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Early Adopters: Correlates of HIV Chemoprophylaxis Use in Recent Online Samples of US Men Who Have Sex with Men

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Abstract To date, little data on pre-exposure prophylaxis (PrEP) users outside of the clinical trial setting are available. A repeated cross-sectional survey of one of the largest social and sexual networking websites for men who have sex with men (MSM) in the United States was conducted in August 2013 (Wave 1) and January 2014 (Wave 2). Multivariable logistic regression models were used to assess factors associated with having heard of and having taken post-exposure prophylaxis (PEP) and PrEP in Wave 1 (N = 4043) and Wave 2 (N = 2737) separately. In Wave 1, 147 (3.6 %) and 61 (1.5 %) reported using PEP and PrEP, respectively, compared to 119 (4.4 %) and 62 (2.3 %) in Wave 2. Higher-risk sexual behaviors were associated with having taken PEP and PrEP, and previous PEP use was associated with having taken PrEP. Understanding factors that are associated with early use of PrEP may help inform wider utilization of PrEP by at risk MSM.

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Introduction

In the United States, there are nearly 50,000 new cases of HIV every year [1] and men who have sex with men (MSM) continue to bear a disproportionate burden of the epidemic, accounting for more than 60 % of new HIV infections in the United States [1]. MSM are at increased risk for HIV acquisition for reasons at multiple levels [2]. These levels include individual (e.g., higher per-contact probability of HIV transmission during anal intercourse, as compared to other sexual behaviors), social (e.g., social stigma, which is thought to lead to internalized homophobia, potentially leading to depression and/or substance use, affecting self-protective behaviors such as condom use or medication adherence), and structural (e.g., social sanctions leading to delays in seeking health services) [2–5]. To reduce HIV incidence among MSM, new interventions will need to address the diversity of factors that place individuals at higher risk of HIV acquisition.

Several recent trials have demonstrated the efficacy of oral tenofovir–emtricitabine (TDF/FTC) for pre-exposure prophylaxis (PrEP) in MSM in reducing HIV acquisition [6–9]. Post-exposure prophylaxis (PEP) is another antiretroviral chemoprophylaxis strategy that consists of a 28-day regimen of antiretrovirals taken following potential exposure to HIV [10]. Although no randomized trials have been done, observational studies have suggested that PEP is also effective in preventing HIV infection, if individuals are able to identify high risk exposures and seek care within 72 h [11]. To date, several studies in diverse geographic locations

have demonstrated that MSM have some interest in, and willingness to, use PrEP [12–17]. However, other studies have shown low community awareness and limited interest in using PrEP, particularly among those who may be at greatest risk [18, 19]. Utilization of both PEP and PrEP remains limited [20, 21].

Although a number of studies have considered theoretical interest in PrEP [12–14, 17–19, 22–26] to date very few studies have considered actual use of PrEP outside of clinical trial settings. Determination of factors associated with real-world PrEP use is essential to understand how best to allow those at greatest risk to access it. To address this gap in the literature, we conducted online surveys at two timepoints to assess awareness and uptake of both PEP and PrEP for HIV prevention among MSM in the United States. We hypothesized that while utilization of PEP and PrEP would be low, it would increase between the two time points. Determination of factors associated with PEP and PrEP awareness and use over time may help guide implementation efforts.

Methods

Participants and Procedures

In August 2013 and January 2014, an anonymous, repeated cross-section online survey of members of one of the largest Internet sites for MSM seeking partners in the United States was conducted. An email recruitment message was sent to all users of the site who resided in the United States at the time of the study, including a description of the study purpose which included a hyperlink to the study website. Upon visiting the study website, individuals were directed to a more detailed description of study procedures and, if interested, were offered the study consent form and then to the study questionnaire. Participants were eligible for the study if they were HIV-uninfected (by self-report) and were over 18 years of age. Two administration options were offered, one through a desktop computer and one via mobile phone. The mobile phone version of the survey was shorter, and did not include some measures, such as some of the questions regarding access to providers (i.e., if participants had a primary care provider) and insurance status.

