the variables included in our final model.

## 2.4. Sensitivity analyses

We conducted two sensitivity analyses. In the first sensitivity analysis, we used a log-binomial model in lieu of the multivariate logistic regression to ensure that our results were not driven by the high prevalence of the outcome, PrEP interest. Then, we included participants who reported any inpatient drug treatment (hospital/rehabilitation) in the PrEP eligible group to assess potential misclassification bias in our results. We did not include outpatient drug treatment, as we expected that this would largely consist of self-help meetings. We conducted all analyses using Stata/SE 14.2 (StataCorp, 2015) and used a threshold of  $p < 0.05$  for statistical significance.

## 3. Results

### 3.1. Concordance of PrEP awareness, interest, and eligibility

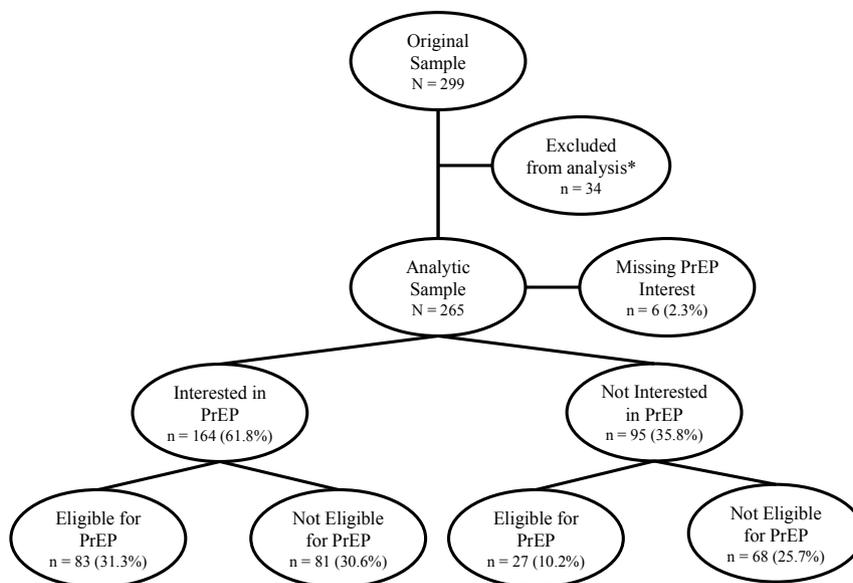
Sixty-two percent of the sample was interested in PrEP, and 43% was eligible for PrEP based on their injection behavior (Fig. 1). Only 24% of participants were previously aware of PrEP (Table 1). Most (63%) were somewhat or very interested in PrEP. Those who were PrEP eligible were more likely to be interested than those who were not eligible. The majority of participants (89%) believed that taking PrEP would be very or somewhat easy. There was no significant difference in beliefs about the ease of PrEP use by PrEP eligibility.

### 3.2. Sociodemographic characteristics by eligibility and interest

Of the analytic sample, 68% were male, 40% were White, and 55% were Black. One-third reported being homeless. Sixty-six percent were SSP clients. Table 2 summarizes the sociodemographic differences by PrEP eligibility and interest. Individuals who were eligible for PrEP were significantly younger (37% vs. 19% age  $\leq 35$ ) and more likely to be female (39% vs. 27%), White (52% vs. 31%), homeless (41% vs. 28%), and single (56% vs. 31%) compared to ineligible individuals. Individuals interested in PrEP were significantly more likely to be homeless (40% vs. 24%), more likely to not be employed (82% vs. 74%), and had more medical diagnoses on average than uninterested individuals (2.73 vs. 2.12).

### 3.3. Drug use, overdose, and treatment by eligibility and interest

All bivariate differences in eligibility for and interest in PrEP by drug use, drug treatment, and overdose are summarized in Table 3. Eligible individuals were significantly more likely than ineligible individuals to: inject cocaine (67% vs. 40%), inject speedballs (72% vs. 49%), smoke crack cocaine (68% vs. 42%), use buprenorphine illicitly (34% vs. 21%), have injected in semi-public/public locations (58% vs. 33%), have ever overdosed (69% vs. 47%), have overdosed in the past 12-months (41% vs. 24%), and have been in inpatient drug treatment in a rehabilitation facility (13% vs. 5%). Compared to those who were not interested in PrEP, interested individuals were significantly more likely to have: injected heroin (97% vs. 88%); injected cocaine (57% vs. 44%); use prescription opioids illicitly (38% vs. 21%); used tranquilizers (39% vs. 24%); and injected in semi-public locations (40% vs. 24%). Furthermore, those interested in PrEP were significantly more likely to engage in risky behaviors, including sharing cottons (38% vs. 18%) and cookers (46% vs. 27%) and injecting with a previously used needle



Note. Percentages are based off of the analytic sample; \*: 1 participant was excluded for having never injected, 31 participants were excluded for reporting having HIV, and 2 participants were excluded for currently taking PrEP.

