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Prevalence of and factors associated with the use of HIV serosorting and other biomedical prevention strategies among men who have sex with men in a US nationwide survey

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Abstract

Introduction—PrEP and Treatment-as-Prevention (TasP) are biomedical strategies to reduce HIV transmission. Some men who have sex with men (MSM) are combining biomedical strategies with HIV serosorting–termed “biomed matching” when both partners are either on PrEP or TasP, or “biomed sorting” when one partner is using PrEP and the other TasP. Nevertheless, there is limited data on the extent of biomed matching/sorting in large geographically diverse samples.

Method—In 2016-2017, 5,021 MSM from across the US were surveyed about their HIV status and HIV viral load/PrEP use, as well as that of their recent casual male partners. For each participant, we calculated the proportion of his partners who were (1) HIV-positive and undetectable, (2) HIV-positive and detectable/unknown, (3) HIV unknown/undiscussed, (4) HIV-negative on PrEP, (5) HIV-negative, not on PrEP.

Results—In total, 66.6% (n=3346) of participants were HIV-negative and not on PrEP, 11.9% (n=599) on PrEP, 14.1% (n=707) HIV-positive and undetectable, 1.1% (n=55) HIV-positive and viral load detectable/unknown, and 6.2% (n=313) HIV unsure/unknown. A participant’s own HIV and PrEP status/was significantly associated with that of his partners (all p<.001), evincing evidence of both serosorting and biomed matching. Among men on PrEP and those who were

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HIV-undetectable, there was also some evidence to suggest these participants dually engaged in biomed matching as well as biomed sorting.

Discussion—We found evidence of biomed matching and sorting, which may compound its effectiveness for those using it (i.e., both partners bring biomedical protection). Unintended consequences of biomed matching/sorting include that men not using a biomedical strategy may be less likely to benefit from a partner's use of the strategy—potentially further driving disparities in HIV infections. Public health campaigns might be well served to highlight not only the benefits that biomedical HIV prevention strategies provide for their users (e.g., "being on PrEP protects me from getting HIV"), but also the benefits that a user brings to his partners (e.g., "my use of PrEP means my partners won't get HIV"), and the benefits of being with a partner who is using a biomedical strategy (e.g., "my partner's use of PrEP/TasP protects me from HIV").

Keywords

Serosorting; men who have sex with men; Pre-Exposure Prophylaxis (PrEP); Treatment as prevention (TasP); HIV

INTRODUCTION

Gay, bisexual, and other men who have sex with men (MSM) remain a critical population at risk for HIV/AIDS[1–4] with new infections on the rise.[5–7] In 2016, the CDC noted that if current infection rates persist, one in six MSM will be diagnosed with HIV during their lifetimes, and, more specifically, one in two Black MSM and one in four Latino MSM.[8] MSM have adopted a variety of strategies in the decades since HIV was discovered, broadly referred to as 'seroadaption,' to reduce the risk of transmission.

Seroadaption[9–15] describes a diverse set of potentially harm-reducing behaviors that use HIV status to inform sexual decision making; examples include seropositioning/strategic positioning[14,16–18] (selectively practicing insertive or receptive anal sex based on a partner's HIV status), selectively having only oral sex or mutual masturbation,[19–21] and serosorting.[14,15,22–27] Serosorting, specifically, describes a person choosing partners of the same HIV serostatus, including to engage in sex without condoms.[28–30]

Data suggest a diverse set of MSM engage in seroadaptive behaviors, and that such behaviors may have increased over time.[14,28–30] For example, one study of San Francisco MSM found that prevalence of seroadaptive behaviors increased from 36% in 2004 to 47% in 2011.[31,32] HIV-positive men were more likely to report seroadaptive behavior patterns compared to HIV-negative men.[14] Studies suggest that serosorting is not as effective at reducing HIV transmission as condom use, and some evidence suggests that serosorting may actually increase HIV acquisition, depending on community-level HIV prevalence.[33] In settings with low HIV testing rates, serosorting can more than double the risk of HIV acquisition.[33]

