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Facilitators and Barriers to Pre-Exposure Prophylaxis Willingness Among Young Men Who Have Sex with Men Who Use Geosocial Networking Applications in California

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Abstract

While correlates of pre-exposure prophylaxis (PrEP) uptake have been explored among older men who have sex with men (MSM), less is known about the facilitators and barriers that encourage uptake among younger MSM (YMSM). This study explores the association between willingness to take PrEP and demographic characteristics, sexual risk, and substance use, and attitudinal factors among YMSM in California who use geosocial networking applications (GSN apps). Based on survey data from YMSM recruited through GSN apps ($n = 687$), PrEP willingness was positively associated with Hispanic ethnicity [adjusted odds ratio (aOR): 1.73; confidence interval (CI): 1.01–2.98; $p = 0.046$], concerns about drug effects (aOR: 0.46; CI: 0.33–0.65; $p < 0.001$), medical mistrust (aOR: 0.71; CI: 0.53–0.96; $p < 0.001$), and concerns about adherence (aOR: 0.65; CI: 0.49–0.89; $p = 0.005$). PrEP willingness was positively associated with medium (aOR: 1.87; CI: 1.14–3.07; $p = 0.014$) and high concern (aOR: 1.84; CI: 1.13–3.01; $p < 0.001$) about contracting HIV and perceived benefits of taking PrEP (aOR: 2.59; CI: 1.78–3.78; $p < 0.001$). In addition to emphasizing the benefits of using PrEP, campaigns that address concerns regarding adherence and side effects may increase interest in and demand for PrEP among YMSM. More opportunities are needed to educate YMSM about PrEP, including addressing their concerns about this new prevention strategy. Providers should speak openly and honestly to YMSM considering PrEP about what to do if side effects occur and how to handle missed doses. Outreach using GSN apps for PrEP education and screening may be an effective way to reach YMSM.

Keywords: pre-exposure prophylaxis (PrEP), young men who have sex with men (YMSM), social networking, medication adherence, medical mistrust

Introduction

THE HIV EPIDEMIC in the US continues to disproportionately impact vulnerable and marginalized communities. While incidence remains high among gay, bisexual, and other men who have sex with men (MSM), the burden is shifting from white to black and Latino MSM.^{1–4} According to the CDC,⁵ nearly half of black MSM and one quarter of Latino MSM will be diagnosed with HIV in their lifetimes (compared to one in 11 white MSM) if current infection rates continue, with a majority of those infections attributable to same-sex sexual contact.³ The burden is also shifting from older to younger MSM (YMSM), with as many as two-thirds

of new HIV infections among youth also attributable to same-sex sexual contact.⁶ YMSM of color have been particularly affected, with HIV prevalence among these men rising according to recent estimates.^{7,8} The HIV epidemic in California largely reflects these trends.^{9,10}

Some prevention efforts specifically target YMSM,¹¹ and more are warranted; however, broader epidemiological analyses suggest that the effect of behaviorally focused HIV prevention efforts on new infections may have plateaued.¹² Thus, in recent years, attention has turned to and enthusiasm has grown for biomedical approaches to HIV prevention. The “test and treat” model, for example, involves routinizing testing for at-risk populations, linking to care those who test

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positive, and ensuring care for those already positive to decrease community viral load.^{13–15} Pre-exposure prophylaxis (PrEP), the use of antiretroviral medications by HIV-negative individuals to prevent infection, is a newly available and promising biomedical tool. Clinical trials estimate that, when taken consistently, PrEP can reduce HIV infection risk by as much as 99%.^{16–18} In the years following its introduction, studies demonstrated that efficacy remains relatively high even with imperfect use (e.g., 76% reduction with five missed doses per week; 96% with three).¹⁶ Also, concerns about PrEP use causing mutations in the HIV virus have largely been allayed. Studies have shown that drug resistance is rare enough that the potential benefit of avoiding HIV infection far outweighs the risk of seroconversion by mutated virus while on PrEP.^{19–21}

Understandably then, PrEP has been integrated into many new prevention efforts across the United States, including California's "Laying a Foundation for Getting to Zero" initiative.²² Previous research, however, has found that despite increasing awareness of and interest in PrEP, uptake remains low, often as little as 1–5% of MSM report having ever taken it.^{23–29} While some evidence suggests this is likely to increase over time,^{30,31} remaining barriers threaten to stymie a broader uptake. Studies show that access to PrEP (i.e., its cost and the cost of health insurance coverage more broadly), the health effects of PrEP (i.e., its side effects and consequences of long-term use), and behavior change related to PrEP (i.e., medication adherence and fears that a decreased perception of risk will lead to increased risk behavior, or what is broadly referred to as "risk compensation") remain significant barriers to uptake among MSM.^{32–38}

Stigma associated with taking PrEP is another barrier, with some MSM reporting being afraid of or having experienced moral judgment and shaming from their peers as well as their health providers.^{39–42} Concerns about stigma are not unfounded: one study showed that members of the general public expressed lower support for funding policies and programs that would facilitate access to PrEP for gay men, with gay black men receiving the least expressed support relative to expressed support for the general population.⁴³ While some research has shown YMSM face similar stigma,^{23,44–46} much less is known about the barriers and facilitators to PrEP willingness and uptake for this population.