Fig. 1. PrEP interest and eligibility.

Note. Percentages are based off of the analytic sample; \*: 1 participant was excluded for having never injected, 31 participants were excluded for reporting having HIV, and 2 participants were excluded for currently taking PrEP.

Table 1

PrEP awareness, interest, and ease of use by PrEP eligibility among people who inject drugs in Baltimore, Maryland.

	Total N (%)	Eligible N (%)	Not Eligible N (%)	p
<b>Awareness of PrEP (n = 263)</b>				
Previously aware of PrEP	63 (24.0)	31 (27.9)	32 (21.1)	0.20
Not previously aware of PrEP	200 (76.1)	80 (72.1)	120 (79.0)	
<b>Interested in PrEP (n = 259)</b>				
Very or Somewhat Interested	164 (63.3)	83 (75.5)	81 (54.4)	< 0.001
Very or Somewhat Uninterested	95 (36.7)	27 (24.6)	68 (45.6)	
Interested				
<b>Think taking PrEP would be easy (n = 255)</b>				
Very or Somewhat Easy	227 (89.0)	100 (90.1)	127 (88.2)	0.63
Very or Somewhat Difficult	28 (11.0)	11 (9.9)	17 (11.8)	

more frequently (5.0 vs. 0.2), than those who were not interested. PrEP interested individuals were more likely to have ever overdosed (63% vs. 46%) and overdosed in the past 12-months (38% vs. 21%) than uninterested individuals. Neither interest nor eligibility differed by receiving naloxone for an overdose or having gone to the emergency room subsequent to a person’s most recent overdose. PrEP interest did not differ based on any of the past 12-month drug treatment variables.

3.4. Multivariate results for correlates of PrEP interest

While accounting for age, sex, race, daily drug injection, past year overdose, and health insurance, the odds of PrEP interest were significantly elevated among those who were PrEP eligible (aOR = 2.46, 95% CI:1.34,4.50) and homeless (aOR = 1.95, 95% CI:1.00,3.83) (Table 4). Each reported medical diagnosis was further associated with increased odds of being interested in PrEP (aOR = 1.16, 95% CI = 1.01,1.33).

3.5. Sensitivity analyses

When we used a log binomial regression, the results were unaffected. PrEP eligibility (aOR = 2.45, 95% CI:1.34, 4.50), homelessness (aOR = 1.95, 95% CI:1.00,3.83), and health diagnoses (aOR = 1.16, 95% CI = 1.01,1.33) remained associated with PrEP interest, and the effect sizes remained the same across variables. There were no additional significant correlates of PrEP interest in this model. When including individuals who had received inpatient drug treatment in the eligible group, 14 new individuals were considered eligible. The multivariate logistic regression results remained largely unchanged. PrEP eligibility (aOR = 2.12, 95% CI:1.17,3.82) and health diagnoses (aOR = 1.15, 95% CI = 1.00,1.32) remained associated with increased odds of being interested in PrEP. The relationship between homelessness and PrEP interest was similar as in the previous analysis, but the result was no longer statistically significant (aOR = 1.86, 95% CI = 0.95,3.65). Again, no new variables had a significant association with PrEP interest.

4. Discussion

The current study demonstrates that PWID are largely unaware of PrEP, but tend to be interested upon awareness. This finding is consistent with the broader literature, reinforcing the understanding that education around PrEP for PWID is sorely lacking (Kuo et al., 2016; Walters et al., 2017b). From our overall sample, only two participants were currently taking PrEP. This low prevalence is particularly striking, as our sample consisted largely of PWID who were already engaged in HIV prevention services. Our results point to the need of integrating more educational efforts about PrEP into existing services for PWID, like SSPs, overdose prevention/response services, and HIV testing/counseling programs. Though increased awareness will likely lead to increased interest in PrEP, educational efforts alone are insufficient to increase PrEP uptake among PWID. Education must be paired with easy access, otherwise PWID will still face the numerous barriers to care, such as a lack of financial resources and discrimination from healthcare providers (Bruggmann, 2012). Thus, low threshold PrEP services beyond education are sorely needed at SSPs and other sites that provide