The study was approved by the local Institutional Review Board. No incentives were provided for participation in this survey.

Measures

PEP and PrEP

Participants were asked if they had ever heard about PEP, defined as medication taken by mouth AFTER a sexual encounter when the participant believed they may have been exposed to HIV, and PrEP, defined as medication taken by mouth BEFORE a sexual encounter as protection against HIV. They were also asked if they had either taken PEP and/or PrEP.

Sexual Behaviors and HIV Risk

Participants were asked how many male sexual partners they had had in the previous 3 months and how many of these partners were anonymous (i.e., met in a public cruising area or bathhouse, or knew for less than 12 h before having sex). Participants were also asked about the numbers of partners with whom they had condomless insertive or receptive anal sex, how many partners told the participant they were HIV-infected, HIV-uninfected, or of unknown HIV serostatus. Participants were also asked to self-report their perceived risk of contracting HIV on a scale of 1–10, with 1 being no risk, and 10 being the highest risk. Participants were also asked if they had ever been diagnosed with chlamydia, gonorrhea, genital herpes, or syphilis.

Healthcare Access/Utilization

Participants were asked about their health insurance status, which was coded as no insurance, private insurance, Medicaid, Medicare, Tricare/Champus, VA coverage, and other or unknown insurance status.

Demographics

Participants were asked to report their age, sexual orientation (bisexual, heterosexual/straight, gay), education status (coded as college graduate or above versus less than college graduate), annual income (coded as <$6000, $6000 to $11,999, $12,000 to $17,999, $18,000 to $23,999, $24,000 to $29,999, $30,000 to $59,999, and $60,000 or above). Region of residence was determined by asking participants for the zipcode of their current residence, and then coding region of residence as New England, Mideast, Great Lakes, Plains, Southeast, Southwest, Rocky Mountain, and Far West.

Statistical Analysis

Frequencies for descriptive characteristics were calculated with medians and interquartile ranges (IQR) for continuous variables and proportions for categorical variables. Bivariate logistic regression models were built to assess the association between all independent variables and each of 4 dependent variables: (1) heard of PEP; (2) heard of PrEP; (3) ever used PEP; and (4) ever used PrEP. Multivariable logistic regression models were run for each dependent variable of interest, containing all variables included in the bivariate analysis regardless of their statistical significance at the bivariate level. This model building approach was chosen to avoid overestimation of effect estimates in models that require statistical significance at the bivariate level for entry into the multivariable model [27]. Due to the completely anonymous nature of the survey, we were unable to link individual responses between Waves 1 and 2. Models for Waves 1 and 2 were run separately, to assess any differences in factors associated with dependent variables between the two waves. Since not all measures of interest were included in the mobile administration of the survey in Wave 1, two multivariable models for each outcome were run. The first model contained all independent variables that were included in both survey modalities, as well as an indicator variable for survey modality (desktop versus mobile phone). The second model was restricted to the desktop administration only, and included health insurance status, which was not collected in the mobile phone version of the survey. Finally, logistic regression models were run to assess factors associated with taking the desktop version of the survey versus the mobile version. An alpha level of ≤0.05 was considered significant. A complete-case analysis was conducted. All analyses were conducted in Stata 13.1 (StataCorp, College Station, TX).

Results

Descriptive Characteristics

Of 99,694 (Wave 1) and 83,343 (Wave 2) emails that were opened, 15,405 (15.5 %, Wave 1) and 9405 (11.3 %, Wave 2) individuals clicked through to the survey, and 9179 (59.6 %) in Wave 1 and 6109 (64.9 %) in Wave 2 started the survey. A total of 4043 (44.0 %) in Wave 1 and 2737 (44.8 %) in Wave 2 completed all questions without missing data, representing the analytic sample. Table 1 lists frequencies of descriptive statistics by survey wave. Median age was 43 years old in Wave 1 compared to 45 in Wave 2, and 79.1 % identified as gay in Wave 1 compared to 82.1 % in Wave 2. More than two-thirds (67.8 % in Wave 1 and 70.0 % in Wave 2) of the sample were college