Many studies of PrEP involving MSM have emerged from preliminary investigations into its feasibility and acceptability, or clinical determinations of its efficacy. Since its approval in 2012, there have been several studies of MSM's attitudes toward PrEP and recent studies have begun to focus on correlates of PrEP uptake, given limitations of studying PrEP willingness and intentions to use PrEP.⁴⁷ However, many of these samples of MSM trend toward older or whiter MSM, with some reporting higher levels of education and income relative to YMSM.^{23,48–51} As such, it remains unclear whether these data reflect the attitudes, behaviors, and experiences of YMSM, especially YMSM of color, or whether men in these samples have similar risk behavior profiles to YMSM.

Previous studies of PrEP that do involve YMSM have shown low awareness^{23,44} and moderate-to-high willingness,^{45,52} with concerns regarding accessing PrEP a commonly reported barrier.^{23,44,46} While these studies provide valuable insight into MSM's attitudes toward and use of PrEP, important questions remain unanswered for YMSM. Data on a full range of barriers and facilitators, as well as their

saliency, for PrEP willingness and uptake among YMSM are lacking, as are data on the associations between sexual risk and substance use on YMSM's attitudes toward PrEP. With many YMSM seeking sexual partners through online- and smartphone-based social networking applications (hereafter referred to as GSN apps), it is imperative that this potentially high-risk population be included in future investigations.^{53–57}

This study explores the association between willingness to take PrEP and demographic characteristics, sexual risk, and substance use, and attitudinal factors among YMSM in California who use GSN apps. Its aim is to better understand the barriers and facilitators for PrEP willingness and uptake among a diverse sample of YMSM at risk for HIV infection, to inform multi-level intervention efforts that may improve PrEP uptake in this population.

Methods

Participants and procedures

This analysis utilizes anonymous survey data collected online from July 9 to August 20, 2015. Potential participants were recruited through several popular GSN apps for YMSM, where they received push notifications advertising the survey. Those interested were first asked if they were willing to participate, and then were given an online screener to assess their eligibility. Participants had to be: 18–29, assigned male sex at birth, sexually active with other men in the last 5 years, HIV negative, and a California resident. Eligible participants clicked through to an online survey that took ~20 min to complete. Upon its completion, participants gave their email address for a \$25 electronic gift card incentive. All study procedures were approved by the North Campus Institutional Review Board at the University of California, Los Angeles.

Measures

PrEP willingness. Participants were asked if they had heard about PrEP and, if so, where they had heard about it (e.g., friend, family member, doctor, sex partner, social media, online/internet, magazine/newspaper, television/radio, HIV/AIDS organization, LGB/T organization, don't know/unsure, or other). They were also asked about additional sources of PrEP awareness such as knowing someone personally who had taken it. Finally, they were asked if they felt they had adequate information to make a decision about taking PrEP. Next, participants were given a brief description of PrEP that included facts about the medication, such as its purpose, efficacy, dosage, side effects, and required medical follow-ups. Participants were then asked to rate (on a 6-point scale ranging from "extremely unlikely" to "extremely likely") how likely they would be to take PrEP. Specifically, participants were asked, "Given this information, how likely would you be to take PrEP if it was available to you?" Those indicating "very likely" or "extremely likely" were considered willing to take PrEP; all others were considered unwilling or uninterested.

Demographics. A comprehensive battery of demographic questions was asked of participants, including race/ethnicity (white, black, Latino, Asian, other/mixed), age (dichotomized to mirror CDC age categorization: 18–24 and 25–29), gender identity (man or other), sexual orientation (gay, bisexual, or other), sexual behavior in the past 5 years (men only, men and

women), employment (full time, part time, student, and other), education (less than high school, high school, and some college and above), income (<\$9999, \$10,000–\$29,999, and >\$30,000), insurance status (insured and not insured), homeless in the past year (yes or no), and US citizenship (yes or no).

HIV risk behaviors. Questions regarding sexual risk pertained to behaviors in the past 6 months and included number of male sexual partners (count), instances of receptive and/or insertive condomless anal sex (CAS) (count), number of HIV-positive male partners, and exchanging sex for money (yes or no). Other risk factors measured were sexually transmitted infection (STI) diagnoses in the past year (yes or no), illicit substance use in the last 6 months (i.e., methamphetamine/crystal, heroin, cocaine/crack, ecstasy/MDMA/Molly, Ketamine/Special K, and GHB), last HIV and STI test (never tested, <6 months, 6–12 months, and >12 months), and self-rated risk and concern for getting HIV (1 = low, 2 = moderate, and 3 = high). Using six of these risk measures (age, number of partners, receptive CAS, HIV-positive partners, insertive CAS with an HIV-positive man, and methamphetamine use), we assigned a risk score to participants based on the CDC's recommendations.⁵⁸ Those with scores ≥ 10 were considered high risk and recommended for PrEP screening. A score ≥ 10 could be achieved in two ways: cumulatively, as a sum total of points scored across various measures, or at once, if the participant reported any receptive CAS in the past 6 months.