**Table 2**  
Socio-demographic characteristics of PWID in Baltimore, Maryland, by PrEP eligibility and interest.

	Total (n = 265)	Eligible (n = 113)	Not Eligible (n = 152)		Interested (n = 164)	Not Interested (n = 95)	
	N (%)	N (%)	N (%)	p	N (%)	N (%)	p
<b>Age</b>							
18-34	71 (26.8)	42 (37.2)	29 (19.1)	0.002	45 (27.4)	25 (26.3)	0.99
35-44	60 (22.6)	28 (24.8)	32 (21.1)		36 (22.0)	22 (23.2)	
45-54	89 (33.6)	31 (27.4)	58 (38.2)		55 (33.5)	31 (32.6)	
55 and older	45 (17.0)	12 (10.6)	33 (21.7)		28 (17.1)	17 (17.9)	
<b>Sex</b>							
Male	180 (67.9)	69 (61.1)	111 (73.0)	0.04	109 (66.5)	68 (71.6)	0.39
Female	85 (32.1)	44 (38.9)	41 (27.0)		55 (33.5)	27 (28.4)	
<b>Race/Ethnicity</b>							
Black	145 (54.7)	48 (42.5)	99 (63.8)	0.002	84 (51.2)	57 (60.0)	0.26
White	106 (40.0)	59 (52.2)	47 (30.9)		69 (42.1)	35 (36.8)	
Other	14 (5.3)	6 (5.3)	8 (5.3)		11 (6.7)	3 (3.2)	
<b>Educational Attainment</b>							
Less than HS	103 (38.9)	37 (32.7)	66 (43.4)	0.20	62 (37.8)	38 (40.0)	0.40
12 <sup>th</sup> grade or GED	111 (41.9)	51 (45.1)	60 (39.5)		73 (44.5)	35 (36.8)	
Some college or more	51 (19.3)	25 (22.1)	26 (17.1)		29 (17.7)	22 (23.2)	
<b>Sexual Orientation</b>							
Heterosexual	244 (92.1)	100 (88.5)	144 (94.7)	0.06	151 (92.1)	87 (91.6)	0.89
Gay/Lesbian/Bisexual/Queer	21 (7.9)	13 (11.5)	8 (5.3)		13 (7.9)	8 (8.4)	
<b>Employment Status</b>							
Full Time	21 (7.9)	8 (6.3)	15 (8.8)	0.65	8 (4.9)	13 (13.7)	0.04
Part Time	32 (12.1)	13 (10.2)	20 (11.7)		21 (12.8)	11 (11.6)	
Not Employed	212 (80.0)	106 (83.5)	136 (19.5)		135 (82.3)	71 (74.7)	
<b>Homeless</b>	89 (33.6)	46 (40.7)	43 (28.3)	0.03	65 (39.6)	23 (24.2)	0.01
<b>Single Marital Status</b>	169 (64.3)	63 (55.8)	106 (70.7)	0.01	101 (62.4)	63 (66.3)	0.52
<b>Baltimore SSP Clients</b>	176 (66.4)	76 (67.3)	100 (65.8)	0.80	110 (67.1)	63 (66.3)	0.90
<b>Insurance</b>							
None	56 (21.7)	23 (20.9)	33 (22.3)	0.77	31 (19.6)	25 (26.6)	0.40
Medicaid Only	127 (49.2)	57 (51.8)	70 (47.3)		81 (51.3)	42 (44.7)	
Other	75 (29.1)	30 (27.3)	45 (30.4)		46 (29.1)	27 (28.7)	
<b>Number of Medical Diagnoses, M(SD)</b>	2.52 (2.26)	2.54 (2.18)	2.5 (2.32)	0.89	2.73 (2.36)	2.12 (2.02)	0.04

Note. Marital status and insurance had n = 2 and n = 7 participants missing data respectively. All other variables were complete.

services to this population.

Furthermore, the majority of our sample believed that it would be easy to take PrEP every day. This finding is important, as it provides evidence that PrEP compliance among PWID is feasible. One common argument against implementing PrEP for PWID is that persons would not comply with the required drug regimen and render the prophylaxis less effective (Guise et al., 2017). Our results argue against this, as our participants largely believed that they could easily take a pill every day. This is particularly notable, given the high prevalence of homelessness in our sample, indicating that PWID who have unstable living situations still feel that they are able to comply with daily medication regimens. Further research on PrEP compliance is still needed as our results suggest that compliance is feasible, but do not conclusively evaluate feasibility.

