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Substance Use and Healthcare Utilization Across the Pre-Exposure Prophylaxis (PrEP) Care Cascade among Black and Latino Men Who Have Sex with Men

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ABSTRACT

Background: Despite the documented efficacy of pre-exposure prophylaxis (PrEP) for HIV prevention, large disparities in uptake and adherence exist among Black and Latino/Hispanic men who have sex with men (BLMSM). Limited data exists among BLMSM on the impact of substance use at different stages of the PrEP Care Cascade. We examined the ways substance (alcohol, cannabis, other drug) use is related to PrEP experiences across the PrEP Care Cascade (PrEP aware/no use; PrEP use/discontinuation; PrEP use/adherent). **Methods:** We utilized data from a national sample of 908 BLMSM ($M_{\text{age}} = 25.17$, range: 18–29), collected between February and October 2020. **Results:** We found that heavier alcohol use, more other drug (e.g., cocaine) use, more participant healthcare utilization, and higher number of partners across all measures of substance use were separately associated with a lower likelihood of being aware of PrEP. These same factors were also associated with a higher likelihood of PrEP adherence. Conversely, only cannabis use was associated with discontinuation of PrEP use. **Conclusions:** While we confirm some earlier findings (i.e., alcohol use is associated with both PrEP discontinuation and PrEP use), we newly identify cannabis as a barrier to the adherence of PrEP. Our findings highlight the need for improved PrEP interventions to increase awareness among BLMSM with substance use who are among the most at-risk for HIV infection.

KEYWORDS

HIV prevention; PrEP; MSM; Black; Latino; healthcare

Introduction

The use of pre-exposure prophylaxis (PrEP) is highly effective at preventing acquisition of HIV, with studies suggesting effectiveness rates upwards of 92% or higher (Grant et al., 2010). However, suboptimal levels of awareness, use, and adherence persist across populations of men who have sex with men (MSM). Disparities in PrEP uptake are attributable to several factors, such as medical mistrust (Kimball et al., 2020), PrEP stigma (Eaton et al., 2017), racism in healthcare (Calabrese et al., 2018), and substance use (Oldfield & Edelman, 2021). Further compounding suboptimal use of PrEP are racial and ethnic disparities in PrEP use—data from the National HIV Behavioral Surveillance (NHBS) study suggest that, among MSM who discussed PrEP with their medical providers, Black MSM had the lowest rates of use (55%), compared to White (68%) and Latino MSM (62%; Kanny et al., 2019). Further work examining trends in PrEP uptake over time demonstrated similar findings with the lowest rate of uptake among Black MSM (6.6%) relative to their White (11.5%) and Latino/Hispanic (9.7%) MSM counterparts (Morgan et al., 2018). Black MSM also

report the highest rates of PrEP discontinuation (Morgan et al., 2018). Meanwhile, scholarship has examined barriers to PrEP use among Black and/or Latino MSM (BLMSM)—such as concerns about its efficacy, perceived stigma associated with its use (Lelutiu-Weinberger & Golub, 2016), and potential discordance between perceived and actual risk of HIV acquisition (Oostrom et al., 2020).

Recent literature suggests these racial and ethnic differences may be attributable to the complex interplay between substance use and PrEP, although findings vary and data are limited (Willie et al., 2021). For example, one study that examined the median days to PrEP discontinuation among a diverse cohort of patients in primary care clinics in San Francisco, CA observed two key findings related to racial and ethnic differences. Specifically, the group with the lowest median days to discontinuation included patients who reported drug use (178 days) compared to those who did not use drugs (285 days); for race, Black patients reported lower median days to discontinuation (120 days) relative to White (330 days) and Latino (188 days) patients (Scott et al., 2019). These data suggest those with substance use who are racial/ethnic minorities may be at greatest risk of PrEP

discontinuation, yet little work has examined the effect of substance use on the PrEP Care Cascade.

The PrEP Care Cascade has multiple outcome related components including PrEP awareness, use, and adherence (Nunn et al., 2017). Research is needed to understand how behavioral components, such as substance use, influence each step in the cascade. Previous research (e.g., Oldfield & Edelman, 2021) has indicated that each step of the PrEP cascade presents unique barriers and challenges for intervention. In their scoping review, Oldfield and Edelman (2021) identified nuanced relations between substance use and stages of the PrEP Care Cascade. Participants who used drugs encountered unique barriers at each stage of the PrEP cascade; for example, overlapping stigmas related to HIV risk and alcohol use was identified as a key barrier in access to PrEP care, yet there were mixed findings regarding the impact of alcohol on PrEP adherence. Because the impact of drug and alcohol use has preliminarily been found to differ across the PrEP Care Cascade, it is meaningful to further disentangle intersections between substance and PrEP use across the cascade.

The intersection of the cascade and substance use have demonstrated mixed findings across each stage and by type of substance used. For example, findings from one study among all MSM suggest that those who consumed alcohol and used drugs were more likely to be aware of PrEP (Card et al., 2020). In another study, cannabis use was not found to have any association with PrEP awareness (Morgan et al., 2016). Researchers using a sample of Black MSM in New York City noted that problematic levels of alcohol use were associated with lower PrEP awareness, though no associations were found between awareness and any other substance use behaviors (Garnett et al., 2018).

Studies that have examined substance use in the context of PrEP adherence have arrived at similarly mixed conclusions. In a qualitative study oversampled for Black and Latino MSM that assessed patient perspectives on PrEP adherence and substance use, a salient theme emerged suggesting that participants attributed missed PrEP doses to the disruptive effect substance use had on their daily routines (Storholm et al., 2017). Conversely, work by Hoenigl et al. (2018) that assessed the effect of substance use on PrEP adherence among mostly White MSM observed no association between these two variables. A similar study focused on stimulant use among mostly White and Hispanic MSM and noted initial disparities in PrEP adherence between people with reported drug use and people without; however, these disparities decreased over time (Goodman-Meza et al., 2019). Still further research among MSM has observed no associations between PrEP adherence and alcohol (Grant et al., 2014; Grov et al., 2019; Hojilla et al., 2018; Okafor et al., 2020), cannabis (Grov et al., 2019; Okafor et al., 2020), or other drug use behaviors (Grant et al., 2014). Taken together, current literature is mixed on the influence of substance use on the PrEP Care Cascade with little specifically examining these relationships among those at greatest risk (i.e., BLMSM) for HIV acquisition.

Substance use may deter PrEP use for a number of reasons – in particular, literature has focused on interactive

toxicity beliefs and unintentional non-adherence. In one study (Kalichman & Eaton, 2017), three-quarters of a sample of MSM reported at least one interactive toxicity belief—they would not take PrEP because they believed mixing substances with anti-retrovirals may be toxic. Furthermore, MSM who use substances, especially when used at heavy levels, may unintentionally forget doses of their PrEP (Kalichman & Eaton, 2017; Tangmunkongvorakul et al., 2013).