PrEP attitudes. Participants were asked to rate their agreement (on a 4-point scale, ranging from “strongly disagree” to “strongly agree”) with 33 statements about PrEP to assess their attitudes toward the prevention strategy (Table 3). These statements were derived from previous research on barriers and facilitators to PrEP use among MSM.^{23,59}

Data analysis

We used principal component analysis as a data reduction strategy for the 33 PrEP attitude statements; our goal was to reduce the large number of single items into parsimonious factors.⁶⁰ Items that did not load onto any factors at a cutoff of 0.5 were excluded. We used a scree plot to determine the appropriate number of factors and assigned items to factors based on loadings >0.5 . Each factor was scored by averaging the items that loaded onto that particular factor. All negatively worded items were reverse coded so that higher scores reflected greater willingness to take PrEP.

Bivariate chi-square tests comparing characteristics (demographics and risk behaviors) of those willing to take PrEP versus those unwilling/uninterested in taking PrEP were performed to determine variables of interest for inclusion in a multivariable model. To compare attitudinal differences between willing and unwilling/uninterested participants, we used the Mann-Whitney test due to non-normality of the factor scales. To adjust for multiple comparisons on the same sample, we used the Benjamini and Hochberg procedure to control the false discovery rate at the 0.05 alpha level.⁶¹ Variables significant at the bivariate level and conceptually relevant covariates were included in a multivariable logistic regression model predicting willingness to take PrEP.

Results

Participant characteristics

Of 3868 participants who expressed interest in the survey, 3842 were consented and screened for eligibility. Only 1777 met inclusion criteria and 762 went on to complete the entire survey. After removing one duplicate survey (determined by IP address), 761 participants remained, of whom 687 had never taken PrEP and were included in our sample. Our overall response rate was higher than previous studies recruiting YMSM through GSN apps in California, which range from 9% to 13%.^{54,62,63} About 43% of participants were from the greater Los Angeles area, 25% were from the Bay Area, and the remaining 32% were from other regions in California. Mean age was 23 years. In terms of race/ethnicity, 33% were Latino, 25% were black, 21% were white, and 21% were other/mixed. Most identified as male (97%), had sex with men exclusively (82%), and identified as gay (80%). Smaller percentages identified as bisexual (17%) or another sexual orientation (3%). Forty percent worked full time, while 23% worked part time and 25% were students. Most completed high school (93%) and over half indicated an annual income $< \$30,000$ (63%). Three-quarters indicated being insured (74%) and nearly all were US citizens (90%).

Sources of knowledge, PrEP willingness, and demographic characteristics

Nearly three-quarters of the sample (74%) had heard about PrEP previously, citing social media (57%), the internet (51%), and friends (47%) as sources. Over half (55%) were willing to take PrEP. Significantly more YMSM who reported adequate information to make a decision about whether to take PrEP were willing to use it compared to those who were unwilling/uninterested (33% vs. 20%, $p < 0.001$). There were no statistically significant associations between prior knowledge of PrEP, or source of PrEP information, and willingness. Race/ethnicity ($\chi^2 = 10.1$; $p = 0.04$), age ($\chi^2 = 10.1$; $p = 0.002$), employment status ($\chi^2 = 10.6$; $p = 0.01$), education level ($\chi^2 = 9.8$; $p = 0.007$), and income ($\chi^2 = 9.1$; $p = 0.01$) were significantly associated with willingness to take PrEP. See Table 1 for a list of all demographic comparisons.

Sexual risk behavior and substance use

Reported sexual risk was high: over 68% of men in the sample scored 10 or higher on the CDC's HIV risk index. The average number of sexual partners in the last 6 months was seven (standard deviation = 20.7); the median number of sexual partners in the last 6 months was four (interquartile range, 2–8). Over half reported receptive CAS with a partner of any serostatus (52%) and over one-fifth reported insertive CAS with an HIV-positive partner (22%). Substance use was common: over three-quarters used alcohol (77%); nearly half used marijuana (43%); over one-fifth used poppers (22%); and nearly one-fifth used an illicit substance (17%) in the past 6 months. Willingness to take PrEP was significantly associated with time since last HIV test ($\chi^2 = 11.9$; $p = 0.008$), level of concern about becoming infected with HIV ($\chi^2 = 30.0$; $p < 0.001$), recent receptive CAS ($\chi^2 = 14.6$; $p < 0.001$), use of illicit drugs in the past 6 months ($\chi^2 = 4.9$; $p = 0.026$), and HIV risk index score ($\chi^2 = 8.3$; $p = 0.004$). See Table 2 for a full listing of sexual risk and substance use behavior comparisons.