graduates, and most (85.9 % in Wave 1 and 87.4 % in Wave 2) of the sample had health insurance. Approximately one-third of the samples in both waves reported having been previously diagnosed with an STI. In Wave 1, of 4043 participants, 1728 (42.7 %) reported having heard of PEP, 1224 (30.3 %) reported having heard of PrEP, 147 (3.6 %) reported having used PEP, and 61 (1.5 %) reported having used PrEP. In Wave 2, of 2737 participants, 1472 (53.8 %) reported having heard of PEP, 1326 (48.5 %) had heard of PrEP, 119 (4.4 %) had used PEP, and 62 (2.3 %) had used PrEP.

Accessing PEP and PrEP

Table 2 lists locations where individuals have obtained PEP or PrEP in Waves 1 and 2 for individuals who provided this information. Participants most frequently obtained PEP and PrEP from their primary care providers, followed by other healthcare providers. A small proportion of individuals obtained PEP and/or PrEP from friends, the Internet, and/or sexual partners.

Awareness of PEP

Table 3 lists the results of multivariable models assessing factors associated with having heard of PEP in Waves 1 and 2. In Wave 1, factors significantly associated with having heard of PEP in multivariable models included younger age (aOR 0.98 per 1-year increase in age, 95 % CI 0.98–0.99), gay identity (aOR 2.53, 95 % CI 2.11–2.03), higher education (aOR 1.95, 95 % CI 1.66–2.29), highest income level ($60,000+/year versus <$6000/year, aOR 1.65, 95 % CI 1.17–2.32), previous diagnosis with an STI (aOR 1.47, 95 % CI 1.27–1.70), and increased number of male sexual partners (aOR 1.01 per additional partner, 95 % CI 1.00–1.02). Living in the Great Lakes, Plains, Southeast, Southwest, and Rocky Mountain geographic areas was associated with decreased odds of having heard of PEP. In Wave 2, individuals identifying as white/Caucasian, African American/Black, Asian, and Native American (compared to any other racial identity) had increased odds of having heard of PEP and only individuals in the Plains region had decreased odds of having heard of PEP. In Wave 2, individuals who had engaged in condomless anal sex in the previous 3 months had decreased odds of having heard of PEP (aOR 0.82, 95 % CI 0.68–0.99). All other associations were similar in magnitude and direction between the two waves.

Experience with PEP

Younger age (aOR 0.97 per 1-year increase in age, 95 % CI 0.96–0.99), gay identity (aOR 2.95, 95 % CI