The primary goal of this study was to determine the differential effects of substance use on the steps of the PrEP Care Cascade among a sample of young Black and/or Latino MSM. And while Black and Latino MSM likely have differing sets of needs and concerns regarding the PrEP cascade, this study serves as a key next step in filling a gap in the literature among this high-risk population. Secondly, we also aimed to identify other key characteristics that may be particularly relevant to each stage of the PrEP Care Cascade, such as healthcare utilization and the number of sex partners. Based on previous literature (Storholm et al., 2017), we hypothesized that increased reports of substance (i.e., alcohol, cannabis, and other drug) use would be associated with poorer outcomes across the PrEP Care Cascade; that is, participants who were only aware of PrEP or had taken PrEP but discontinued. Additionally, we expected that participants who utilized healthcare and reported more sexual partners would be more likely to use and adhere to PrEP given their potential perceived HIV risk and access to providers who could prescribe PrEP.

Methods

Study design and participant recruitment

Data were drawn from the *PrEP and Substance Use National Survey*, a comprehensive survey designed to advance understanding of experiences with HIV testing, PrEP use, substance use, mental health, and victimization among young BLMSM. Data were collected between March and August 2020 in partnership with the Human Rights Campaign, the nation's largest LGBTQ advocacy group and political lobbying organization in the United States. All respondents spoke English- and/or Spanish, were Black and/or Latino, were 18–29 years of age, resided in the United States, and reported having anal sex with another man at least once in the past 12 months at the time of survey completion.

BLMSM were invited to participate in an anonymous, online, self-report survey hosted by the survey website REDCap. Participants were recruited from national networks, several large mailing lists, and social media (Twitter, Facebook, and Instagram) with the assistance from Human Rights Campaign's wide-reaching network of community partners. State health departments, local community-based organizations, HIV centers, and other health centers sent a survey announcement to their members and clients to advertise the survey. For their participation, participants were provided a \$15 Amazon.com gift card. All study protocols were approved by the University of Connecticut Institutional Review Board.

Data screening and cleaning procedures

Given challenges with online recruitment and duplicate responses from humans (e.g., the same person using multiple e-mail addresses) and computers (e.g., bots or computer scripts written to complete a survey for the purpose of collecting incentives), the survey was designed a priori to prevent ineligible responders and bots from completing the survey through a multi-step consent and sorting process. This process included a response tree protocol that diverted participants who were ineligible by age, sex assigned at birth, ethnoracial identity, and last time having anal sex with a man. Two measures were developed to help identify whether responders were bots or humans. The first measure involved generating a random number within REDCap, unique to the person taking it, and asking the participant to repeat the number shown, but in words, into a textbox. Second, participants were asked to write about their first childhood memory.

Measures

Sexual orientation

To measure sexual orientation, participants were asked “Which of the following best describes your sexual orientation?” Participants could choose from “*Bisexual*,” “*Gay, same gender loving*,” “*Heterosexual or straight*,” “*Pansexual*,” “*Queer*,” “*Not sure or questioning*” or “*Other*.”

Gender identity

To measure gender identity, participants were asked, “What is your gender?” Response options included, “*Agender*,” “*Genderfluid*,” “*Genderqueer*,” “*Non-binary*,” “*Man*,” “*Transgender*,” “*Woman*” and “*Other*.”

Ethnicity/race

Two separate questions assessed ethnicity and race. First, participants were asked “Are you Hispanic/Latino?” Response options were “*No*” and “*Yes*.” All participants then were presented an item that read, “What is your race? (check all that apply).” Response options included, “*American Indian or Alaska Native*,” “*Asian*,” “*Black or African American*,” “*Native Hawaiian or other Pacific Islander*,” “*White*,” and “*None of these*.” Given the low percentages of some racial identities, we recoded this variable to include: “*White Hispanic/Latino*,” “*Black/Indigenous/People of Color (BIPOC) who also identified as Hispanic/Latino*,” and “*BIPOC who did not identify as Hispanic/Latino*.” Per recent recommendations regarding the inclusion of race and ethnicity in analytic models (Ross et al., 2020), we included the variable as a descriptive of the sample, but we did not hypothesize different patterns of PrEP or substance use across race/ethnicity.

PrEP Care Cascade

To measure where participants fell on the PrEP Care Cascade, a series of items were asked regarding their PrEP use. One item asked “Do you know what PrEP is?” with response

options of “*No*” and “*Yes*.” A separate question was asked of participants who reported that they were aware of PrEP: “Have you ever taken PrEP before, even if just one pill?” Response options were “*No*” and “*Yes*.” A third item asked participants who reported they had ever taken PrEP, “Do you currently take PrEP?” with response options of “*No*” and “*Yes*.” Last, PrEP adherence was measured using an item that asked participants who reported that they were currently using PrEP, “We know it is very common for people to miss or skip doses of medication. Thinking about taking PrEP, what percent of your PrEP medication would you say you have taken since starting PrEP? You can say anywhere from 0% meaning you have not taken any of your PrEP medication all the way up to 100% meaning you have taken every single dose of your PrEP medication. Or you may be anywhere between 0% and 100%.” Participants could write-in a numeric value between 0 (*least adherent*) to 100 (*most adherent*).

Alcohol use

The sum of three items from the Hazard Alcohol Use domain of the US AUDIT (Higgins-Biddle & Babor, 2018) was used to assess alcohol use among participants who reported lifetime alcohol use. The first item read, “How often do you have a drink containing alcohol?” with response options of 0 (*Never*), 1 (*Less than monthly*), 2 (*Monthly*), 3 (*Weekly*), 4 (*2–3 times a week*), 5 (*4–6 times a week*), and 6 (*Daily*). The second item read, “How many drinks containing alcohol do you have on a typical day when you are drinking?” with response options of 0 (*1 drink*), 1 (*2 drinks*), 2 (*3 drinks*), 3 (*4 drinks*), 4 (*5–6 drinks*), 5 (*7–9 drinks*), and 6 (*10 or more drinks*). The third question asked, “How often do you have six or more drinks on one occasion?” with response options of 0 (*Never*), 1 (*Less than monthly*), 2 (*Monthly*), 3 (*Weekly*), 4 (*2–3 times a week*), 5 (*4–6 times a week*), and 6 (*Daily*). The summed variable included a possible range from 0–12. Higher scores correspond to heavier alcohol use.

Cannabis use

Participants were asked, “In the past 3 months, how often have you used cannabis (cannabis, pot, grass, hash, etc.)?” Participants responded on a Likert scale, from 0 (*Never*), 1 (*Less than monthly*), 2 (*Monthly*), 3 (*Weekly*), 4 (*2–3 times a week*), 5 (*4–6 times a week*), and 6 (*Daily*).

Other drug use

To measure other drug use, we calculated a sum score of the number of participant-reported drugs used without a prescription. The selection of which drugs to include was informed by the National Institutes of Drug Abuse (NIDA)-modified ASSIST screener. Drugs included were cocaine, stimulants, methamphetamines, inhalants, sedatives/sleeping pills, hallucinogens, street opioids, prescription opioids, and medications to promote sexual functioning. Participants answered “*No*” or “*Yes*” to whether or not they had taken each substance in the past 3 months. These values were then summed together for a total drug use score with a possible range from 0 to 9.