TABLE 1. DEMOGRAPHIC CHARACTERISTICS AMONG YOUNGER MEN WHO HAVE SEX WITH MEN IN CALIFORNIA BY WILLINGNESS ($N=687$)

Characteristic	Total, n (%)	Willing, n (%)	Unwilling or uninterested, n (%)	χ^2 (p value)
	687 (100.0)	380 (55.3)	307 (44.7)	
Race/ethnicity				10.1 (0.04)
White	142 (20.7)	70 (18.4)	72 (23.5)	
Black	174 (25.3)	90 (23.7)	84 (27.4)	
Latino	227 (33.0)	144 (37.9)	83 (27.0)	
Asian	44 (6.4)	21 (5.5)	23 (7.5)	
Other/mixed	100 (14.6)	55 (14.5)	45 (14.7)	
Mean age (SD)	23 (3.2)	23 (3.2)	24 (3.1)	
Age category				10.1 (0.002)
18–24	434 (63.2)	260 (68.4)	174 (56.7)	
25–29	253 (36.8)	120 (31.6)	133 (43.3)	
Gender identity				0.0 (0.98)
Man	669 (97.4)	370 (97.4)	299 (97.4)	
Other	18 (2.6)	10 (2.6)	8 (2.6)	
Sexual orientation				2.6 (0.27)
Gay	551 (80.2)	313 (82.4)	238 (77.5)	
Bisexual	119 (17.3)	58 (15.3)	61 (19.9)	
Other	17 (2.5)	9 (2.4)	8 (2.6)	
Sexual behavior				3.3 (0.07)
Men only	560 (81.5)	319 (83.9)	241 (78.5)	
Men and women	127 (18.5)	61 (16.1)	66 (21.5)	
Employment				10.6 (0.01)
Employed full time	273 (39.7)	140 (36.8)	133 (43.3)	
Employed part time	157 (22.8)	81 (21.3)	76 (24.8)	
Full time student	168 (24.5)	111 (29.2)	57 (18.6)	
Other	89 (13.0)	48 (12.6)	41 (13.4)	
Education ^a				9.8 (0.007)
Less than high school	44 (6.4)	17 (4.5)	27 (8.8)	
Completed high school	143 (20.8)	92 (24.2)	51 (16.6)	
Some college and above	496 (72.2)	270 (71.1)	226 (73.6)	
Income ^a				9.1 (0.01)
<\$9999	176 (25.6)	112 (29.5)	64 (20.8)	
\$10,000–\$29,999	254 (37.0)	134 (35.3)	120 (39.1)	
>\$30,000	196 (28.5)	95 (25.0)	101 (32.9)	
Current insurance	509 (74.1)	287 (75.5)	222 (72.3)	0.9 (0.34)
Homeless in last year	47 (6.8)	23 (6.1)	24 (7.8)	0.8 (0.36)
US citizen	616 (89.7)	342 (90.0)	274 (89.3)	0.4 (0.53)

^aFive participants declined to answer education question, 61 participants did not provide income. SD, standard deviation.

Principal component analysis and attitudes toward PrEP

Principal component analysis yielded 8 unique factors to assess attitudes about PrEP. Six of the 33 statements regarding PrEP were excluded from the final set because they did not load onto any of the factors, did not load on any factor above 0.5, or were not conceptually aligned with other items within a single factor. Two items: “I would take PrEP if there weren’t any side effects” and “I don’t trust drug companies” loaded onto two factors; so they were assigned to the factor with the higher loading. Based on the results of the factor analysis, we identified the following categories for measuring attitudes and concerns about PrEP: access/affordability, stigma and disclosure, drug effects, perceived benefits, risk compensation, lack of perceived need, medical mistrust, and adherence. See Table 3 for a list of items within each factor and accompanying factor loadings.

With the exception of access/affordability, all attitudinal measures were significantly associated with willingness to take PrEP ($p < 0.001$ in all cases). YMSM who were un-

willing to take or uninterested in taking PrEP had more concerns about stigma, drug effects, risk compensation, necessity, medical mistrust, and adherence. However, participants who indicated they would be willing to take PrEP had higher perceived benefits of the prevention strategy. See Table 4 for a summary of attitudinal analyses.