We identified correlates of PrEP eligibility that can inform interventions and services for PWID. In particular, those eligible for PrEP were more likely to have overdosed and been in inpatient rehabilitation, in addition to demographic differences. By identifying ways in which PWID at high risk for acquiring HIV interact with service systems, we can determine where it may be beneficial to integrate PrEP with existing services. We found that drug treatment facilities and places that provide overdose services may be locations where PrEP services for PWID can potentially be integrated efficiently. To date, only a few studies have examined PrEP awareness and interest in substance use treatment settings at all, but these studies do indicate that only a small portion of individuals in treatment are aware of PrEP but about half would be interested in taking it (Shrestha et al., 2017; Stein et al., 2014). This disparity between awareness and interest highlights the importance of providing PrEP services as part of drug treatment. Integrating PrEP into existing services may be a more cost effective and efficient approach to making PrEP accessible to PWID, especially given

the high level of interest in such settings (Shrestha et al., 2017).

Our results also speak to the self-awareness of PWID about their own health risks. Importantly, eligibility for PrEP was a significant correlate of interest in PrEP even when accounting for other factors. The PrEP eligible individuals in our sample were at the highest risk for HIV infection, as they reported sharing injection equipment. From this, we can understand that PWID recognize their risk for HIV and are consequently interested in ways to protect themselves from becoming infected. This finding argues against the traditional understanding that PWID generally have poor self-awareness or insight into their health behaviors and risks. Our results suggest that PWID do in fact have good insight into their personal risk for HIV, but direct evaluations of this are still needed. These findings reflect existing literature that indicates PWID are able to identify their own HIV risk and take self-protective behaviors (Abdul-Quader et al., 2013; Booth and Wiebel, 1992; Friedman et al., 1999; Latkin et al., 2003).

Health comorbidities were also significantly correlated with PrEP interest. Interest in PrEP increased with each additional medical diagnosis an individual had received. The potential implications of this finding are twofold. First, individuals who have other physical health problems may be more aware of their health and potential health risks. This increased health awareness may lead PWID with comorbid health problems to be more interested in taking preventative measures to ensure their health. Studies in other populations have in fact demonstrated that increased health awareness is associated with increased positive health behaviors (Mosca et al., 2006). Second, individuals who have received a diagnosis from a doctor may be more engaged with the health care system. Thus, these individuals may have better access to health care and consequently feel that PrEP is a feasible option for them. They may also have received some information about PrEP during their health care interactions. The lack of significance in the

**Table 3**  
Drug use, overdose, and HIV risk behaviors among PWID in Baltimore, Maryland by PrEP eligibility and interest.