Table 1 Descriptive statistics for study sample, Wave 1 and Wave 2

	Wave 1 N = 4043	Wave 2 N = 2737
Age (years; median, IQR)	43 (32–52)	45 (34–53)
Gender/sexual identity[a]		
Homosexual/gay	3198 (79.1 %)	2247 (82.1 %)
Bisexual	854 (21.1 %)	548 (20.0 %)
Heterosexual/straight	87 (2.2 %)	54 (2.0 %)
Ethnicity[a]		
Caucasian/white	3441 (85.1 %)	2332 (85.2 %)
African American/black	160 (4.0 %)	91 (3.3 %)
Hispanic/Latino/Chicano	315 (7.8 %)	244 (8.9 %)
Asian/Asian American/Pacific Islander	114 (2.8 %)	80 (2.9 %)
Native American/American Indian	96 (2.4 %)	47 (1.7 %)
Multiracial	116 (2.9 %)	80 (2.9 %)
College graduate or above (versus less than college education)	2741 (67.8 %)	1917 (70.0 %)
Annual income (pre-tax)		
<$6000	199 (4.9 %)	133 (4.9 %)
$6000–$11,999	192 (4.8 %)	103 (3.8 %)
$12,000–$17,999	201 (5.0 %)	148 (5.4 %)
$18,000–$23,999	249 (6.2 %)	160 (5.9 %)
$24,000–$29,999	291 (7.2 %)	189 (6.9 %)
$30,000–$59,999	1130 (28.0 %)	793 (29.0 %)
$60,000+	1781 (44.1 %)	1211 (44.3 %)
Any health insurance (N = 2804 in Wave 1)	2408 (85.9 %)	2392 (87.4 %)
Country region[b]		
New England	584 (14.4 %)	424 (15.5 %)
Mideast	607 (15.0 %)	415 (15.2 %)
Great Lakes	546 (13.5 %)	394 (14.4 %)
Plains	337 (8.3 %)	209 (7.6 %)
Southeast	1021 (25.3 %)	652 (23.8 %)
Southwest	331 (8.2 %)	230 (8.4 %)
Rocky Mountain	172 (4.3 %)	114 (4.2 %)
Far West	445 (11.0 %)	299 (10.9 %)
Ever diagnosed with an STI[c]	1272 (31.5 %)	923 (33.7 %)
Number of male sexual partners in past 3 months (median, IQR)	3 (2–6)	4 (2–8)
Any condomless anal sex in past 3 months (insertive or receptive)	2457 (60.8 %)	2027 (74.1 %)
Any anonymous partners in past 3 months	2619 (64.8 %)	1905 (69.6 %)
Self-perceived risk of HIV (median, IQR of scale of 1–10; 1 = no risk, 10 = high risk)	3 (2–5)	3 (2–5)
Aware of PEP	1728 (42.7 %)	1472 (53.8 %)
Aware of PrEP	1224 (30.3 %)	1326 (48.5 %)
Used PEP	147 (3.6 %)	119 (4.4 %)
Used PrEP	61 (1.5 %)	62 (2.3 %)

[a] The question asked respondents to: "check all that apply" percentages may not add up to 100 %

[b] *New England* CT, ME, MA, NH, RI, VT; *Mid-Atlantic* DE; District of Columbia, MD, NJ, NY, PA; *Great Lakes* IL, IN, MI, OH, WI; *Plains* IA, KS, MN, MO, NE, ND, SD; *Southeast* AL, AR, FL, GA, KY, LA, MI, NC, SC, TN, VA, WV; *Rocky* CO, ID, MT, UT, WY; *Far West* AK, CA, HI, NV, OR, WA

[c] Includes chlamydia, genital herpes, gonorrhea, and/or syphilis

Table 2 Location where individuals obtained PEP or PrEP, Wave 1 and Wave 2

| | Wave 1 | | Wave 2 | |
Location	PEP (N = 173)	PrEP (N = 65)	PEP (N = 192)	PrEP (N = 101)
Primary healthcare provider	97 (56.1 %)	35 (53.9 %)	100 (52.1 %)	67 (66.3 %)
Healthcare provider other than primary	70 (40.5 %)	18 (27.7 %)	87 (45.3 %)	31 (30.7 %)
Friend	10 (5.8 %)	6 (9.2 %)	6 (3.1 %)	1 (1.0 %)
Over the Internet	7 (4.1 %)	2 (3.1 %)	0	2 (2.0 %)
Sex partner	5 (2.9 %)	2 (3.1 %)	2 (1.0 %)	1 (1.0 %)

Participants could choose more than one answer; totals may not add up to 100 %

1.56–5.58), white/Caucasian versus all other race/ethnicities (aOR 1.97, 95 % CI 1.01–3.85), African American versus all other race/ethnicities (aOR 3.15, 95 % CI 1.30–7.62), and multiracial versus all other race/ethnicities (aOR 2.55, 95 % CI 1.15–5.66) identity, higher education (aOR 2.11, 95 % CI 1.29–3.46), history of diagnosis with an STI (aOR 1.75, 95 % CI 1.23–2.49), increased number of male sexual partners (aOR 1.02 per additional partner, 95 % CI 1.01–1.04), and anonymous partners in the previous 3 months (aOR 1.64, 95 % CI 1.04–2.59) were associated with having ever taken PEP. Age, race/ethnicity, and anonymous partners were not associated with ever having taken PEP in Wave 2. All other associations were similar in direction and magnitude.