Multivariable regression

Hispanic/Latino YMSM were more likely than white YMSM to be willing to take PrEP [odds ratio (OR): 1.73; confidence interval (CI): 1.01–2.98; $p = 0.046$]. Compared to YMSM reporting low concern for getting HIV, those with medium (OR: 1.87; CI: 1.14–3.07; $p = 0.014$) and high concern (OR: 1.84; CI: 1.13–3.01; $p = 0.015$) were nearly twice as likely to be willing to take PrEP. Greater concerns about PrEP drug effects were associated with decreased odds of being willing to take it (OR: 0.46; CI: 0.33–0.65; $p < 0.001$). Increased medical mistrust was associated with decreased willingness to take PrEP (OR: 0.71; CI: 0.53–0.96; $p = 0.026$). Finally, greater concerns regarding

TABLE 2. SEXUAL RISK BEHAVIOR AND SUBSTANCE ABUSE RISK AMONG YOUNGER MEN WHO HAVE SEX WITH MEN IN CALIFORNIA BY WILLINGNESS (N=687)

Variable	Total, n (%)	Willing, n (%)	Unwilling or uninterested, n (%)	χ^2 (p value)
How would you rate your risk of getting HIV				5.4 (0.07)
Low	297 (43.2)	156 (41.1)	141 (45.9)	
Moderate	288 (41.9)	156 (41.1)	132 (43.0)	
High	71 (10.3)	48 (12.6)	23 (7.5)	
Last HIV test				11.9 (0.008)
<6 months ago	356 (51.8)	203 (53.4)	153 (49.8)	
6–12 months ago	142 (20.7)	64 (16.8)	78 (25.4)	
>12 months ago	95 (13.8)	50 (13.2)	45 (14.7)	
I've never been tested	94 (13.7)	63 (16.6)	31 (10.1)	
How concerned are you about becoming infected with HIV				30.0 (<0.001)
Not concerned	181 (26.3)	69 (18.2)	112 (36.5)	
Somewhat concerned	217 (31.6)	129 (33.9)	88 (28.7)	
Very concerned	289 (42.1)	182 (47.9)	107 (34.9)	
Number of men had sex with in the last 6 months				8.1 (0.09)
0	32 (4.7)	12 (3.2)	20 (6.5)	
1	106 (15.4)	53 (13.9)	53 (17.3)	
2–5	295 (42.9)	163 (42.9)	132 (43.0)	
6 or more	254 (37.0)	152 (40.0)	102 (33.3)	
Average number of male sexual partners in the past 6 months (SD)	7 (20.7)	9 (27.3)	5 (5.8)	
Median number of male sexual partners in the past 6 months (IQR)	4 (2–8)	4 (2–8)	4 (2–7)	
Had receptive condomless anal sex with a man in last 6 months	360 (52.4)	224 (58.9)	136 (44.3)	14.6 (<0.001)
Had an HIV-positive male partner in the last 6 months	73 (10.6)	44 (11.6)	29 (9.4)	0.8 (0.37)
Had insertive condomless anal sex with an HIV-positive man in last 6 months	151 (22.0)	88 (23.2)	63 (20.5)	0.7 (0.41)
Main HIV-positive partner currently	23 (3.3)	11 (2.9)	12 (3.9)	0.5 (0.46)
Condom use all the time for anal sex in the last 6 months	236 (34.4)	126 (33.2)	110 (35.8)	0.5 (0.46)
Substances in the last 6 months				
Alcohol	529 (77.0)	298 (78.4)	231 (75.2)	1.0 (0.33)
Marijuana/pot	299 (43.5)	166 (43.7)	133 (43.3)	0.0 (0.92)
Poppers	148 (21.5)	79 (20.8)	69 (22.5)	0.3 (0.59)
Other illicit drugs	116 (16.9)	75 (19.7)	41 (13.4)	4.9 (0.03)
Methamphetamine/crystal	31 (4.5)	20 (5.3)	11 (3.6)	
Heroin	2 (0.3)	2 (0.5)	0 (0.0)	
Cocaine/crack	46 (6.7)	32 (8.4)	14 (4.6)	
Ecstasy/MDMA/Molly	80 (11.6)	53 (13.9)	27 (8.8)	
Ketamine/special k	8 (1.2)	5 (1.3)	3 (1.0)	
GHB	16 (2.3)	10 (2.6)	6 (2.0)	
Ever exchanged sex for money, drugs, or place to stay	79 (11.5)	47 (12.4)	32 (10.4)	0.6 (0.43)
Any STD diagnosis in the past year	134 (19.5)	72 (18.9)	62 (20.2)	0.2 (0.68)
Gonorrhea	69 (10.0)	34 (8.9)	35 (11.4)	
Chlamydia	64 (9.3)	31 (8.2)	33 (10.7)	
Syphilis	27 (3.9)	16 (4.2)	11 (3.6)	
Other	18 (2.6)	10 (2.6)	8 (2.6)	
Last STD test				3.3 (0.35)
<6 months ago	331 (48.2)	183 (48.2)	148 (48.2)	
6–12 months ago	154 (22.4)	77 (20.3)	77 (25.1)	
>12 months ago	110 (16.0)	64 (16.8)	46 (15.0)	
I've never been tested	92 (13.4)	56 (14.7)	36 (11.7)	
CDC's HIV risk index score				10.4 (0.001)
Low (<10)	237 (31.1)	109 (28.7)	124 (40.4)	
High (\geq 10)	524 (68.9)	271 (71.3)	183 (59.6)	

IQR, interquartile range; SD, standard deviation; STD, sexually transmitted disease.