	Total (n = 265) N (%)	Eligible (n = 113) N (%)	Not Eligible (n = 152) N (%)	p	Interested (n = 164) N (%)	Not Interested (n = 95) N (%)	p
<b>Injection Drug Use in Past 6 Months</b>							
Heroin	247 (93.9)	108 (95.6)	139 (92.7)	0.33	158 (96.9)	84 (88.4)	0.01
Cocaine	137 (51.9)	76 (67.3)	61 (40.4)	< 0.001	93 (57.1)	42 (44.2)	0.05
Speedball	155 (58.7)	81 (71.7)	74 (49.0)	< 0.001	102 (62.6)	51 (53.7)	0.16
Prescription Opioids	33 (12.5)	14 (12.4)	19 (12.6)	0.96	25 (15.3)	8 (8.4)	0.11
<b>Non-injection Drug Use in Past 6 Months</b>							
Marijuana	133 (50.2)	57 (50.4)	76 (50.0)	0.94	90 (54.9)	41 (43.2)	0.07
Crack Cocaine	142 (53.6)	77 (68.1)	65 (42.8)	< 0.001	95 (57.9)	46 (48.4)	0.14
Heroin	103 (39.0)	48 (42.5)	55 (36.4)	0.32	69 (42.3)	31 (32.6)	0.12
Prescription Opioids	83 (31.4)	41 (36.6)	42 (27.6)	0.12	62 (37.8)	20 (21.3)	0.01
Cocaine	54 (20.5)	20 (17.9)	34 (22.4)	0.37	34 (20.9)	19 (20.0)	0.87
Buprenorphine/Suboxone	70 (26.4)	38 (33.6)	32 (21.1)	0.02	49 (29.9)	20 (21.1)	0.12
Tranquilizers	87 (33.0)	41 (36.6)	46 (30.3)	0.28	63 (38.7)	23 (24.2)	0.02
<b>Main Injection Location</b>							
Private ( <i>own or other's home</i> )	141 (56.0)	46 (41.8)	95 (66.9)	< 0.001	79 (49.7)	59 (67.1)	0.02
Semi-Public ( <i>public bathroom, abandoned building, vehicle</i> )	86 (34.1)	47 (42.7)	39 (27.5)		64 (40.3)	21 (23.9)	
Public ( <i>street, park, stairwell, shooting gallery</i> )	25 (9.9)	17 (15.5)	8 (5.6)		16 (10.1)	8 (9.1)	
<b>Injection-related HIV Risk Behaviors</b>							
Shared Cottons in Past 30 Days	82 (31.1)	–	–	–	63 (38.4)	17 (18.1)	0.001
Shared Cookers in Past 30 Days	104 (39.4)	–	–	–	76 (46.3)	25 (26.6)	0.002
Times injected with a shared needle in past 30 days, <i>M(SD)</i>	3.2 (16.2)	–	–	–	5.0 (20.3)	0.2 (0.7)	0.02
<b>Drug Overdose History</b>							
Ever overdosed	148 (56.1)	77 (68.8)	71 (46.7)	< 0.001	102 (62.6)	44 (46.3)	0.01
Overdosed in past 12 months	83 (31.3)	46 (40.7)	37 (24.3)	0.004	62 (37.8)	20 (21.1)	0.005
Received Naloxone for last overdose (n = 147)	83 (56.5)	38 (50.0)	45 (63.4)	0.10	58 (56.3)	25 (58.1)	0.84
Went to emergency room for last overdose (n = 148)	53 (36.1)	25 (32.5)	28 (40.0)	0.34	39 (38.2)	14 (31.8)	0.46
<b>Drug Treatment in Past 12 Months</b>							
Inpatient Hospital	18 (6.8)	10 (8.9)	8 (5.3)	0.25	13 (7.9)	5 (5.3)	0.42
Inpatient Rehab	23 (8.7)	15 (13.3)	8 (5.3)	0.02	18 (11.0)	5 (5.3)	0.12
Outpatient Treatment	83 (31.3)	36 (31.9)	47 (30.9)	0.87	49 (29.9)	31 (32.6)	0.64

Note. Missing data was as follows: n = 1 missing for injection cocaine, speedball, and prescription opioids, non-injection heroin, cocaine, prescription opioids, and tranquilizers, shared cottons and cookers, and ever overdosed; n = 2 missing for injection heroin; n = 11 missing for times injected with a shared needle; n = 13 missing for main injection location. All other variables were complete.

relationship between insurance status and PrEP interest is of note. It is likely that the study population is more likely to receive healthcare in ERs than through provider visits, so that even having insurance is not associated with exposure and therefore interest in PrEP.

The results should be viewed in light of several limitations. First, we

could not assess all dimensions of the CDC PrEP eligibility criteria. The CDC recommends PrEP for those who are receiving medication assisted treatments and who are at high risk for sexual transmission of HIV, in addition to those at risk for HIV due to sharing injection equipment. Our survey instrument did not have measures of sexual risk for HIV, so

**Table 4**  
Bivariate and multivariate logistic regression results for correlates on PrEP Interest (N = 252).

	Bivariate Models			Multivariate Model		
	OR	95% CI	p-value	aOR	95% CI	p-value
<b>Age</b>						
18-34	REF	–	–	REF	–	–
35-44	0.91	0.44, 1.87	0.80	1.18	0.51, 2.73	0.69
45-54	0.99	0.51, 1.90	0.97	1.58	0.63, 4.01	0.33
55 and older	0.92	0.42, 1.99	0.82	1.53	0.54, 4.31	0.43
<b>Sex</b>						
Male	REF	–	–	REF	–	–
Female	1.27	0.73, 2.21	0.39	1.20	0.65, 2.22	0.57
<b>Race/Ethnicity</b>						
White	REF	–	–	REF	–	–
Black	0.75	0.44, 1.27	0.28	0.96	0.46, 2.00	0.91
Other	1.86	0.49, 7.10	0.36	3.73	0.62, 22.42	0.15
Meets PrEP Eligibility Criteria	2.58	1.50, 4.43	0.001	2.46	1.34, 4.50	0.003
Homeless	2.06	1.17, 3.61	0.01	1.95	1.00, 3.83	0.05
Overdose in past 12 months	2.28	1.27, 4.09	0.01	1.64	0.84, 3.19	0.15
Injects Drugs Daily	2.02	0.97, 4.21	0.06	1.65	0.72, 3.76	0.24
<b>Insurance</b>						
None	REF	–	–	REF	–	–
Medicaid Only	1.56	0.82, 2.97	0.18	1.57	0.76, 3.24	0.22
Other	1.37	0.68, 2.79	0.38	1.38	0.61, 3.15	0.44
Number of Medical Diagnoses, <i>M(SD)</i>	1.14	1.01, 1.29	0.04	1.16	1.01, 1.33	0.04