Awareness of PrEP

Table 4 lists results of multivariable models assessing factors associated with having heard of PrEP in Waves 1 and 2. In Wave 1, younger age (aOR 0.98, 95 % CI 0.97–0.98), gay identity (aOR 2.33, 95 % CI 1.89–2.86), higher education (aOR 1.53, 95 % CI 1.29–1.83), higher income ($60,000+/year versus <$6000/year; aOR 1.68, 95 % CI 1.15–2.46), previous diagnosis with an STI (aOR 1.51, 95 % CI 1.30–1.77), increased number of male sexual partners in the past 3 months (aOR 1.01 per additional partner, 95 % CI 1.00–1.02), and having previously used PEP (aOR 4.83, 95 % CI 2.37–7.12) were associated with increased odds of having heard of PrEP. In Wave 2, African American or multiracial identity was associated with increased odds of having heard of PrEP. Other associations were similar in magnitude and direction to Wave 1.

Experience with PrEP

In Wave 1, higher education (aOR 2.50, 95 % CI 1.02–6.11), previous history of an STI (aOR 2.48, 95 % CI 1.37–4.51), number of male sexual partners in the previous 3 months (aOR 1.02, 95 % CI 1.01–1.05), and having used PEP in the past (aOR 22.5, 95 % CI 12.4–40.9) were

associated with increased odds of having used PrEP. In Wave 2, gay identity and history of STI were not associated with having taken PrEP. All other associations were similar in magnitude and direction.

Discussion

In this analysis of an online sample of MSM in the United States, we found suboptimal awareness and low utilization of both PEP and PrEP soon after FDA approval of PrEP for prevention of acquisition of HIV infection. The majority of MSM who could benefit from PrEP were not using it. Awareness and use increased between the two waves in August 2013 and January 2014, however PrEP use and awareness remained suboptimal in January 2014. Although these two time points were relatively close together, the availability and scale-up of PrEP programs in the United States is changing rapidly. While PrEP has only recently received FDA approval, PEP has been used for HIV prevention for considerably longer [10]. Low rates of PEP utilization suggest that, even if MSM are aware of PEP, there may be difficulties in recognizing their high-risk behaviors or knowing where to obtain it, since PEP entails self-identification of a high-risk exposure and care-seeking with 72 h for optimal chemo-protection. Structural or interpersonal barriers, such as stigma and poverty, may limit the ability of individuals to seek out timely care [28, 29]. Recurrent exposure to HIV and high HIV incidence following the use of PEP has been documented, suggesting that even if PEP is effective for a single exposure, additional interventions, such as PrEP, may be necessary to curb HIV incidence [20, 30].

Prior use of PEP was associated with use of PrEP in both survey waves. Individuals who become aware of and who have accessed PEP may be more likely to utilize PrEP, since they had prior experience with antiretrovirals for HIV prevention. Participants who sought PEP may also have been counseled by their providers about PrEP, which could have facilitated the transition on to PrEP. This finding is consistent with previous studies, which have demonstrated

Table 3 Multivariable results from models assessing factors associated with having heard of and taken PEP