Healthcare utilization

To measure participant health care utilization, one question asked, “About how long has it been since you last visited a health care provider for a routine checkup? A routine checkup is a general physical exam, not an exam for a specific injury, illness, or condition.” Response options included, 0 (*Never*), 1 (*More than 3 years ago*), 2 (*1–3 years ago*), 3 (*6–12 months ago*), 4 (*3–6 months ago*), and 5 (*Less than 3 months ago*). Participants who selected *Don’t know/Not sure* were treated as missing.

Number of partners

To measure the number of sexual partners, participants were asked, “In the past 3 months, how many total sex partners have you had? This includes oral, vaginal, or anal sex.” Participants could write-in their numeric number of partners. Responses ranged from 0 to 8.

Additional demographics

Income was measured by asking participants to report their annual income before taxes. Response options were, *Less than \$10,000*, *\$10,000 to \$15,000*, *\$15,001 to \$20,000*, *\$20,001 to \$25,000*, *\$25,001 to 35,000*, *\$35,001 to 50,000*, *\$50,001 to 75,000*, *\$75,001 to 100,000*, and *\$100,001 or more*. Region was created from participant reported zip codes; states were identified by each provided zip code and categorized into four regions: *West*, *Northeast*, *South*, and *Midwest*.

Participants and analytic sample

In total, 2,479 BLMSM aged 18–29 across the United States entered the survey website (e.g., consent page); among these respondents, 958 (38.6%) were not eligible to complete the survey because they were outside of the eligible age range (18–29 years old), did not reside in the United States at the time of survey attempt, and/or did not identify as a sexual and/or gender minority, resulting in 1,522 participants who were eligible and consented to participate. Among those eligible, 426 participants entered, but did not complete more than the first few survey questions, and were thus excluded. A final overall sample of $N=992$ BLMSM were available for analyses.

Some participants from the larger sample of 992 were excluded from the analyses that are presented in this article. Participants who reported living with HIV ($n=84$) were excluded given our focus on PrEP, bringing the analytic sample to $N=908$. Further, 134 participants did not provide complete responses to determine where along the PrEP Care Cascade they fell. Given our online survey included a large battery of questions related to health experiences, we expect that the missing data on the PrEP cascade items was due to either participants skipping some survey questions, not completing enough of the survey to be presented the PrEP items, or not fully understanding what PrEP was. However, those missing on the PrEP cascade ($n=134$) were more likely to identify as “not sure/questioning” regarding their sexual orientation. No other

differences in missingness based on sexual orientation, race and/or ethnicity, income, or employment status were found. In reporting the mean differences of study variables, we illustrated the mean values in study variables among a smaller set ($n=774$) of BLMSM who reported valid responses to the PrEP Care Cascade.

To define the PrEP Care Cascade, we utilized four PrEP items to create mutually exclusive groups. First, those participants who reported knowing what PrEP was, but had never taken PrEP, were defined by *PrEP Awareness* (Group 1, $n=390$). Those participants who reported having taken PrEP in the past, but who were no longer currently taking PrEP were defined by *PrEP Discontinuation* (Group 2, $n=140$). Given literature that has found that PrEP efficacy is up to 96% when PrEP is taken 4 of 7 days a week (57% of the time), adherent PrEP use was defined as taking 57% or more of prescribed PrEP doses (Anderson et al., 2012; Buchbinder, 2018; Parsons et al., 2017). Of those participants who reported currently taking PrEP, 98% met this adherent threshold. These individuals were defined as *PrEP Adherent* (Group 3, $n=224$). Those participants who reported current PrEP use but reported using < 57% of their PrEP medication doses ($n=16$) were not included in any of the three groups, and were too small of a group to constitute a 4th group on our PrEP Care Cascade. On average, these participants took their PrEP doses as prescribed only 35% of the time. Finally, four participants were unaware of PrEP and were also removed.

Analytic strategy

We first report descriptive statistics of participants included in the overall sample. We then report the mean differences across study variables grouped by PrEP experiences. All variables were examined to ensure that they had acceptable levels of skew and kurtosis (Behrens, 1997). Outliers were Winsorized (i.e., outliers were adjusted rather than trimmed) to fall 1.5 times the interquartile range below the 25th percentile or above the 75th percentile. To determine collinearity, we examined VIF scores using the commonly accepted cutoff of 10 (Hair et al., 2010) and identified no elevations. We assessed our research questions through a series of logistic regressions using the statistical program MPlus v.8 (Muthén & Muthén, 1998–2001). Consistent with other work examining a PrEP Care Cascade (Blashill et al., 2020), we conducted a series of separate logistical regression models for each of the Care Cascade groups. Prior work examining a PrEP Care Cascade has used this same analytic approach and thus we opted to replicate this analytic strategy accordingly (Blashill et al., 2020; Kimball et al., 2020; Parmley et al., 2022). To test the hypothesized associations between substance use and each of the three cascade group memberships, we used the following model:

$$Y = \beta_0 + \beta_1 (\text{healthcare utilization}) + \beta_2 (\text{number of partners}) + \beta_3 (\text{other drug use}) + \beta_4 (\text{alcohol use}) + \beta_5 (\text{cannabis})$$

Data presented as part of our logistic regression models were performed using multiple imputation (MI) procedures. MI is used to estimate missing data (Graham et al., 2007; Little et al., 2014; Schafer & Graham, 2002) given 18.5% of data were missing due to skipped responses. Differences were found for age, ethnicity, and sexual orientation between missing and non-missing data (e.g., younger participants were more likely to contain missing data, Hispanic/Latino participants were less likely to have missing data). To address these differences and to maximize the likelihood of meeting the assumption that the data were missing at random, relevant auxiliary variables (e.g., age, sexual orientation, gender identity, minority stress, mental health symptoms) were included in our MI (Collins et al., 2001). One hundred MI datasets were generated using the software program Amelia II (Honaker et al., 2011), and the results of the analyses of the 100 datasets were averaged using MPlus per Rubin's Rules (Rubin, 1987).

Results

The reported descriptive statistics reflect the original dataset prior to MI procedures (see Table 1 for full demographics; $N=908$). Participants were between the ages of 18–29 years

Table 1. Sociodemographic information for the total analytic sample ($N=908$).