TABLE 3. PRINCIPAL COMPONENT ANALYSIS ON ATTITUDES TOWARD PRE-EXPOSURE PROPHYLAXIS

Factor	Item	Loading
1. Access/ affordability	I wouldn't be able to take PrEP because I don't have a doctor or healthcare provider	0.85
	I wouldn't be able to take PrEP because I don't have health insurance	0.83
	I don't know how to enroll in health insurance so I can start taking PrEP	0.79
	I wouldn't be able to afford PrEP	0.62
	I don't know how to find a doctor who can give me a PrEP prescription	0.62
	I don't know where to go to get a PrEP prescription	0.54
2. Stigma	I would be concerned about family members finding out if I started taking PrEP	0.67
	I would be concerned about friends finding out if I started taking PrEP	0.66
	I would be uncomfortable asking a doctor for PrEP prescription	0.70
	I would be uncomfortable talking to a doctor about my sexual behavior	0.70
	I would be concerned about sex partners finding out if I started taking PrEP	0.63
3. Drug effects	Not knowing if there are long-term side effects of taking PrEP makes me very uncomfortable	0.77
	I am concerned about side effects or feeling sick from taking PrEP	0.77
	I am concerned that PrEP is only partially effective	0.54
	I would be very uncomfortable taking HIV medicines when I don't have HIV	0.49
	I would take PrEP if there weren't any side effects ^a	0.47
4. Perceived benefits	Taking PrEP would be a good way to protect myself from getting HIV	0.76
	PrEP would help me worry less about getting HIV	0.73
	PrEP use should be encouraged to prevent the spread of HIV	0.72
	I would use condoms less if I started taking PrEP	
5. Risk compensation	I am concerned that I would take more sexual risks if I started taking PrEP	0.78
	I think people who take PrEP will take more sexual risks	0.64
6. Lack of perceived need	I don't need PrEP because I always use condoms	0.75
	I don't need PrEP because I'm not at risk for getting HIV	0.68
7. Mistrust	I don't trust doctors or healthcare providers	0.57
	I don't trust drug companies ^b	0.58
8. Adherence	It would be difficult for me to remember to take PrEP every day	0.47
	It would be difficult for me to see my doctor every 2–3 months for follow-up if I started taking PrEP	0.61

^aCross-loaded with Factor 8.

^bCross-loaded with Factor 3.

PrEP, pre-exposure prophylaxis.

ability to adhere to PrEP were associated with decreased willingness (OR: 0.65; CI: 0.49–0.88; $p < 0.005$). Higher scores in perceived benefits of PrEP were associated with higher odds of willingness (OR: 2.59; CI: 1.78–3.78). See Table 5 for full multivariate regression results.

Discussion

This study examined willingness to take PrEP, and its associated facilitators and barriers, by simultaneously exam-

ining a full range of factors, including the demographic characteristics, sexual risk, and substance use behavior, and attitudes toward PrEP for a diverse group of California YMSM who use GSN apps. Previous investigations examined facilitators and barriers to PrEP uptake qualitatively; others used single-item attitudinal measures that may not fully elucidate key domains related to PrEP use.^{23,33,44,46,64}

Attitudinal factors including drug effects, perceived benefits, medical mistrust, and adherence were all significantly associated with willingness to take PrEP after adjusting for other

TABLE 4. ATTITUDES TOWARD PRE-EXPOSURE PROPHYLAXIS AMONG YOUNGER MEN WHO HAVE SEX WITH MEN IN CALIFORNIA BY WILLINGNESS ($N=687$)

Variable	Total Mean (SD)	Willing Mean (SD)	Unwilling or uninterested Mean (SD)	Mann-Whitney U (p value)
Access/affordability	2.4 (0.7)	2.4 (0.8)	2.3 (0.7)	101019.5 (0.08)
Stigma	2.1 (0.7)	2.0 (0.7)	2.3 (0.7)	116870.5 (<0.001)
Drug effects	2.6 (0.7)	2.4 (0.7)	2.8 (0.6)	125448.5 (<0.001)
Perceived benefits	3.3 (0.6)	3.5 (0.6)	3.0 (0.6)	82656.5 (<0.001)
Risk compensation	2.4 (0.7)	2.3 (0.7)	2.5 (0.7)	117502.5 (<0.001)
Lack of perceived need	2.0 (0.7)	1.8 (0.7)	2.1 (0.7)	121198 (<0.001)
Mistrust	2.0 (0.8)	1.8 (0.8)	2.2 (0.8)	121198 (<0.001)
Adherence	2.0 (0.7)	1.9 (0.7)	2.3 (0.7)	123892 (<0.001)

SD, standard deviation.