	Heard of PEP		Taken PEP	
	Wave 1 OR (95 % CI) N = 4043	Wave 2 OR (95 % CI) N = 2737	Wave 1 OR (95 % CI) N = 4043	Wave 2 OR (95 % CI) N = 2737
Age (years)	**0.98 (0.98–0.99)**	**0.99 (0.98–1.00)**	**0.97 (0.96–0.99)**	NS
Gay sexual identity/orientation (versus any other)	**2.53 (2.11–3.03)**	**1.60 (1.31–1.97)**	**2.95 (1.56–5.58)**	**4.94 (1.80–13.6)**
Race/ethnicity[a]	NS		NS	
Caucasian/white		**1.81 (1.24–2.65)**	**1.97 (1.01–3.85)**	
African American/black		**1.77 (1.03–3.06)**	**3.15 (1.30–7.62)**	
Hispanic/Latino/Chicano		1.22 (0.82–1.82)	1.87 (0.95–3.69)	
Asian/Asian American/Pacific Islander		**2.26 (1.26–4.05)**	2.06 (0.80–5.28)	
Native American/American Indian		**2.09 (1.09–3.99)**	0.43 (0.09–2.18)	
Multiracial		1.62 (0.95–2.77)	**2.55 (1.15–5.66)**	
College graduate or above (versus less than college education)	**1.95 (1.66–2.29)**	**1.61 (1.34–1.94)**	**2.11 (1.29–3.46)**	**1.75 (1.04–2.96)**
Annual income (pre-tax)	Ref	NS	NS	NS
<$6000	0.76 (0.49–1.19)			
$6000–$11,999	1.07 (0.69–1.65)			
$12,000–$17,999	0.72 (0.47–1.11)			
$18,000–$23,999	1.05 (0.70–1.57)			
$24,000–$29,999	1.18 (0.84–1.65)			
$30,000–$59,999	**1.65 (1.17–2.32)**			
$60,000+				
Country region[b]			NS	NS
New England	Ref	Ref		
Mideast	0.97 (0.76–1.23)	0.78 (0.59–1.04)		
Great Lakes	**0.61 (0.47–0.79)**	0.82 (0.61–1.09)		
Plains	**0.65 (0.49–0.87)**	**0.68 (0.48–0.96)**		
Southeast	**0.76 (0.61–0.95)**	0.78 (0.61–1.01)		
Southwest	**0.58 (0.43–0.77)**	0.91 (0.65–1.29)		
Rocky Mountain	**0.61 (0.42–0.88)**	0.75 (0.49–1.16)		
Far West	1.07 (0.82–1.40)	1.07 (0.78–1.48)		
Ever diagnosed with an STI[c]	**1.47 (1.27–1.70)**	**1.85 (1.56–2.20)**	**1.75 (1.23–2.49)**	2.21 (1.48–3.30)
Number of male sexual partners in past 3 months	**1.01 (1.00–1.02)**	**1.04 (1.02–1.07)**	**1.02 (1.01–1.04)**	1.09 (1.05–1.13)
Any condomless anal sex in past 3 months (insertive or receptive)	NS	**0.82 (0.68–0.99)**	NS	1.77 (1.03–3.07)
Any anonymous partners in past 3 months	NS	NS	**1.64 (1.04–2.59)**	NS
Mobile survey administration[d]	**0.77 (0.66–0.90)**		NS	
Any health insurance[e]		**1.36 (1.05–1.75)**		NS

Bold values that were statistically significant in the multivariable analyses at the $p < 0.05$ level

NS not significant

Only significant results from multivariable analyses are presented in this table; refer to Supplementary Tables 1 and 3 for results of full multivariable models and bivariate models

[a] Each race/ethnicity was included separately versus all others

[b] *New England* CT, ME, MA, NH, RI, VT; *Mideast* DE; District of Columbia, MD, NJ, NY, PA; *Great Lakes* IL, IN, MI, OH, WI; *Plains* IA, KS, MN, MO, NE, ND, SD; *Southeast* AL, AR, FL, GA, KY, LA, MI, NC, SC, TN, VA, WV; *Rocky* CO, ID, MT, UT, WY; *Far West* AK, CA, HI, NV, OR, WA

[c] Includes chlamydia, genital herpes, gonorrhea, and/or syphilis

[d] Question was not asked in Wave 2

[e] Question was not asked in mobile administration of the survey

Table 4 Multivariable results from models assessing factors associated with having heard of and taken PrEP