	M=25.16	SD = 2.78
Age	n	%
Latino/Hispanic		
Yes	594	59.9
No	398	40.1
Race		
American Indian/Alaskan Native	34	3.4
Asian	6	0.6
Black/African American	408	41.4
Native Hawaiian/ Pacific Islander	3	0.3
White (Hispanic/Latino)	263	26.5
Non-White Hispanic/Latino	195	19.7
Biracial	66	6.7
Multiracial	17	1.7
Sexual Orientation		
Bisexual	125	12.6
Gay/same gender loving	754	76.0
Heterosexual	10	1.0
Pansexual	42	4.2
Queer	40	4.0
Questioning	15	1.5
Something else	6	0.6
Region		
West	240	24.2
Midwest	105	10.6
South	513	51.7
Northeast	124	12.5
Education Status		
Never attended school	2	0.2
Less than high school	10	1.0
High school or GED	146	14.7
Some college/technical school	337	34.0
College degree	380	38.3
Graduate school	117	11.8
PrEP Care Cascade (total $n=774$)		
PrEP Awareness	390	50.4
PrEP Discontinuation	140	18.1
PrEP Adherent	244	31.5

Note. This table excludes participants who were living with HIV.

Table 2. Differences in substance use, healthcare utilization, and number of partners of participants across the PrEP Care Cascade.

	Overall M (SD)	Descriptive statistics by group		
		PrEP awareness (Group 1, $n=390$)	PrEP discontinuation (Group 2, $n=140$)	PrEP adherent (Group 3, $n=244$)
Alcohol use	5.74 (3.43)	5.62 (3.27)	5.90 (3.45)	6.66 (3.15)
Other drug use	1.33 (1.13)	1.09 (1.09)	1.16 (1.07)	1.66 (1.09)
Cannabis use	1.91 (2.30)	1.87 (2.24)	2.24 (2.44)	1.91 (2.33)
Healthcare utilization	3.38 (1.36)	2.99 (1.31)	3.40 (1.28)	3.94 (1.28)
Number of partners	2.85 (2.48)	2.39 (2.22)	2.52 (2.31)	3.79 (2.72)

Note. Alcohol use ranges 0–12 (higher scores correspond to heavier drinking); Other drug use ranges 0–9 (0=none, 9=all 9 other substances, actual range was 0–5), Cannabis use ranges 0–6 (0=Never, 6= Daily), Healthcare utilization ranges 0–5 (0=Never, 5=Less than 3 months ago), and Number of Partners ranges from 0–8. Data presented for participants with valid responses to PrEP Care Cascade variables ($n=774$).

old ($M=25.16$, $SD=2.78$), all participants were male assigned at birth. Respondents represented diverse subgroups of BLMSM from 41 states. About three-quarters of the sample identified as gay or same gender loving (76%). More than half (59.9%) the sample reported a Hispanic/Latino identity, and 41.1% reported their race as Black. With respect to education status, almost half (49.9%) of the sample reported not having a college degree.

PrEP Care Cascade

Table 2 presents sample differences across each of the three PrEP Care Cascade groups from the non-imputed dataset. Participants who were *PrEP Aware* reported the lowest levels of all substance use, healthcare utilization, and number of sexual partners. Participants characterized by *PrEP Discontinuation* had the highest reports of cannabis use. Participants who were *PrEP Adherent* reported the highest levels of alcohol use and other drug use, as well as healthcare utilization and number of partners.

Findings from logistic regression models

The results from the series of our logistic regression models are presented in Table 3. To present the findings, we illustrate the odds of engaging in each substance use, utilizing healthcare, and the number of sexual partners across each of the three PrEP Care Cascade groups using participants' reports of their PrEP experiences.

In our model we examined if heavier alcohol use (i.e., average of 3 US AUDIT alcohol items), was associated with greater likelihood of *PrEP Awareness*, *PrEP Discontinuation*, and *PrEP Adherence*. More alcohol use was associated with less *PrEP Awareness*, however, more alcohol use was also associated with more *PrEP Adherence* at a trend-level. There was no significant association between alcohol use and *PrEP Discontinuation*.

Similar to alcohol use, use of a greater number of other drug (e.g., cocaine, stimulates) use was significantly associated with less *PrEP Awareness*. Similarly, those with higher

Table 3. Results from logistic regression models that examine the relation between substance use behaviors and PrEP Care Cascade groups.

	PrEP awareness (Group 1)			PrEP discontinuation (Group 2)			PrEP adherent (Group 3)		
	<i>B</i> [SE]	Odds ratio [95% CI]	<i>p</i>	<i>B</i> [SE]	Odds ratio [95% CI]	<i>p</i>	<i>B</i> [SE]	Odds ratio [95% CI]	<i>p</i>
Healthcare utilization	−0.30 [0.06]	0.74 [0.67–0.83]	.00	0.05 [0.07]	1.05 [0.94–1.09]	.51	0.41 [0.06]	1.51 [1.34–1.70]	.00
Number of partners	−0.10 [0.03]	0.90 [0.85–0.96]	.00	−0.08 [0.04]	0.93 [0.85–0.99]	.07	0.18 [0.03]	1.20 [1.13–1.28]	.00
Alcohol use	−0.06 [0.03]	0.94 [0.89–0.99]	.03	0.01 [0.04]	1.01 [0.94–1.09]	.79	0.06 [0.03]	1.06 [1.00–1.13]	.056
Other substance use	−0.27 [0.09]	0.77 [0.64–0.92]	.00	0.03 [0.12]	1.03 [0.82–1.31]	.78	0.16 [0.10]	1.18 [0.96–1.45]	.10
Cannabis use	0.04 [0.03]	1.00 [0.98–1.11]	.23	0.07 [0.04]	1.08 [0.99–1.17]	.08	−0.04 [0.03]	0.93 [0.87–1.00]	.051

Note. * $p < .05$; ** $p \leq .001$. Other Substance Use is a sum score of the number of other drugs without a prescription (e.g., cocaine, stimulants, methamphetamines, opioids, inhalants) reported by participants.

All models were adjusted for age, race, ethnicity, income, and region.

reports of other drugs were also more likely to be part of the *PrEP Adherence* group ($p = .10$). There was no significant association between other substance use and *PrEP Discontinuation*.

Notably, cannabis use demonstrated a different pattern from both alcohol use and other drug use. There was no association between cannabis use and *PrEP Awareness*. However, a positive trend-level association emerged with *PrEP Discontinuation* and a trend-level negative association emerged between cannabis use and *PrEP Adherence*.

Finally, we also examined healthcare utilization and number of partners in their associations with each of the cascade model groups. We found a differential pattern between healthcare utilization and the PrEP Care Cascade in the context of substance use. Specifically, more healthcare utilization was positively associated with *PrEP Adherence* but negatively associated with *PrEP Awareness*. Similarly, a greater number of sex partners was positively associated with *PrEP Adherence* but negatively associated with *PrEP Awareness* only in the context of substance use. There was a trend-level negative association between number of sex partners and *PrEP Discontinuation*.

Discussion

This is one of the first studies to utilize a large national sample of BLMSM young adults to consider nuances in substance use and healthcare access across the PrEP Care Cascade, highlighting a group of BLMSM whose PrEP adherence may be reduced in relation to cannabis use. Specifically, we examined the complex relationship between substance use and the PrEP Care Cascade, including measures of PrEP awareness, discontinuation, and adherence. Several key findings were observed. First, alcohol use and other drug use were each associated with lower PrEP awareness but also greater levels of adherence to PrEP. As expected, similar patterns were observed with regards to healthcare utilization and number of partners, increases in each being associated with lower awareness but greater adherence. Conversely, cannabis use was associated only with discontinuation of PrEP use (at a trending level, $p = .08$).