In addition to behavioral strategies, biomedical strategies involving the use of antiretroviral medications, can also reduce the risk of HIV transmission. For HIV-positive individuals, using antiretroviral therapy (ART) to reduce viral load to undetectable levels greatly reduces

infectiousness. One study[34] found that reducing the burden of viral load in a given community through wide-scale treatment-as-prevention (TasP) could reduce HIV transmission at the population level.[34,35] In 2016, the Prevention Access Campaign issued a consensus statement indicating that individuals with undetectable HIV viral loads present negligible risk for HIV transmission to their partners,[36] and there has since been consistent increasing support that HIV undetectable individuals do not transmit HIV,[37,38] including endorsement by the CDC.[39] Meanwhile, for HIV-negative individuals, anti-retroviral drugs, in the form of once-daily Emtricitabine/Tenofovir, have been approved for use in the US as HIV pre-exposure prophylaxis (PrEP) since 2012.[40–42] PrEP and TasP are among the most promising biomedical tools available to prevent HIV transmission.[43–46]

The extent to which MSM are currently employing *combinations* of biomedical and behavioral strategies to reduce HIV transmission risk has not been well described. Newcomb et al.[47] introduced the term "biomed matching" to refer to individuals who seek out partners who are using the same biomedical prevention strategy (e.g., HIV-negative men on PrEP partnering with each other, or HIV-positive men seeking out other virally suppressed individuals). Whereas "biomed *sorting*" (a term that we do not believe has yet been used in the literature) more broadly describes individuals who seek out partners who are using a biomedical strategy, regardless of whether that strategy is PrEP or TasP (i.e., men on PrEP having sex with partners on PrEP or virally suppressed HIV-positive men, and vice versa).[48] In contrast to biomed matching, one can biomed sort without using a biomedical strategy themselves (i.e., someone not on PrEP seeking out partners who are on PrEP or using TasP). Unintended consequences of biomed matching/sorting include that men not using a biomedical strategy may be less likely to benefit from a partner's use of the strategy—potentially further driving disparities in HIV infections. Whereas, there are benefits to be gleaned when one's partner uses a biomedical strategy (e.g., his partner is on PrEP or his partner his HIV-positive undetectable) even if he is HIV-negative and not using PrEP himself. To our knowledge, there have been no published studies explicitly estimating rates of biomed sorting and matching. Further, it is also unclear if the use or integration of biomedical and behavioral practices vary between HIV-positive and HIV-negative men. Such data would be essential to informing public health messages around the benefits that biomedical strategies bring to the users themselves (e.g., "PrEP protects me"), as well as their partners ("PrEP/TasP protects my partners"), and the benefits of having a partner who is using a strategy ("My partner's use of PrEP/TasP protects me").

Current Study

Although behavioral HIV risk reduction strategies such as serosorting have been described well in the literature, the combined use of seroadaptive and biomedical strategies among MSM has not.[49–51] To address this gap, we implemented a brief self-administered survey in a variety of settings (online, in sexual health clinics, and community-based outreach). We report demographic and behavioral differences by HIV status and assess the prevalence of various bio-behavioral strategies employed by MSM that could reduce their HIV risk.

METHOD

Recruitment

Between May 2016 and March 2017, data were collected from participants recruited from six different settings. To be eligible, participants had to report being over the age of 18, cisgender male, and report sex with a man in the past 5 years.

1. *Tablet devices with MSM in clinical settings (e.g., waiting area) of both HIV and sexual health clinics in NYC:* A variety of methods were used to recruit MSM patients in clinical settings (n = 162). These included posted flyers in waiting areas, asking providers to refer their patients to the study, and directly approaching MSM patients in waiting areas and asking them if they were interested in completing an online survey. A privacy screen, which prevents the device from being viewed at an angle, was used and we had a separate private room available should participants have wanted to complete the survey alone. Participants were told that their responses on the survey as well as their participation in the project would not be disclosed to their provider.

2. *Online, with participants recruited via a sexual networking website or via porn websites*: For a 30 day period, we hosted a banner advertising the survey on a popular men-for-men sexual networking website. The same banner was used on the porn websites for a period of 39 days. The ad was restricted to the U.S. Those clicking the banner were taken to a separate secure webpage where the survey was housed. We generated 934 responses from the sexual networking website and 454 from the porn websites.

3. *Mobile devices, with participants recruited via a popular geo-social sexual networking app:* We had one pop-up message that was displayed to participants when they opened the app for the first time during a given 12-hour window. We generated 1891 responses from eligible participants via this method.

4. *Online, with MSM recruited via Facebook.* We ran an ad on Facebook for 11 days. This method generated 454 responses.

5. *Tablet devices with MSM recruited in gay neighborhood settings* (e.g., gay bars, clubs): Teams of two project staff visited gay neighborhoods/spaces (e.g., gay bars) and approached patrons to see if they would be interested in completing a survey about sexual health. Those interested were handed a tablet device to complete the survey alone. This method generated 292 participants.