Note: OR = odds ratio, aOR = adjusted odds ratio.

we were unable to assess the sexual risk criteria. As we did not measure medication assisted treatment/treatment compliance for our sample, we were also unable to assess this aspect of the CDC criteria. Thus, some individuals in our sample may be misclassified. Despite this, our classification criteria likely capture the majority of participants who are eligible for PrEP. Few participants reported any drug treatment on other measures, so it is unlikely that a significant portion of our sample would be eligible due to their participation in medication assisted treatment. Our sensitivity analysis supported this, as our results did not change when participants who had received any inpatient treatment were included in the eligible group. Injection related risk for HIV has been shown to be more important for transmission among males, while sexual risk behaviors tend to be more salient for females (Strathdee et al., 2001). As our sample was primarily male, we would not expect these limitations to significantly impact our results. Nonetheless, PWID do have a high sexual risk for HIV, so there may be some misclassification that future studies should address (Des Jarlais et al., 2011; Neaigus et al., 2013). Misclassification may explain the change in the significance of homelessness on PrEP interest between our primary and sensitivity analyses. There may also have been some social desirability bias present in our measures of use of PrEP.

Our results have multiple implications for HIV prevention policy. First, given the association between the number of medical diagnoses and PrEP interest, policies should be implemented that support the integration of PrEP with other medical services, especially with overdose services. Integrating PrEP services across the healthcare landscape may lead to enhanced PrEP access and utilization among PWID. Second, efforts should be undertaken to improve the ability of homeless persons to access PrEP services. Lastly, existing SSPs and other services for PWID should integrate low-threshold PrEP services, including providing education and referrals, to further support their harm reduction mission.

Future research needs to further explore important opportunities to contact individuals who are likely to be both interested and eligible for PrEP. Identifying targeted ways to engage PWID as well as where best to engage persons who are at particularly high risk for HIV in PrEP care is a key strategy to improve the cost effectiveness of PrEP in this population. In addition, research should continue to identify barriers to PrEP access and engagement and successful strategies for overcoming these prevention barriers. While this paper only addressed oral PrEP, future research should also assess the acceptability of injectable PrEP for PWID, as their familiarity with needles may make this a more a population where PrEP injections may be particularly viable. Moreover, research also needs to address how continuums of PrEP care developed for other populations can be applied to PWID in order to maximize health.

PrEP is a valuable tool to combat HIV among PWID; however, there has been insufficient education about PrEP and integration of PrEP into existing services for PWID. Most PWID in Baltimore, MD are unaware of PrEP but are interested in taking it to prevent HIV. Being at increased risk for HIV, particularly through sharing injection equipment, is associated with increased interest in PrEP, suggesting that PWID have insight into their own HIV risk. Drug treatment facilities and overdose services should integrate PrEP services into their existing programs, as individuals attending these programs are likely to be interested in PrEP, eligible for it, or both. Increasing PrEP access and use amongst PWID is important to the future of HIV prevention in the context of the current opioid epidemic.

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#### Contributors

SGS is the principle investigator of the study that collected the data used. JNP and STA contributed to data collection. KES conducted the analysis, with guidance from SGS, JNP, STA, and BWW. All authors contributed to writing the manuscript. All authors approved the final manuscript before submission.

#### Conflict of Interest

No financial disclosures were reported by the authors of this paper.

