



Increases in Pre-exposure Prophylaxis Use and Decreases in Condom Use: Behavioral Patterns Among HIV-Negative San Francisco Men Who have Sex with Men, 2004–2017

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Published online: 10 October 2018

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Abstract

Using data from the National HIV Behavioral Surveillance of men who have sex with men (MSM), we estimated the prevalence of sexual behaviors among HIV-negative San Francisco MSM between 2004 and 2017. We estimate a recent increase in the 1-year prevalence of pre-exposure prophylaxis (PrEP) use, from 9.8% in 2014 to 44.9% in 2017. Over that same period, we estimate a decrease in the prevalence of consistent condom use, from 18.5 to 9.4%, and an increase in the percent of individuals with multiple condomless anal intercourse partners. We conclude that while risks for HIV infection may be decreasing among San Francisco MSM due, in part, to increases in PrEP use, the population faces increased risks for other sexually transmitted infections (STIs). Because PrEP alone does not protect against other STIs, we strongly recommend that PrEP users use condoms when possible, routinely screen for STIs, and disclose infections with sexual partners.

Keywords Men who have sex with men (MSM) · Pre-exposure prophylaxis (PrEP) · Condomless anal intercourse · Serosorting · Seroadaptive behaviors

Introduction

At policy and individual levels, HIV prevention strategies among men who have sex with men (MSM) have changed markedly over the last 15 years. In brief, increased serostatus awareness and the effects of antiretroviral treatment (ART) on acquisition and transmission have added new strategies—serosorting and other seroadaptive behaviors, treatment of HIV-positive individuals (treatment as prevention), and emtricitabine/tenofovir as pre-exposure prophylaxis (PrEP)—to the prevention toolkit, which historically primarily included abstinence, condom use, and partner reduction. In San Francisco, recent changes have been uniquely influenced by city policy and services: the San Francisco

Department of Public Health has included PrEP as part of its HIV prevention strategy since 2013 while the City Clinic offers free or low-cost HIV and sexually transmitted infections (STI) services, including condoms, PrEP, and STI diagnosis and treatment.

Surveillance of sexual behaviors among MSM over time in cities such as San Francisco can document changing HIV prevention strategies. For example, differences and changes in risks can provide context to changes in HIV incidence, and show where HIV prevention campaigns are succeeding or struggling. Additionally, because sexual behaviors are related to other health outcomes, such as other STI, such data can offer insight on other aspects of MSM health. In this Brief Report, we estimate the prevalence of sexual behaviors among HIV-negative San Francisco MSM, cross-sectionally between 2004 and 2017, with a focus on changes between 2014 and 2017—an era of increased PrEP promotion.

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Methods

Our data are from San Francisco's implementations of the Centers for Disease Control and Prevention's (CDC) National HIV Behavioral Surveillance for MSM (NHBS

MSM). The cross-sectional surveys, conducted via time-location sampling in 2004, 2008, 2011, 2014, and 2017 are described in detail elsewhere [1–3]. Individuals were eligible for participation if they were 18 years of age or older, male (by self-identification and assignment at birth), residing in the San Francisco Bay Area, and reported a lifetime history of oral or anal sex with a male partner. We obtained informed consent for the staff-administered surveys and, separately, HIV testing.

The surveys consisted of national and local components. Our local surveys in San Francisco included detailed questions on up to five most-recent sexual partnerships within the last 6 months. Responses to these questions allow us to classify individuals according to their behavioral pattern in the last 6 months, using a previously described hierarchical approach that includes seroadaptive strategies. In this system, each classification takes precedence over any lower-level classification [3–7]. For example, we classify PrEP users who engage in consistent condom use as PrEP users since consistent condom use is a lower-level classification than PrEP use in our hierarchy. Our ordering of classifications roughly corresponds to average risk for HIV infection [8]. The mutually exclusive categories in the behavioral hierarchy are, in descending order: no anal intercourse; PrEP use (defined as use in the last 12 months rather than the last 6 months since our pre-2017 surveys did not ask about 6-month occurrence of PrEP use); consistent condom use, defined as no condomless anal intercourse (C-AI); pure serosorting, defined by no anal intercourse with HIV-negative or unknown-status partners; condom serosorting, defined by no C-AI with HIV-positive or unknown-HIV-status partners; seropositioning, defined by no receptive anal intercourse with HIV-positive or unknown-status partners; condom seropositioning, defined by no condomless receptive anal intercourse with HIV-positive or unknown-status partners; and no discernible risk-reduction strategy, defined by not meeting any of the above criteria. We assumed no PrEP use in 2004 and 2008, as the surveys in those years did not, unfortunately, assess for preventative use of HIV medication. PrEP questions in the 2011, 2014, and 2017 surveys have not specified the drug formulation. Thus, we caution that our measure of PrEP use does not refer to any specific drug or drug combination, particularly for the 2011 survey, which occurred prior to FDA approval of emtricitabine/tenofovir as PrEP (in a prior manuscript [3], we chose to assume no PrEP use in 2011 due to this uncertainty; we do not use that decision in the present study). We define unknown-status-partners relative to the respondents' knowledge; that is, it is not necessarily the case that an unknown-status partner does not know his own HIV status.