TABLE 5. MULTIVARIATE LOGISTIC REGRESSION PREDICTING WILLINGNESS TO TAKE PRE-EXPOSURE PROPHYLAXIS AMONG YOUNGER MEN WHO HAVE SEX WITH MEN IN CALIFORNIA (N=687)

Variable	Odds ratio	95% CI	p
Race/ethnicity			
White	Ref.		
Black/African American	1.27	0.73–2.21	0.397
Hispanic/Latino	1.73	1.01–2.98	0.046
Other/mixed	1.03	0.57–1.85	0.922
Age			
18–24	Ref.		
25–29	0.70	0.47–1.06	0.090
Employment			
Employed full time	Ref.		
Employed part time	0.89	0.52–1.51	0.655
Full time student	1.51	0.88–2.60	0.134
Other	0.83	0.44–1.57	0.561
Education			
Less than high school	Ref.		
Completed part time	1.35	0.55–3.30	0.510
Some college and above	1.15	0.51–2.64	0.734
Income			
<\$9999	Ref.		
\$10,000–\$29,999	0.88	0.54–1.44	0.613
>\$30,000	1.08	0.61–1.93	0.786
Last HIV test			
<6 months ago	Ref.		
6–12 months ago	0.72	0.44–1.18	0.196
>12 months ago	1.10	0.63–1.92	0.737
I've never been tested	1.31	0.70–2.43	0.398
Concern for getting HIV			
Low	Ref.		
Medium	1.87	1.14–3.07	0.014
High	1.84	1.13–3.01	0.015
Had receptive condomless anal sex with a man in last 6 months			
No	Ref.		
Yes	1.32	0.91–1.93	0.145
Other illicit drug use^a			
No	Ref.		
Yes	1.50	0.89–2.52	0.125
Stigma	1.07	0.78–1.47	0.678
Drug effects	0.46	0.33–0.65	<0.001
Perceived benefits	2.59	1.78–3.78	<0.001
Risk compensation	0.83	0.62–1.11	0.204
Lack of perceived need	0.85	0.62–1.15	0.291
Medical mistrust	0.71	0.53–0.96	0.026
Adherence	0.65	0.49–0.88	0.005

^aIncludes Methamphetamine/crystal, heroine, cocaine/crack, ecstasy/MDMA/Molly, ketamine/special K, GHB. CI, confidence interval.

covariates. Future efforts to educate YMSM about PrEP, and engage YMSM in PrEP screening, must pay careful attention to these factors to improve uptake within YMSM communities.

In addition to attitudes about PrEP, Hispanic/Latino ethnicity and concern for contracting HIV were both significantly positively associated with willingness to take PrEP. California leads the United States in its total number of La-

tino residents⁶⁵ and Latinos make up the largest number of new HIV/AIDS cases in the state.⁶⁶ Latino YMSM may be particularly vulnerable to HIV due to lack of health insurance, language barriers, and other cultural factors that impede their ability to negotiate safer sex.⁶⁷ Our data suggest high PrEP willingness among Latino YMSM, indicating the need for culturally and linguistically tailored programs to encourage PrEP uptake in this population.

The relationship between concern for contracting HIV and willingness has been well documented.^{32,35,38,68} These data are consistent with the Health Belief Model, which posits that perceived susceptibility is a key antecedent to behavior change,⁶⁹ and may indicate that messaging about PrEP is reaching some of its target audience, as those who perceive themselves at greater risk display greater willingness to take PrEP. Opportunities for YMSM to reflect on engagement in risk behaviors and encouragement to assess HIV risk may be one strategy for increasing PrEP willingness.⁷⁰ Recent efforts to characterize motivation for PrEP use consider willingness as part of the PrEP Contemplation Stage, which is an important precursor to PrEP uptake.²⁸

Adherence to PrEP is a common concern among MSM and YMSM.^{26,34,71} Efficacy studies demonstrate that even with suboptimal adherence, PrEP can be up to 96% effective.¹⁶ These data must be disseminated widely to YMSM and the medical providers who serve them to allay fears that missing doses forecloses a PrEP prescription. Instead, clear and accessible information about PrEP adherence, strategies for remembering to take the medication, and guidance about what to do if a dose is missed should be highlighted. In our earlier work on PrEP uptake and adherence with YMSM, we found that, although 90% of current PrEP users reported taking their medication 6–7 times/week, difficulty in remembering to take it was one of the top reasons they discontinued it.⁷² Other research on PrEP adherence for YMSM shows that nearly two-thirds are adherent.⁷³ These data suggest the need for further research on barriers and facilitators to PrEP adherence among YMSM to ensure optimal outcomes for users. Future developments in PrEP, such as long-term injectable formats and on-demand PrEP, may be promising solutions to address adherence concerns among YMSM.^{52,74–76}