6. *Online with participants from an ongoing cohort study of HIV-negative gay and bisexual men*. The *One Thousand Strong* study is following a U.S. national sample of 1,071 gay and bisexual men for a period of 3 years. Enrollment for the cohort has been described in detail elsewhere,[52] but sampling was targeted (using census data) such that the distribution of participants in the panel would closely mirror that of gay and bisexual men across the U.S, and all participants were confirmed to be HIV-negative at enrollment. Participants in *One Thousand Strong* complete online assessments annually; however, the study team also

conducted check-in surveys half way between annual assessments to verify participant contact information. During the 18-month check-in survey participants were offered an opportunity to complete an additional brief online survey, in which the measures for this study were embedded. In total, 834 participants completed this assessment.

Across recruitment methods, participants were informed they were completing a sexual health survey. Recruitment materials and the informed consent did not market the study as one being about PrEP, serosorting, etc.

Incentives

As an incentive, participants from clinic settings were offered a gift certificate to see a movie at a local movie theater. Participants from online settings (adult websites, hook-up website, geosocial sexual networking app, Facebook, and the *One Thousand Strong* cohort) were entered into a raffle to win one of fifty $20 amazon gift cards. With the exception of the *One Thousand Strong* cohort, the survey in online settings was anonymous, but participants were told they would need to provide an email address if they wanted to be entered into the raffle for the gift card. Finally, participants surveyed in gay neighborhood settings were offered one scratch off lottery ticket valued at $1 each for completing the survey.

Measures

Participants completed a self-administered computerized survey that took approximately 10 minutes to complete. The survey itself assessed demographic characteristics as well as sexual behaviors for main and casual male partners in the prior three months using the Brief Seroadaptive Assessment Tool (B-SAT),[53] a brief-intercept self-administered sexual behavior data collection method.[14,54–57] The B-SAT first asks about sexual behavior with a main partner and then separately asks about sexual behavior with casual partners who were HIV-positive and undetectable, HIV-positive and not undetectable (or viral load was not discussed), HIV-negative and on PrEP, HIV-negative and not on PrEP (or PrEP was not discussed), and partners whose status was unknown/not discussed. The B-SAT also assesses participant's HIV status and viral load (if HIV-positive) or PrEP use (if HIV-negative). Study procedures were approved by relevant organizational Institutional Review Boards.

Analysis plan

We report (1) demographic differences in the samples across the recruitment venues, followed by (2) demographic differences across participants' HIV status. In so doing, we categorized participants' HIV status into five mutually exclusive groups: HIV-positive and undetectable; HIV-positive and detectable or of unknown viral load; HIV-negative and on PrEP; HIV-negative and not on PrEP; and HIV status unsure/unknown. Finally, we report the extent to which participants were engaged in serosorting and biomed matching. In so doing, for each participant HIV-status, we report the proportion of his casual male partners from the past 3 months who were (1) HIV-positive and undetectable, (2) HIV-positive and detectable/unknown, (3) HIV unknown/undiscussed, (4) HIV-negative on PrEP, and (5) HIV-negative, not on PrEP. We also compared participants' HIV status by the total number of casual male partners in the previous three months, as well as by the reported HIV status for participants'

main partner (for those in a relationship, $n = 2,027$). As appropriate, we used ANOVA, chi-squared, and Kruskal-Wallis tests. Statistical significance was set and $\alpha = 0.05$ and all analyses were conducted in SPSS version 22.

RESULTS

Participants came from all 50 US states plus the District of Columbia and Puerto Rico (though the survey itself was in English). First, we report data on how the composition of our sample varied by recruitment source (see Table 1). All variables examined differed significantly by recruitment venue. Participants from the hook-up website were oldest on average ($M = 46.1$), whereas those via gay neighborhood settings in NYC were youngest on average ($M = 32.3$). Clinic settings had the highest proportion of men of color (84%) whereas *One Thousand Strong* had the lowest (29.1%). Participants recruited via Facebook and clinic settings tended to report the least amount of education and those from LGBT neighborhood settings tended to report the most education. Participants from the *One Thousand Strong* cohort were the most likely to identify as gay and those from the hookup website were the least (95% vs. 71.2%). Participants surveyed via the *One Thousand Strong* cohort (53.8%) and adult websites (52.2%) were among the most likely to report being in a relationship, whereas those surveyed via the geosocial sexual networking app were the least (30.1%). Finally, participants from clinic settings were the most likely to report being HIV-positive and undetectable (44.4%) or HIV-negative on PrEP (23.5%) (i.e., using a biomedical strategy).