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#### References

- Abdul-Quader, A.S., Feelemyer, J., Modi, S., Stein, E.S., Briceno, A., Semaan, S., Horvath, T., Kennedy, G.E., Des Jarlais, D.C., 2013. Effectiveness of structural-level needle/syringe programs to reduce HCV and HIV infection among people who inject drugs: A systematic review. *AIDS Behav.* 17, 2878–2892.
- Bernard, C.L., Brandeau, M.L., Humphreys, K., Bendavid, E., Holodny, M., Weyant, C., Owens, D.K., Goldhaber-Fiebert, J.D., 2016. Cost-effectiveness of HIV preexposure prophylaxis for people who inject drugs in the United States. *Ann. Intern. Med.* 165, 10–19.
- Booth, R., Wiebel, W.W., 1992. Effectiveness of reducing needle-related risks for HIV through indigenous outreach to injection drug users. *Am. J. Addict.* 1, 277–287.
- Bruggmann, P., 2012. Accessing Hepatitis C patients who are difficult to reach: It is time to overcome barriers. *J. Viral. Hepat.* 19, 829–835.
- Cáceres, C.F., Koechlin, F., Goicochea, P., Sow, P.-S., O'Reilly, K.R., Mayer, K.H., Godfrey-Faussett, P., 2015. The promises and challenges of pre-exposure prophylaxis as part of the emerging paradigm of combination HIV prevention. *J. Int. AIDS Soc.* 18 (Suppl. 3), 19949.
- Canary, L., Hariri, S., Campbell, C., Young, R., Whitcomb, J., Kaufman, H., Vellozzi, C., 2017. Geographic disparities in access to syringe services programs among young persons with hepatitis c virus infection in the United States. *Clin. Res. Infect. Dis.* 65, 514–517.
- Centers for Disease Control and Prevention (CDC), 2014. Preexposure prophylaxis for the prevention of HIV infection in the United States-2014: A clinical practice guideline. <https://www.cdc.gov/hiv/pdf/guidelines/PrEPguidelines2014.pdf>.
- Centers for Disease Control and Prevention (CDC), 2016. Diagnoses of HIV infection in the United States and dependent areas, 2015. *HIV Surveill. Rep.* 27, 1–114.
- Choopanya, K., Martin, M., Suntharasamai, P., Sangkum, U., Mock, P.A., Leethochawalit, M., Chiamwongpaet, S., Kitisin, P., Natrujirrote, P., Kittimunkong, S., 2013. Antiretroviral prophylaxis for HIV infection in injecting drug users in Bangkok, Thailand (the Bangkok Tenofovir Study): A randomised, double-blind, placebo-controlled phase 3 trial. *Lancet* 381, 2083–2090.
- Compton, W.M., Jones, C.M., Baldwin, G.T., 2016. Relationship between nonmedical prescription-opioid use and heroin use. *N. Engl. J. Med.* 2016, 154–163.
- Des Jarlais, D.C., Arasteh, K., McKnight, C., Hagan, H., Perlman, D.C., Semaan, S., 2011. 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* 101, 1277–1283.
- Des Jarlais, D.C., Nugent, A., Solberg, A., Feelemyer, J., Mermin, J., Holtzman, D., 2015. Syringe service programs for persons who inject drugs in urban, suburban, and rural areas—United States, 2013. *MMWR Morb. Mortal. Wkly. Rep.* 64, 1337–1341.
- Eisingerich, A.B., Wheelock, A., Gomez, G.B., Garnett, G.P., Dybul, M.R., Piot, P.K., 2012. Attitudes and acceptance of oral and parenteral HIV preexposure prophylaxis among potential user groups: A multinational study. *PLoS One* 7, e28238.
- Escudero, D.J., Kerr, T., Wood, E., Nguyen, P., Lurie, M.N., Sued, O., Marshall, B.D., 2015. Acceptability of HIV pre-exposure prophylaxis (PrEP) among people who inject drugs (PWID) in a Canadian setting. *AIDS Behav.* 19, 752–757.
- Fernandes, R.M., Cary, M., Duarte, G., Jesus, G., Alarcão, J., Torre, C., Costa, S., Costa, J., Carneiro, A.V., 2017. Effectiveness of needle and syringe programmes in people who inject drugs—An overview of systematic reviews. *BMC Public Health* 17, 309.
- Food and Drug Administration (FDA), 2014. Truvada for PrEP fact sheet: Ensuring safe and proper use. United States Department of Health and Human Services, Washington D.C. <https://www.fda.gov/downloads/Drugs/DrugSafety/PostmarketDrugSafetyInformationforPatientsandProviders/UCM312290.pdf>.
- Friedman, S.R., Neaigus, A., Jose, B., Curtis, R., Ildefonso, G., Goldstein, M., Des Jarlais, D.C., 1999. Networks, norms and solidaristic/altruistic action against AIDS among the demonized. *Sociol. Focus* 32, 127–142.
- Gibson, D.R., Flynn, N.M., Perales, D., 2001. Effectiveness of syringe exchange programs in reducing HIV risk behavior and HIV seroconversion among injecting drug users. *AIDS* 15, 1329–1341.