	Heard of PrEP		Taken PrEP	
	Wave 1 OR (95 % CI) N = 4043	Wave 2 OR (95 % CI) N = 2737	Wave 1 OR (95 % CI) N = 4043	Wave 2 OR (95 % CI) N = 2737
Age (years)	**0.98 (0.97–0.98)**	**0.99 (0.98–1.00)**	NS	**0.97 (0.94–1.00)**
Gay sexual identity/orientation (versus any other)	**2.33 (1.89–2.86)**	**1.39 (1.12–1.71)**	NS	NS
Race/ethnicity[a]	NS	1.31 (0.90–1.91)		
Caucasian/white		1.75 (1.01–3.01)	NS	NS
African American/black		0.95 (0.64–1.41)		
Hispanic/Latino/Chicano		1.36 (0.78–2.37)		
Asian/Asian American/Pacific Islander		1.51 (0.81–2.84)		
Native American/American Indian		1.70 (1.00–2.89)		
Multiracial				
College graduate or above (versus less than college education)	**1.53 (1.29–1.83)**	**1.56 (1.30–1.89)**	**2.50 (1.02–6.11)**	**2.95 (1.26–6.88)**
Annual income (pre-tax)			NS	NS
<$6000	Ref	Ref		
$6000–$11,999	0.86 (0.53–1.42)	0.63 (0.37–1.10)		
$12,000–$17,999	1.48 (0.93—2.36)	0.64 (0.39–1.05)		
$18,000–$23,999	0.92 (0.58–1.48)	**0.59 (0.36–0.96)**		
$24,000–$29,999	1.26 (0.81–1.96)	0.70 (0.44–1.13)		
$30,000–$59,999	1.27 (0.87–1.86)	0.66 (0.44–1.00)		
$60,000+	**1.68 (1.15–2.46)**	0.73 (0.48–1.11)		
Country region[b]		NS	NS	NS
New England	Ref			
Mideast	1.14 (0.88–1.47)			
Great Lakes	0.82 (0.63–1.08)			
Plains	0.81 (0.59–1.10)			
Southeast	**0.77 (0.61–0.97)**			
Southwest	**0.64 (0.46–0.88)**			
Rocky Mountain	0.74 (0.50–1.11)			
Far West	1.08 (0.82–1.43)			
Ever diagnosed with an STI[c]	**1.51 (1.30–1.77)**	**1.93 (1.62–2.30)**	**2.48 (1.37–4.51)**	NS
Number of male sexual partners in past 3 months	**1.01 (1.00–1.02)**	**1.04 (1.02–1.07)**	**1.02 (1.01–1.05)**	**1.09 (1.04–1.15)**
Any condomless anal sex in past 3 months (insertive or receptive)	NS	**NS**	NS	**3.67 (1.22–11.1)**
Used PEP in the past	**4.83 (3.27–7.12)**	**8.87 (4.57–17.2)**	**22.5 (12.4–40.9)**	**31.5 (16.7–59.7)**
Mobile survey administration[d]	**0.72 (0.61–0.85)**		NS	

Bold values that were statistically significant in the multivariable analyses at the $p < 0.05$ level

NS not significant

Only significant results from multivariable analyses are presented in this table; refer to Supplementary Tables 2 and 4 for results of full multivariable models and bivariate models

[a] Each race/ethnicity was included separately versus all others

[b] *New England* CT, ME, MA, NH, RI, VT; *Mideast* DE; District of Columbia, MD, NJ, NY, PA; *Great Lakes* IL, IN, MI, OH, WI; *Plains* IA, KS, MN, MO, NE, ND, SD; *Southeast* AL, AR, FL, GA, KY, LA, MI, NC, SC, TN, VA, WV; *Rocky* CO, ID, MT, UT, WY; *Far West* AK, CA, HI, NV, OR, WA

[c] Includes chlamydia, genital herpes, gonorrhea, and/or syphilis

[d] Question was not asked in Wave 2

that prior use of PEP by MSM was associated with intent to use, and experience with, PrEP [15, 21]. These results highlight that PEP users are a key population for consideration for PrEP, particularly if they have accessed PrEP more than once in a short period of time.

In this study, individuals with a history of STI diagnosis had both more frequently heard of PEP and PrEP and used PEP and PrEP. This finding may be reflecting that individuals who reported STIs may have increased health literacy and increased access to healthcare services, or providers may have included counseling about PEP and PrEP as a result of their STI diagnosis. Furthermore, individuals screening for STIs have likely discussed sexual behaviors with their healthcare providers, who may be more likely to receive counseling about PEP and PrEP as they may have discussed their sexual behaviors with providers. Studies have shown that asking about sexual orientation and behaviors is acceptable to patients in healthcare settings in the United States [31, 32]. Discussing sexual health particularly in the context of primary care may be especially important to curb the spread of HIV and other STIs [32].