In an alternate version of the behavioral classification, we remove the PrEP category, but reclassify PrEP users based on their sexual behaviors. For example, in the without-PrEP

classification, PrEP users who reported always using condoms are classified as having consistent condom use. The re-classification allows for examination of sexual behaviors occurring overall, regardless of whether they occur alongside PrEP use, and provides insight on behavioral changes over periods of increased PrEP use.

Other behaviors of interest in this study, include the number of C-AI partners, the number of known HIV-positive partners, and the number of unknown-status partners. The recall period of interest for these behaviors of interest, which we measured using the partnership questions in the local surveys (described above), is the last 6 months.

Restricting analysis in this study to self-reported HIV-negative individuals who completed the local component of the survey, we computed, for each year, the number and percent of individuals in each behavioral group of interest. The percentages represent estimated prevalence in the underlying populations. We applied χ^2 tests for trend to assess for changes in prevalence over time. We applied χ^2 tests to assess for differences in demographic or behavioral characteristics between 2014 and 2017. We used a critical level of $\alpha=0.05$ for all tests.

Results

NHBS MSM in San Francisco recruited 1205, 402, 367, 297, and 392 self-reported HIV-negative MSM who completed the local component of the survey in 2004, 2008, 2011, 2014, and 2017, respectively. A prior publication presents demographic estimates for 2004–2014.³ Statistical tests suggest that, compared to the 2014 population, the 2017 population had a larger percent of individuals with a college degree (68.6% vs. 55.9%, $\chi^2=11.2$, $p<0.01$) and a yearly income of \$50,000 or greater (64.5% vs. 53.7%, $\chi^2=7.6$, $p=0.01$). We failed to detect differences in age, race/ethnicity, or insurance status.

Table 1 shows the behavioral hierarchy, PrEP use, and partner selection over time. The percentages in this table represent estimated prevalence in the underlying populations; for brevity, we omit the word “estimate” or related language in this section. In the behavioral classification with PrEP use, we see an increase in the one-year prevalence of PrEP use, from 0% in 2004 to 43.1% in 2017, with a 33.3 percentage-point increase between 2014 and 2017. The test for trend suggests a shift in the proportions of behavior categories ($\chi^2=559.4$, $p<0.01$). The overall prevalence of use in 2017 (that is, without the hierarchical classification) was 44.9%. The increase in PrEP use has been accompanied by a downward trend in the prevalence of consistent condom use ($\chi^2=136.0$, $p<0.01$), from 36.8% in 2004 to 7.1% in 2017, with a 10.4 percentage-point decrease between 2014 and 2017.