Findings have been mixed regarding the relationship between substance use and awareness of PrEP. Earlier work by Garnett et al. (2018) found that hazardous levels of alcohol use were associated with lower PrEP awareness among Black MSM in New York City, though no associations were found between PrEP awareness and any other substance use

behaviors. More recent research among a cohort of ~7,000 sexual and gender minority men in Canada observed that those who drank alcohol and used other drugs, relative to those reporting infrequent use, were more likely to be aware of PrEP (Card et al., 2020). Our results are similar to earlier findings—that is, we found that both alcohol use and other drug use were associated with lower odds of being aware of PrEP. Taken together, this body of work and the findings from the current study suggest that we are failing to effectively reach men who would likely benefit from accessing PrEP.

Past research has suggested nuances in regards to how use of a variety of substances may impact adherence to PrEP medication as prescribed. For example, one study among Canadian MSM linked higher alcohol use levels and moderate-to-high cocaine use with a greater likelihood of missing one or more PrEP doses in the past four days (Shuper et al., 2020). Additional work has demonstrated associations between stimulant use and PrEP nonadherence (Hojilla et al., 2018; 2019; Okafor et al., 2020) while another study noted an association between event-level club drug use and same-day and next-day missed PrEP doses (Groves et al., 2019). Still further work has suggested no association between alcohol or substance use and past 6-month PrEP use (Morgan et al., 2018). Our findings corroborate these associations, yet it is noteworthy that there was a trending association between alcohol and substance use and higher levels of PrEP adherence. One key difference, however, between our own work and that of past studies is our specific focus on BLMSM, suggesting we are observing a unique set of findings that highlight racial and ethnic differences in the association between alcohol or substance use and PrEP adherence. One possibility for this set of results is that these individuals may be interfacing more frequently with clinicians who see them as clinically indicated for PrEP, although past research suggests this outcome may be unlikely (Hoots et al., 2016). Another explanation for our findings may be more indirect in nature: Alcohol use and substance use are associated with increased sexual risk (Parsons et al., 2005) which in itself may increase adherence to PrEP medication. Future research should aim to develop a better understanding of this complex relationship among BLMSM, particularly longitudinal trends, in order to increase rates of adherence among this high-risk population.

Healthcare access and utilization are key factors in explaining observed disparities in the PrEP Care Cascade. Well documented research has shown that both Black (Cahill

et al., 2017; Quinn et al., 2019) and Latino MSM (García & Harris, 2017) have experienced high levels of mistrust of medical providers and/or report discriminatory experiences with medical providers. Our own findings of greater health-care utilization being associated with lower PrEP awareness may corroborate this past work. One possibility is that, due to a high level of mistrust, even when patients attend primary care appointments, they may be reluctant to disclose their sexual history to their provider, leading to a missed opportunity to learn of PrEP's existence and utility. Past research supports this hypothesis having observed potential missed opportunities for clinicians to identify MSM who may benefit from PrEP, given low sensitivity of clinical indications and guidelines (Lancki et al., 2018). More specifically, recent evidence shows that there are discrepancies in provider prescribing behaviors of PrEP across disciplines (e.g., primary care providers vs. infectious disease providers; Silapaswan et al., 2017), knowledge gaps (Leech et al., 2020; Spector et al., 2015), concerns about prescribing PrEP to patients with a history of substance use (Laborde et al., 2020), and disparities in clinical indications for PrEP among Black MSM in particular (Hoots et al., 2016). Each of these factors, both patient- and prescriber-side, undoubtedly impact engagement in the PrEP Care Cascade among BLMSM. Future research in this area should aim to develop interventions to not only at improve engagement in the cascade but also to repair and improve patient trust in the medical system.

Beyond PrEP awareness and adherence, we also observed a trending association ($p = .051$) between cannabis use and PrEP discontinuation. These findings suggest that people who use cannabis may be an intervention target for increasing, or at least sustaining, levels of PrEP use. Although little work exists directly examining this association, a close comparison can be examined in a sample of young Black MSM in Chicago (Morgan et al., 2016). This study examined the impact of cannabis use on the HIV Care Cascade, finding no effect on any stage of care from receipt of an HIV test through viral suppression (Morgan et al., 2016). Another study among a large, diverse cohort of young MSM, observed that cannabis use was associated with lower rates of past-six month PrEP use (Morgan et al., 2018) while the primary reason for PrEP discontinuation was having trouble getting to doctors' appointments (Morgan et al., 2018). While these studies are not directly comparable, they are an interesting set of results that fall on either side of a recent uptick in cannabis decriminalization sweeping the United States. In fact, prior work among MSM has suggested that higher perceptions of cannabis decriminalization were associated with increased rates of use (Morgan et al., 2021), regardless of local ordinances in place. This uptick in perception, and corresponding cannabis use, may explain our own findings, especially as further work has shown that cannabis use was associated with lower likelihood of keeping appointments for HIV-related care (Dietz et al., 2010). In sum, use of cannabis itself may disrupt or inhibit one's ability to keep medical appointments leading to increased rates of PrEP discontinuation. Future research, however, will need to assess this hypothesis in much greater detail in order to ascertain potential intervention targets for increasing use of PrEP.

These findings may have implications for policy and intervention work. First, our study suggests that MSM who report substance use are less aware of PrEP and report lower uptake of PrEP. Given that MSM—especially Black MSM—who report substance use are at the highest risk of HIV infection, increased efforts including outreach, messaging and interventions are needed to improve PrEP care outcomes in this population and specifically PrEP uptake. Second, given that various substances may affect PrEP care outcomes differently, efforts should be made to explore and address specific types of substances (i.e., alcohol, cannabis, others). Third, as public health professionals work to address the substance use epidemic in the United States, which has largely included addressing opioid use, efforts should be made to align HIV prevention approaches (i.e., PrEP) with multiple substance use preventions (extending to alcohol, cannabis), especially among populations that are most at risk (i.e., Black MSM).

Limitations

Though we utilized a large dataset of BLMSM from across the United States and documented more clarity in the associations between PrEP experiences and substance use, our study is not without limitations. First, our data were collected from participants with the time and resources to complete an online survey. We expect that participants who were able to complete a comprehensive survey during COVID-19 may be uniquely linked to supportive community organizations and/or healthcare. Thus, these findings may not generalize to especially vulnerable BLMSM who use high frequencies of illicit substances and without access to healthcare. Similarly, as the use of some illicit substances (e.g., cocaine) was low, we were unable to examine the patterns of associations by individual substances. Future work should aim to replicate these patterns with individual illicit substances. Second, our data are cross-sectional and thus we are unable to make temporal conclusions regarding whether substance use and PrEP experiences were occurring concurrently. We suggest that future longitudinal research follow participants over time given substance use and PrEP care may fluctuate over time, and in turn explain changes in PrEP use and adherence. Last, our operationalization of PrEP users included anyone reporting current PrEP use and adhering > 57% of their PrEP medication doses. Overall, we observed a high level of adherence to PrEP among our study participants, so we were unable to understand substance use and health care utilization among participants ($n=16$) who took their PrEP only 35% of the time. This group is of particular importance and should be targeted in future studies.