- Grant, R.M., Lama, J.R., Anderson, P.L., McMahan, V., Liu, A.Y., Vargas, L., Goicochea, P., Casapia, M., Guanira-Carranza, J.V., Ramirez-Cardich, M.E., 2010. Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. *N. Engl. J. Med.* 363, 2587–2599.
- Guise, A., Albers, E.R., Strathdee, S.A., 2017. 'PrEP is not ready for our community, and our community is not ready for PrEP': Pre-exposure prophylaxis for HIV for people who inject drugs and limits to the HIV prevention response. *Addiction* 112, 572–578.
- Kuo, I., Olsen, H., Patrick, R., Phillips, G., Magnus, M., Opoku, J., Rawls, A., Peterson, J., Hamilton, F., Kharfen, M., 2016. Willingness to use HIV pre-exposure prophylaxis among community-recruited, older people who inject drugs in Washington, DC. *Drug Alcohol Depend.* 164, 8–13.
- Latkin, C.A., Sherman, S., Knowlton, A., 2003. HIV prevention among drug users: Outcome of a network-oriented peer outreach intervention. *Health Psychol.* 22, 332.
- MacDonald, M., Law, M., Kaldor, J., Hales, J., Dore, G.J., 2003. Effectiveness of needle and syringe programmes for preventing HIV transmission. *Int. J. Drug Policy* 14, 353–357.
- Mathers, B.M., Degenhardt, L., Phillips, B., Wiessing, L., Hickman, M., Strathdee, S.A., Wodak, A., Panda, S., Tyndall, M., Toufik, A., 2008. Global epidemiology of injecting drug use and HIV among people who inject drugs: a systematic review. *Lancet* 372, 1733–1745.
- Meyers, K., Golub, S.A., 2015. Planning ahead for implementation of long acting HIV prevention: Challenges and opportunities. *Curr. Opin. HIV AIDS* 10, 290.
- Mosca, L., Mochari, H., Christian, A., Berra, K., Taubert, K., Mills, T., Burdick, K.A., Simpson, S.L., 2006. National study of women's awareness, preventive action, and barriers to cardiovascular health. *Circulation* 113, 525–534.
- Neaigus, A., Reilly, K.H., Jenness, S.M., Hagan, H., Wendel, T., Gelpi-Acosta, C., 2013. Dual HIV risk: Receptive syringe sharing and unprotected sex among HIV-negative injection drug users in New York City. *AIDS Behav.* 17, 2501–2509.
- Parsons, V.L., Moriarity, C.L., Jonas, K., Moore, T.F., Davis, K.E., Tompkins, L., 2014. Design and estimation for the national health interview survey, 2006–2015. *Vital. Health Stat.* 2, 165.
- Shrestha, R., Karki, P., Altice, F.L., Huedo-Medina, T.B., Meyer, J.P., Madden, L., Copenhagen, M., 2017. Correlates of willingness to initiate pre-exposure prophylaxis and anticipation of practicing safer drug-and sex-related behaviors among high-risk drug users on methadone treatment. *Drug Alcohol Depend.* 173, 107–116.
- StataCorp, 2015. Stata Statistical Software: Release 14. StataCorp LP. College Station, TX.
- Stein, M., Thurmond, P., Bailey, G., 2014. Willingness to use HIV pre-exposure prophylaxis among opiate users. *AIDS Behav.* 18, 1694–1700.
- Strathdee, S.A., Galai, N., Safaiean, M., Celentano, D.D., Vlahov, D., Johnson, L., Nelson, K.E., 2001. Sex differences in risk factors for HIV seroconversion among injection drug users: A 10-year perspective. *Arch. Intern. Med.* 161, 1281–1288.
- Van Handel, M.M., Rose, C.E., Hallisey, E.J., Kolling, J.L., Zibbell, J.E., Lewis, B., Bohm, M.K., Jones, C.M., Flanagan, B.E., Siddiqi, A.-E., 2016. County-level vulnerability assessment for rapid dissemination of HIV or HCV infections among persons who inject drugs, United States. *J. AIDS* 73, 323–331.
- Walters, S.M., Reilly, K.H., Neaigus, A., Braunstein, S., 2017a. Awareness of pre-exposure prophylaxis (PrEP) among women who inject drugs in NYC: the importance of networks and syringe exchange programs for HIV prevention. *Harm Reduct. J.* 14, 40.
- Walters, S.M., Rivera, A.V., Starbuck, L., Reilly, K.H., Boldon, N., Anderson, B.J., Braunstein, S., 2017b. Differences in awareness of pre-exposure prophylaxis and post-exposure prophylaxis among groups at-risk for HIV in New York State: New York City and Long Island, NY, 2011–2013. *J. AIDS.* 75, S383–S391.