Table 1 Behaviors among HIV-negative MSM, San Francisco, 2004–2017

	2004	2008	2011	2014	2017	χ^2, p
Behavioral classification, last 6 months						
No anal intercourse	287 (23.8)	114 (28.4)	84 (22.9)	62 (20.9)	84 (21.4)	1.8, 0.18
PrEP use ^a	0 (0.0)	0 (0.0)	5 (1.4)	29 (9.8)	169 (43.1)	559.4, 0.00
Consistent condom use	444 (36.8)	123 (30.6)	111 (30.2)	52 (17.5)	28 (7.1)	136.0, 0.00
Pure serosorting	283 (23.5)	100 (24.9)	109 (29.7)	106 (35.7)	84 (21.4)	2.6, 0.10
Condom serosorting	67 (5.6)	16 (4.0)	24 (6.5)	15 (5.1)	5 (1.3)	6.4, 0.01
Seropositioning	61 (5.1)	19 (4.7)	23 (6.3)	16 (5.4)	10 (2.6)	1.5, 0.22
Condom seropositioning	10 (0.8)	5 (1.2)	2 (0.5)	2 (0.7)	1 (0.3)	1.3, 0.25
No discernible strategy	53 (4.4)	25 (6.2)	9 (2.5)	15 (5.1)	11 (2.8)	1.5, 0.21
Behavioral classification without PrEP use, last 6 months						
No anal intercourse	287 (23.8)	114 (28.4)	84 (22.9)	62 (20.9)	84 (21.4)	1.8, 0.18
Consistent condom use	444 (36.8)	123 (30.6)	113 (30.8)	55 (18.5)	37 (9.4)	115.7, 0.00
Pure serosorting	283 (23.5)	100 (24.9)	110 (30.0)	120 (40.4)	169 (43.1)	71.1, 0.00
Condom serosorting	67 (5.6)	16 (4.0)	24 (6.5)	16 (5.4)	21 (5.4)	0.0, 0.96
Seropositioning	61 (5.1)	19 (4.7)	25 (6.8)	21 (7.1)	36 (9.2)	9.3, 0.00
Condom seropositioning	10 (0.8)	5 (1.2)	2 (0.5)	2 (0.7)	3 (0.8)	0.1, 0.72
No discernible strategy	53 (4.4)	25 (6.2)	9 (2.5)	21 (7.1)	42 (10.7)	15.4, 0.00
PrEP use, last 12 months						
PrEP use	0 (0.0)	0 (0.0)	5 (1.4)	29 (9.8)	176 (44.9)	583.2, 0.00
Number of condomless anal intercourse partners, last 6 months						
0	731 (60.7)	237 (59.0)	197 (53.7)	117 (39.4)	121 (30.9)	119.3, 0.00
1	339 (28.1)	116 (28.9)	110 (30.0)	94 (31.6)	101 (25.8)	0.0, 0.95
2	82 (6.8)	32 (8.0)	28 (7.6)	29 (9.8)	52 (13.3)	14.3, 0.00
3	28 (2.3)	10 (2.5)	17 (4.6)	27 (9.1)	38 (9.7)	50.0, 0.00
4	12 (1.0)	4 (1.0)	9 (2.5)	14 (4.7)	30 (7.7)	52.6, 0.00
5+	13 (1.1)	3 (0.7)	6 (1.6)	16 (5.4)	50 (12.8)	103.1, 0.00
Number of HIV-infected partners, last 6 months						
0	1103 (91.5)	357 (88.8)	313 (85.3)	255 (85.9)	321 (81.9)	31.4, 0.00
1	86 (7.1)	39 (9.7)	45 (12.3)	34 (11.4)	61 (15.6)	25.9, 0.00
2+	16 (1.3)	6 (1.5)	9 (2.5)	8 (2.7)	10 (2.6)	4.4, 0.04
Number of unknown-status partners, last 6 months						
0	813 (67.5)	284 (70.6)	297 (80.9)	245 (82.5)	317 (80.9)	50.4, 0.00
1	182 (15.1)	60 (14.9)	34 (9.3)	26 (8.8)	38 (9.7)	15.4, 0.00
2+	210 (17.4)	58 (14.4)	36 (9.8)	26 (8.8)	37 (9.4)	28.1, 0.00

^aWithin the last 12 months

In the without-PrEP behavioral classification, we also see a downward trend in consistent condom use ($\chi^2 = 115.7$, $p < 0.01$), from 36.8% in 2004 to 9.4% in 2017. This has been accompanied by an upward trend in pure serosorting ($\chi^2 = 71.1$, $p < 0.01$), from 23.5% in 2004 to 43.1% in 2017, and an upward trend in having no discernible strategy ($\chi^2 = 15.4$, $p < 0.01$), from 4.4% in 2004 to 10.7% in 2017.

In the bottom half of Table 1, we see a downward trend in the percent of individuals with no C-AI partner ($\chi^2 = 119.3$, $p < 0.01$), from 60.7% in 2004 to 30.9% in 2017. The percent of individuals with five or more C-AI partners rose from 1.1% in 2014 to 12.8% in 2017 ($\chi^2 = 103.1$, $p < 0.01$). These changes have been accompanied by a downward trend in the percent of individuals with no HIV-positive partner

($\chi^2 = 31.4$, $p < 0.01$), from 91.5% in 2004 to 81.9% in 2017 and an upward trend in the percent of individuals with no unknown-status partner ($\chi^2 = 50.4$, $p < 0.01$), from 67.5% in 2004 to 80.9% in 2017.