Conclusions

We utilized a large national sample of BLMSM to confirm some earlier findings focused on the relation between alcohol use and PrEP, and newly identify cannabis as a barrier to PrEP. With these findings, we note that there is a need

to continue addressing the gap between advances made in HIV prevention tools and actual use of HIV prevention tools. Stakeholders and policy makers should continue their efforts in addressing the links between the substance use epidemic in the United States with consideration to HIV prevention approaches especially among populations who share disproportionate burden of HIV infection.

Disclosure statement

The authors declare no conflicts of interest.

Ethical approval

The research presented uses research on human subjects; IRB approval was obtained from the University of Connecticut (IRB protocol #L19-030). The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards

Informed consent

All participants provided electronic consent to participate in this study.

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References

- Anderson, P. L., Glidden, D. V., Liu, A., Buchbinder, S., Lama, J. R., Guanira, J. V., McMahan, V., Bushman, L. R., Casapia, M., Montoya-Herrera, O., & Veloso, V. G. (2012). Emtricitabine-tenofovir concentrations and pre-exposure prophylaxis efficacy in men who have sex with men. *Science Translational Medicine*, 4(151), 125–151.
- Behrens, J. T. (1997). Principles and procedures of exploratory data analysis. *Psychological Methods*, 2(2), 131–160. <https://doi.org/10.1037/1082-989X.2.2.131>
- Blashill, A. J., Brady, J. P., Rooney, B. M., Rodriguez-Diaz, C. E., Horvath, K. J., Blumenthal, J., Morris, S., Moore, D. J., & Safren, S. A. (2020). Syndemics and the PrEP Cascade: Results from a sample of young latino men who have sex with men. *Archives of Sexual Behavior*, 49(1), 125–135. <https://doi.org/10.1007/s10508-019-01470-7>
- Buchbinder, S. P. (2018). Maximizing the benefits of HIV preexposure prophylaxis. *Topics in Antiviral Medicine*, 25(4), 138–142.
- Cahill, S., Taylor, S. W., Elsesser, S. A., Mena, L., Hickson, D., & Mayer, K. H. (2017). Stigma, medical mistrust, and perceived racism may affect PrEP awareness and uptake in black compared to white gay and bisexual men in Jackson, Mississippi and Boston, Massachusetts. *AIDS Care*, 29(11), 1351–1358. <https://doi.org/10.1080/09540121.2017.1300633>
- Calabrese, S. K., Earnshaw, V. A., Krakower, D. S., Underhill, K., Vincent, W., Magnus, M., Hansen, N. B., Kershaw, T. S., Mayer, K. H., Betancourt, J. R., & Dovidio, J. F. (2018). A closer look at racism and heterosexism in medical students' clinical decision-making related to HIV pre-exposure prophylaxis (PrEP): Implications for PrEP education. *AIDS and Behavior*, 22(4), 1122–1138. [10.1007/s10461-017-1979-z](https://doi.org/10.1007/s10461-017-1979-z)
- Card, K. G., Fournier, A. B., Sorge, J. T., Morgan, J., Grace, D., Ham, D., Lachowsky, N. J., & Trussler, T. (2020). Substance use patterns and awareness of biomedical HIV prevention strategies among sexual and gender minority men in Canada. *AIDS Care*, 32(12), 1506–1514. <https://doi.org/10.1080/09540121.2020.1719026>
- Collins, L. M., Schafer, J. L., & Kam, C. M. (2001). A comparison of inclusive and restrictive strategies in modern missing data procedures. *Psychological Methods*, 6(4), 330–351.
- Dietz, E., Clum, G. A., Chung, S. E., Leonard, L., Murphy, D. A., Perez, L. V., Harper, G. W., & Ellen, J. M. (2010). Adherence to scheduled appointments among HIV-infected female youth in five U.S. cities. *The Journal of Adolescent Health: official Publication of the Society for Adolescent Medicine*, 46(3), 278–283. <https://doi.org/10.1016/j.jadohealth.2009.06.013>
- Eaton, L. A., Kalichman, S. C., Price, D., Finneran, S., Allen, A., & Maksut, J. (2017). Stigma and conspiracy beliefs related to pre-exposure prophylaxis (PrEP) and interest in using PrEP among black and white men and transgender women who have sex with men. *AIDS and Behavior*, 21(5), 1236–1246. <https://doi.org/10.1007/s10461-017-1690-0>
- García, M., & Harris, A. L. (2017). PrEP awareness and decision-making for Latino MSM in San Antonio, Texas. *PLoS One*, 12(9), e0184014. <https://doi.org/10.1371/journal.pone.0184014>
- Garnett, M., Hirsch-Moverman, Y., Franks, J., Hayes-Larson, E., El-Sadr, W. M., & Mannheimer, S. (2018). Limited awareness of pre-exposure prophylaxis among black men who have sex with men and transgender women in New York City. *AIDS Care*, 30(1), 9–17. <https://doi.org/10.1080/09540121.2017.1363364>
- Goodman-Meza, D., Beymer, M. R., Kofron, R. M., Amico, K. R., Psaros, C., Bushman, L. R., Anderson, P. L., Bolan, R., Jordan, W. C., Rooney, J. F., Wohl, A. R., & Landovitz, R. J. (2019). Effective use of pre-exposure prophylaxis (PrEP) among stimulant users with multiple condomless sex partners: A longitudinal study of men who have sex with men in Los Angeles. *AIDS Care*, 31(10), 1228–1233. <https://doi.org/10.1080/09540121.2019.1595523>
- Graham, J. W., Olchowski, A. E., & Gilreath, T. D. (2007). How many imputations are really needed? Some practical clarifications of multiple imputation theory. *Prevention Science*, 8(3), 206–213. <https://doi.org/10.1007/s11121-007-0070-9>
- Grant, R. M., Anderson, P. L., McMahan, V., Liu, A., Amico, K. R., Mehrotra, M., Hosek, S., Mosquera, C., Casapia, M., Montoya, O., Buchbinder, S., Veloso, V. G., Mayer, K., Charialertsak, S., Bekker, L.-G., Kallas, E. G., Schechter, M., Guanira, J., Bushman, L., ... Glidden, D. V. (2014). Uptake of pre-exposure prophylaxis, sexual practices, and HIV incidence in men and transgender women who have sex with men: A cohort study. *The Lancet Infectious Diseases*, 14(9), 820–829. [https://doi.org/10.1016/S1473-3099\(14\)70847-3](https://doi.org/10.1016/S1473-3099(14)70847-3)
- 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., Montoya-Herrera, O., Fernández, T., Veloso, V. G., Buchbinder, S. P., Charialertsak, S., Schechter, M., Bekker, L.-G., Mayer, K. H., Kallás, E. G., ... Glidden, D. V. (2010). Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. *New England Journal of Medicine*, 363(27), 2587–2599. <https://doi.org/10.1056/NEJMoa1011205>
- Grov, C., Rendina, H. J., John, S. A., & Parsons, J. T. (2019). Determining the roles that club drugs, marijuana, and heavy drinking play in PrEP medication adherence among gay and bisexual men: Implications for treatment and research. *AIDS and Behavior*, 23(5), 1277–1286. <https://doi.org/10.1007/s10461-018-2309-9>
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Prentice-Hall, Inc.
- Higgins-Biddle, J. C., & Babor, T. F. (2018). A review of the Alcohol Use Disorders Identification Test (AUDIT), AUDIT-C, and USAUDIT for screening in the United States: Past issues and future directions. *The American Journal of Drug and Alcohol Abuse*, 44(6), 578–586. <https://doi.org/10.1080/00952990.2018.1456545>
- Hoenig, M., Jain, S., Moore, D., Collins, D., Sun, X., Anderson, P. L., Corado, K., Blumenthal, J. S., Daar, E. S., Milam, J., Dubé, M. P., & Morris, S. (2018). Substance use and adherence to HIV preexposure prophylaxis for men who have sex with men. *Emerging Infectious Diseases*, 24(12) <https://doi.org/10.3201/eid2412.180400>
- Hojilla, J. C., Satre, D. D., Glidden, D. V., McMahan, V. M., Gandhi, M., Defechereux, P., Guanira, J. V., Mehrotra, M., Grant, R. M., & Carrico, A. W. (2019). Brief report: Cocaine use and pre-exposure