Greater medical mistrust was associated with less willingness to take PrEP, highlighting the need to address wariness with the health system among YMSM. Previous research documents medical mistrust among both racial/ethnic minority and sexual minority communities.^{77,78} For example, a study of black MSM by Eaton et al.³⁹ showed that nearly one-fifth do not trust doctors and healthcare workers. Another study by Mutchler et al.⁷⁹ noted high levels of misconceptions and mistrust about PrEP among black YMSM and their close friends, including skepticism about the efficacy of PrEP and fears that PrEP might cause people to develop HIV. While we did not see an interaction effect by race/ethnicity in our data, the literature on medical mistrust among black communities is robust.^{77,80–83} Community-based agencies focused on LGB/T health have disseminated guidelines for providers to increase cultural competence in working with sexual minority men.⁸⁴ More work should be done on increasing PrEP knowledge and attitudes in communities of color.⁴⁶ In addition, researchers have noted the importance of attitudes among care providers when discussing PrEP with

YMSM. In a recent mixed methods study of clinicians involved in the NIH-funded Adolescent Medicine Trials Network for HIV/AIDS Interventions (ATN), Mullins et al. found that most thought the CDC guidelines were compatible with their practice; however, there was variability in what they considered to be appropriate characteristics for suitable candidates.⁸⁵ Other studies highlight that providers' willingness to prescribe PrEP is associated with PrEP knowledge⁸⁶ and experience in treating HIV-positive people,^{87,88} suggesting that resources be devoted to PrEP training for clinicians in general, since YMSM are more likely to be seen by general practitioners than HIV specialists,⁸⁹ and PrEP navigation for YMSM patients.⁷⁹

Previous research indicates YMSM are concerned about PrEP's long-term side effects.^{23,68} Fatigue, nausea, and headache have been documented and YMSM should be given strategies to alleviate these symptoms and encouraged to continue the medication, as side effects often resolve with a few weeks.⁹⁰ Literature on "seasons of risk" highlights particular times when individuals may be at an elevated risk for acquiring STIs, including HIV.⁷⁴ Providers should be attuned to these times that may elevate HIV risk for YMSM and emphasize that PrEP does not necessarily require long-term use. Rather, YMSM, in partnership with their providers, can evaluate their use of PrEP over time during routine medical visits to ensure that decisions regarding PrEP uptake and discontinuation are based on accurate risk assessment. As new evidence regarding long-term side effects of PrEP becomes available, providers should share it with their patients.

In this study, perceived benefits of PrEP, including the belief that PrEP offered effective protection against HIV and taking PrEP would decrease worry about infection, were associated with greater willingness. Popular discourse around PrEP has sometimes promoted negative images of those who use it. For instance, PrEP users have been called "irresponsible" and "promiscuous."⁴⁰ This messaging can be damaging to community perceptions about the benefits of PrEP.^{41,91} In response, more can be done to increase positive associations with PrEP. Reframing PrEP users as knowledgeable, responsible men who take an active role in maintaining their health may increase positive associations with PrEP. Providing empirically based, accessible information about PrEP's efficacy can also increase knowledge of its benefits, which are associated with increased willingness to take PrEP.

Limitations

This research should be interpreted in light of several limitations, including convenience sampling and the use of willingness as a primary outcome measure. Previous research has highlighted differences in willingness to use PrEP, intentions to use PrEP, and actual PrEP uptake.^{47,92} Future work should seek to measure all three of these outcomes, in addition to other important stages of the PrEP cascade (e.g., adherence and discontinuation).²⁸ In addition, participants for this study were a self-selected group, which may represent a bias toward those who are more interested in PrEP, and, being from California, may not represent YMSM across the country. Data were self-reported, which may mean over- or under-reporting of willingness to take PrEP. Finally, while we derived a comprehensive list of attitudes based on the

extant literature, we may have missed important issues for YMSM that influence willingness to take PrEP.

Despite the limitations enumerated above, this study contributes to a growing body of literature on factors that influence YMSM's willingness to take PrEP. Prioritizing concerns related to adherence, medical mistrust, and medication side effects in campaigns that promote PrEP may increase interest in and demand for PrEP among YMSM. Once enrolled, providers should speak openly and honestly with YMSM on PrEP about what to do if side effects occur and how to handle missed doses. Providers should also highlight PrEP's limitations, such as its failure to protect against other STIs, as well as its benefits, such as its potential to reduce anxiety around HIV infection. Any step YMSM take to address their sexual health and wellbeing should be seen as an opportunity to educate them about PrEP. For example, as part of AB2640, California now requires that information about PrEP be provided as part of HIV post-test counseling.⁹³ GSN apps may facilitate this process given their popularity among YMSM. Future research should focus on how to foster these opportunities and measure their effectiveness at increasing PrEP willingness and uptake among YMSM.

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