In addition to a history of STIs and recent condomless anal sex, respondents who reported having anonymous sex partners, increased number of sexual partners, and using drugs during sex were more likely to have used PEP. Current FDA and CDC guidelines for the use of PrEP include guidelines based on higher-risk sexual behavior, including having an increased number of partners and a history of inconsistent condom use [33]. In the current study, self-perceived risk of HIV was not associated with increased PEP or PrEP use or awareness of either modality in multivariable models. Awareness of HIV risk is essential if individuals who might benefit are to initiate PEP and PrEP. A previous study in Brazil demonstrated that HIV seroconversions that occurred following non-occupational PEP prescription were among individuals who chose not to take PEP due to underestimation of their risk [11]. Counseling patients on how to identify sexual risks and to optimize their adherence to PEP or PrEP regimens will be important to maximize effectiveness of these HIV prevention interventions.

The results of this study highlight suboptimal use of PEP and PrEP among MSM. Reasons for suboptimal use of PEP and PrEP are likely related to awareness of the HIV prevention strategies as well as factors such as cost [16]. Furthermore, both PEP and PrEP require discussing sexual behaviors with healthcare providers. This may pose a barrier to accessing both HIV prevention modalities, particularly in geographic areas with higher levels of social stigma towards sexual minority populations [28]. Increasing awareness of PEP and PrEP may increase uptake of PEP and PrEP, but it is likely there are other barriers

associated with low use of antiretroviral chemoprophylaxis. Future work should focus on identification of these barriers and testing strategies to overcome them.

The results of this study must be interpreted in the context of several limitations. This study was a convenience sample recruited through an online social and sexual networking website. Since data about individuals who did not respond to the survey was not collected, it is unknown the degree to which they differed from the responders, which could potentially result in selection bias. There was a large degree of attrition over the course of the survey, but it was not dissimilar to that seen in other online samples of MSM [14, 15]. The two waves of the survey were only 5 months apart, and with just two time points this analysis may be limited in its ability to detect time trends in PrEP use. However, PrEP use is changing rapidly in the United States, so it is not implausible that use of PrEP would change in this period of time. Study measures were collected via self-report, which may introduce misclassification was well as the potential for social desirability bias. However, the anonymous nature of the survey may reduce bias as compared to face-to-face survey interviewing. Previous studies have demonstrated that audio computer-assisted self-interviewing (ACASI) reduces bias compared to face-to-face interviewing [34, 35]. However, studies assessing bias in anonymous, online survey administration compared to ACASI or face-to-face interviewing have yet to be done. The sample was generally White and of high socioeconomic status, which may not be generalizable to the populations where HIV is spreading most rapidly in the United States, like young Black and Latino MSM. Future work should be done to assess barriers and facilitators to PrEP uptake among younger MSM and MSM of color, who bear the highest burden of HIV incidence in the United States [1]. PrEP roll-out needs to be culturally tailored, so that it can achieve optimal benefits for protection against HIV, and such work is necessary for understanding how to maximize PrEP effectiveness in the highest incidence populations in the United States.

Despite these limitations, this study is an assessment of PEP and PrEP attitudes and experience among the largest sample of MSM in the United States studied to date, and provides early evidence of factors associated with the use of PrEP outside of a clinical trial. Findings demonstrate suboptimal awareness of bio-behavioral HIV prevention strategies, and low utilization of both PEP and PrEP. Efforts to increase uptake of PEP and PrEP, given its demonstration of high levels of PrEP efficacy for HIV prevention for MSM [6] should focus on educating consumers and providers about its benefits in preventing HIV transmission. Further work is necessary to better understand barriers and facilitators to obtaining and accessing PEP and PrEP. The current study suggests that further work

needs to be done in all these domains if PrEP implementation can play a role in decreasing HIV spread among MSM.

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