- prophylaxis: Adherence, care engagement, and kidney function. *Journal of Acquired Immune Deficiency Syndromes* (1999), 81(1), 78–82. <https://doi.org/10.1097/QAI.0000000000001972>
- Hojilla, J. C., Vlahov, D., Glidden, D. V., Amico, K. R., Mehrotra, M., Hance, R., Grant, R. M., & Carrico, A. W. (2018). Skating on thin ice: Stimulant use and sub-optimal adherence to HIV pre-exposure prophylaxis. *Journal of the International AIDS Society*, 21(3), 1–5. <https://doi.org/10.1002/jia2.25103>
- Honaker, J., King, G., & Blackwell, M. (2011). Amelia II: A program for missing data. *Journal of Statistical Software*, 45(7), 1–47. [Database] <https://doi.org/10.18637/jss.v045.i07>
- Hoots, B. E., Finlayson, T., Nerlander, L., & Paz-Bailey, G. (2016). Willingness to take, use of, and indications for pre-exposure prophylaxis among men who have sex with men—20 US cities, 2014. *Clinical Infectious Diseases* 63(5), 672–677. <https://doi.org/10.1093/cid/ciw367>
- Kalichman, S. C., & Eaton, L. (2017). Alcohol-antiretroviral interactive toxicity beliefs as a potential barrier to HIV pre-exposure prophylaxis among men who have sex with men. *Journal of the International AIDS Society*, 20(1), 21534. <https://doi.org/10.7448/IAS.20.1.21534>
- Kanny, D., Jeffries, W. L., Chapin-Bardales, J., Denning, P., Cha, S., Finlayson, T., Wejnert, C., Abrego, M., Al-Tayyib, A., Anderson, B., Barak, N., Beckford, J. M., Bolden, B., Brady, K. A., Brandt, M. G., Brantley, M., Braunstein, S., Buyu, C., Cano, R., ... Wortley, P. (2019). Racial/ethnic disparities in HIV preexposure prophylaxis among men who have sex with men — 23 urban areas, 2017. *MMWR. Morbidity and Mortality Weekly Report*, 68(37), 801–806. <http://dx.doi.org/10.15585/mmwr.mm6837a2>
- Kimball, D., Rivera, D., Gonzales, M., & Blashill, A. J. (2020). Medical mistrust and the PrEP cascade among Latino sexual minority men. *AIDS and Behavior*, 24(12), 3456–3461. <https://doi.org/10.1007/s10461-020-02916-z>
- Laborde, N. D., Kinley, P. M., Spinelli, M., Vittinghoff, E., Whitacre, R., Scott, H. M., & Buchbinder, S. P. (2020). Understanding PrEP persistence: Provider and patient perspectives. *AIDS and Behavior*, 24(9), 2509–2519. <https://doi.org/10.1007/s10461-020-02807-3>
- Lancki, N., Almirol, E., Alon, L., McNulty, M., & Schneider, J. A. (2018). Preexposure prophylaxis guidelines have low sensitivity for identifying seroconverters in a sample of young Black MSM in Chicago. *AIDS (London, England)*, 32(3), 383–392. <https://doi.org/10.1097/qad.0000000000001710>
- Leech, A. A., Christiansen, C. L., Linas, B. P., Jacobsen, D. M., Morin, I., & Drainoni, M. L. (2020). Healthcare practitioner experiences and willingness to prescribe pre-exposure prophylaxis in the US. *Plos One*, 15(9), e0238375. <https://doi.org/10.1371/journal.pone.0238375>
- Lelutiu-Weinberger, C., & Golub, S. A. (2016). Enhancing PrEP access for black and Latino men who have sex with men. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 73(5), 547–555. <https://doi.org/10.1097/QAI.0000000000001140>
- Little, T. D., Jorgensen, T. D., Lang, K. M., & Moore, E. W. G. (2014). On the joys of missing data. *Journal of Pediatric Psychology*, 39(2), 151–162. <https://doi.org/10.1093/jpepsy/jst048>
- Morgan, E., Dyar, C., Hayford, C. S., Whitton, S. W., Newcomb, M. E., & Mustanski, B. (2021). Perceptions of marijuana decriminalization among young sexual and gender minorities in Chicago: An initial measure validation and test of longitudinal associations with use. *Cannabis and Cannabinoid Research*, 6(2), 156–164. <https://doi.org/10.1089/can.2019.0072>
- Morgan, E., Khanna, A. S., Skaathun, B., Michaels, S., Young, L., Duvoisin, R., Chang, M., Voisin, D., Cornwell, B., Coombs, R. W., Friedman, S. R., & Schneider, J. A. (2016). Marijuana use among young black men who have sex with men and the HIV care continuum: Findings from the uConnect cohort. *Substance Use & Misuse*, 51(13), 1751–1759. <https://doi.org/10.1080/10826084.2016.1197265>
- Morgan, E., Moran, K., Ryan, D. T., Mustanski, B., & Newcomb, M. E. (2018). Threefold increase in PrEP uptake over time with high adherence among young men who have sex with men in Chicago. *AIDS and Behavior*, 22(11), 3637–3644. <https://doi.org/10.1007/s10461-018-2122-5>
- Morgan, E., Ryan, D. T., Newcomb, M. E., & Mustanski, B. (2018). High rate of discontinuation may diminish PrEP coverage among young men who have sex with men. *AIDS and Behavior*, 22(11), 3645–3648. <https://doi.org/10.1007/s10461-018-2125-2>
- Muthén, L. K., & Muthén, B. O. (1998–2011). *Mplus user's guide* (6th ed.). Muthén & Muthén.
- Nunn, A. S., Brinkley-Rubinstein, L., Oldenburg, C. E., Mayer, K. H., Mimiaga, M., Patel, R., & Chan, P. A. (2017). Defining the HIV pre-exposure prophylaxis care continuum. *AIDS (London, England)*, 31(5), 731–734. <https://doi.org/10.1097/qad.0000000000001385>
- Okafor, C. N., Hucks-Ortiz, C., Hightow-Weidman, L. B., Magnus, M., Emel, L., Beachamp, G., Kuo, I., Hendrix, C., Mayer, K. H., & Shoptaw, S. J. (2020). Brief report: Associations between self-reported substance use behaviors and PrEP acceptance and adherence among black MSM in the HPTN 073 study. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 85(1), 23–29. <https://doi.org/10.1097/QAI.0000000000002407>
- Oldfield, B. J., & Edelman, E. J. (2021). Addressing unhealthy alcohol use and the HIV pre-exposure prophylaxis care continuum in primary care: a scoping review. *AIDS and Behavior*, 25(6), 1777–1789. <https://doi.org/10.1007/s10461-020-03107-6>
- Ostrom, L., Rosentel, K., Motley, D., & Hill, B. J. (2020). Discordance in objective and self-perceived HIV risk: A potential barrier to pre-exposure prophylaxis in young gay and bisexual men. *The Journal of the Association of Nurses in AIDS Care*, 31(1), 103–109. <https://doi.org/10.1097/jnc.000000000000137>
- Parmley, L. E., Harris, T. G., Chingombe, I., Mapingure, M., Mugurungi, O., Rogers, J. H., Gozhora, P., Wu, Y., Samba, C., Musuka, G., & Hakim, A. J. (2022). Engagement in the pre-exposure prophylaxis (PrEP) cascade among a respondent-driven sample of sexually active men who have sex with men and transgender women during early PrEP implementation in Zimbabwe. *Journal of the International AIDS Society*, 25(2), e25873. <https://doi.org/10.1002/jia2.25873>
- Parsons, J. T., Kutnick, A. H., Halkitis, P. N., Punzalan, J. C., & Carbonari, J. P. (2005). Sexual risk behaviors and substance use among alcohol abusing HIV-positive men who have sex with men. *Journal of Psychoactive Drugs*, 37(1), 27–36. <https://doi.org/10.1080/02791072.2005.10399746>
- Parsons, J. T., Rendina, H. J., Lassiter, J. M., Whitfield, T. H., Starks, T. J., & Grov, C. (2017). Uptake of HIV pre-exposure prophylaxis (PrEP) in a national cohort of gay and bisexual men in the United States: the motivational PrEP cascade. *Journal of Acquired Immune Deficiency Syndromes* (1999), 74(3), 285–292. <https://doi.org/10.1097/QAI.0000000000001251>
- Quinn, K., Dickson-Gomez, J., Zarwell, M., Pearson, B., & Lewis, M. (2019). A gay man and a doctor are just like, a recipe for destruction?: How racism and homonegativity in healthcare settings influence PrEP uptake among young black MSM. *AIDS and Behavior*, 23(7), 1951–1963. <https://doi.org/10.1007/s10461-018-2375-z>
- Ross, P. T., Hart-Johnson, T., Santen, S. A., & Zaidi, N. L. B. (2020). Considerations for using race and ethnicity as quantitative variables in medical education research. *Perspectives on Medical Education*, 9(5), 318–323. <https://doi.org/10.1007/s40037-020-00602-3>
- Rubin, D. B. (1987). *Multiple imputation for nonresponse in surveys*. Wiley.
- Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods*, 7(2), 147–177.
- Scott, H. M., Spinelli, M., Vittinghoff, E., Morehead-Gee, A., Hirozawa, A., James, C., Hammer, H., Liu, A., Gandhi, M., & Buchbinder, S. (2019). Racial/ethnic and HIV risk category disparities in preexposure prophylaxis discontinuation among patients in publicly funded primary care clinics. *AIDS*, 33(14), 2189–2195. <https://doi.org/10.1097/QAD.0000000000002347>
- Shuper, P. A., Joharchi, N., Bogoch, I. I., Loutfy, M., Crouzat, F., El-Helou, P., Knox, D. C., Woodward, K., & Rehm, J. (2020). Alcohol consumption, substance use, and depression in relation to HIV pre-exposure prophylaxis (PrEP) nonadherence among gay, bisexual, and other men-who-have-sex-with-men. *BMC Public Health*, 20(1), 1782. <https://doi.org/10.1186/s12889-020-09883-z>