Discussion

Our estimates suggest a dramatic recent increase in the one-year prevalence of PrEP use among HIV-negative MSM in San Francisco, rising from fewer than one in ten in 2014 towards nearly half of HIV-negative men by 2017. An increase of this magnitude can plausibly have contributed to a continuing decline in HIV incidence in San Francisco. A

recent modeling study estimates, for example, that in 2014, PrEP use prevented roughly 40 HIV infections among San Francisco MSM [8], a year in which there were 71 fewer diagnoses among non-injecting MSM compared to 2013 [9]. Incidence has continued to decline since this time, in parallel with the increases in PrEP use suggested by the present study: the local health department reported 155 new infections among non-injecting MSM in 2016, compared to 224 in 2014 [9].

This reduction in HIV incidence is concurrent with a large decrease in consistent condom use. Between 2014 and 2017, we estimate that the percent of HIV-negative MSM in San Francisco practicing consistent condom use fell from 17.5 to 7.1%. This has been accompanied by an increase in the number of condomless anal intercourse sexual partners. We estimate, for example, that the percent of HIV-negative MSM with 5 or more sexual partners increased from 5.4% in 2014 to 12.8% in 2017. Together, these findings may explain why San Francisco MSM are facing increases in sexually transmitted infections (STIs) such as chlamydia, gonorrhea, and syphilis. Over the last few years, San Francisco has reported steep increases in these STIs among male residents: between 2014 and 2016, the number of diagnoses of rectal chlamydia increased from 1408 to 2127 while the number of cases of rectal gonorrhea increased from 874 to 1415 [10, 11]. Similarly, NHBS suggests that between 2014 and 2017, the one-year prevalence of gonorrhea among San Francisco MSM increased from 12.9% to 19.0% ($\chi^2 = 5.5$, $p = 0.02$) while the prevalence of chlamydia increased from 7.9% to 17.0% ($\chi^2 = 15.3$, $p < 0.01$). These increases are larger than expected from trends in STI testing—NHBS suggests just a slight recent increase in the percent of San Francisco MSM testing for STI once a year or more (64.5% in 2014 to 71.3% in 2017, $\chi^2 = 4.3$, $p = 0.04$)—and represent a serious public health problem, particularly because some STIs may be increasingly difficult to treat. Strains of gonorrhea, for example, are now resistant to all current antibiotics [12]. In summary, the increase in the use of PrEP accompanying a decrease in the use of condoms may explain why HIV continues to decline while STIs continue to rise.

We acknowledge limitations to our approach. Notably, because our partnership questions only assess for up to five recent sexual partnerships and because behavioral patterns change over time, our behavioral classification does not provide a complete characterization of individuals' sexual partners and sexual behaviors. Nevertheless, because roughly two-thirds of HIV-negative survey participants in 2017 had five or fewer sexual partnerships within the last 6 months, we contend that the behavioral classification offers a fairly detailed snapshot of behaviors without involving large response burden.

Regardless of concerns about the completeness of the behavioral classification, we are confident in concluding that

increases in PrEP use are occurring among San Francisco MSM alongside decreases in consistent condom use. Though the increasing popularity of PrEP has likely helped reduce HIV incidence in San Francisco, the current drug package, emtricitabine/tenofovir, cannot prevent or treat other STIs, such as chlamydia, gonorrhea, and syphilis. Meanwhile, our findings suggest an increase in the percent of individuals with no discernible harm-reduction strategy other than PrEP use. This is a troubling trend: the modeling study suggests that having no discernible harm-reduction strategy involves a very high risk for HIV infection [8] while the iPrEx trial suggests that PrEP is not fully protective against HIV infection, particularly when adherence is not high [13]. Given these concerns, we strongly support the Centers for Disease Control and Prevention's recommendation that PrEP use be accompanied by condom use when possible [14]: use of condoms offers protection against increasingly difficult-to-treat STIs and would provide additional protection against HIV infection. Additionally, we urge PrEP users to routinely test for STIs and disclose infections with sexual partners.

Funding This study was funded by CDC (Grant Number NU62PS005077).

Compliance with Ethical Standards

Conflict of interest All authors declare no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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

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