- Silapaswan, A., Krakower, D., & Mayer, K. H. (2017). Pre-exposure prophylaxis: A narrative review of provider behavior and interventions to increase PrEP implementation in primary care. *Journal of General Internal Medicine*, 32(2), 192–198. <https://doi.org/10.1007/s11606-016-3899-4>
- Spector, A. Y., Remien, R. H., & Tross, S. (2015). PrEP in substance abuse treatment: A qualitative study of treatment provider perspectives. *Substance Abuse Treatment, Prevention, and Policy*, 10, 1. [10.1186/1747-597X-10-1](https://doi.org/10.1186/1747-597X-10-1)[PMC][25575428]
- Storholm, E. D., Volk, J. E., Marcus, J. L., Silverberg, M. J., & Satre, D. D. (2017). Risk perception, sexual behaviors, and PrEP adherence among substance-using men who have sex with men: A qualitative study. *Prevention Science*, 18(6), 737–747. <https://doi.org/10.1007/s11121-017-0799-8>
- Tangmunkongvorakul, A., Chariyalertsak, S., Amico, K. R., Saokhieo, P., Wannalak, V., Sangangamsakun, T., Goicochea, P., & Grant, R. (2013). Facilitators and barriers to medication adherence in an HIV prevention study among men who have sex with men in the iPrEx study in Chiang Mai, Thailand. *AIDS Care*, 25(8), 961–967. <https://doi.org/10.1080/09540121.2012.748871>
- Willie, T. C., Kershaw, T. S., Blackstock, O., Galvao, R. W., Safon, C. B., Tekeste, M., Ogburn, D. F., Wilbourn, B., Modrakovic, D., Taggart, T., Kaplan, C., Caldwell, A., & Calabrese, S. K. (2021). Racial and ethnic differences in women's HIV risk and attitudes towards pre-exposure prophylaxis (PrEP) in the context of the substance use, violence, and depression syndemic. *AIDS Care*, 33(2), 219–228. <https://doi.org/10.1080/09540121.2020.1762067>