Table 2 reports on demographic differences by participants' HIV status, all of which were statistically significant. HIV-positive and undetectable participants were the oldest on average ($M = 43.11$) and those not knowing their status were the youngest on average ($M = 33.8$). HIV-positive and men who said they did not know their HIV status were among the most likely to be men of color (49% and 44.7% respectively). Men on PrEP tended to report more education than other groups (64.6% had completed college). Men who did not know their HIV status were the least likely to identify as gay and the least likely to be in a current relationship.

Table 3 reports on HIV serosorting and biomed matching/sorting among participants in the sample. Among men who reported casual male sex partners in the prior 3 months, HIV-negative participants who were not on PrEP reported the fewest partners on average (Mdn = 3), whereas HIV-positive and undetectable participants and participants on PrEP reported the greatest, on average (Mdn = 6). By and large, participants tended to report partners whose HIV-status and biomedical strategy matched their own. For example, the proportion of casual partners who were HIV-positive and undetectable was significantly higher among participants who were themselves HIV-positive and undetectable at 0.28 (versus 0.20 for participants who were HIV-positive and detectable, 0.12 among those HIV-negative and on PrEP, 0.07 for those HIV-negative and not on PrEP, and 0.08 for participants who did not know their HIV status, $p < 0.001$). The proportion of partners HIV-positive and detectable was highest among those who were themselves HIV-positive and detectable at 0.16 (versus 0.06 for those HIV-positive and undetetable, 0.02 for those HIV-negative on PrEP, 0.01 for those HIV-negative and not on PrEP, and 0.02 for participants who did not know their HIV

status, $p < 0.001$). This pattern of "matching" was observed for all five HIV status groups. Full results in Table 3.

In contrast to the strong evidence that partcipants were engaging in biomed *matching*, there was some evidence of biomed *sorting.* In terms of proportions of partners, participants who were HIV-positive and undetectable said that 28% of their partners were HIV-positive and undetectable (i.e., biomed *matched*), 27% of their partners were HIV unknown/not discussed, and 24% were on PrEP (i.e., biomed *sorted*). Participants on PrEP said that 41% of their partners were on PrEP (i.e., biomed *matched*), 28% were HIV-negative not on PrEP, 17% were HIV unknown/not discussed, and 12% were HIV-positive undetectable (i.e., biomed *sorted*). HIV-negative men not on PrEP said that 44% of their partners were also HIV-negative and not on PrEP (i.e., serosorting), 26% were HIV unknown, 22% were on PrEP (i.e., biomed *sorted*), 7% were HIV undetectable (i.e., biomed *sorted*), and 1% were HIV-positive and detectable (or viral load not known).

We next examined whether participants had engaged in condomless anal sex (CAS) with partners across HIV categories. Overall, HIV-positive participants were more likely to engage in CAS than HIV-negative participants; however, HIV-positive participants tended to report engaging in CAS more so with HIV-positive partners than compared to HIV-negative participants—and HIV-negative participants tended to engage in CAS with other HIV-negative partners. See Table 3. There was stronger evidence of biomed sorting when it came to CAS. HIV-positive undetectable participants tended to report CAS more when their partners were also HIV-positive (i.e., biomed *matched*) as well as when their partners were on PrEP (CAS with 31.2% of partners on PrEP; i.e., biomed *sorted*), as opposed to when their partners were HIV-negative and not on PrEP (CAS with 21.6% of these partners) or when they did not know the status of their partners (CAS with 24% of these partners). Similarly for men on on PrEP, CAS was most common when partners were also on PrEP (CAS with 29.4% of these partners; i.e., biomed *matched*), HIV-negative and not on PrEP (CAS with 23.5% of these partners; i.e., serosorting), or HIV-positive and undetectable (CAS with 19.4% of these partners; i.e., biomed *sorted*). Whereas, among men on PrEP, CAS was least common when partners were HIV-positive and detectable (9.4%) or when partners status was unknown (12.2%). For HIV-negative men not on PrEP, CAS was most common when partners were also HIV-negative and not on PrEP (CAS with 12.9% of these partners; i.e., serosorting), followed by when partners were on PrEP (CAS with 11% of these partners; i.e., biomed *sorted*), when status was not discussed/unknown (CAS with 8.2% of these partners), when partners were HIV-positive undetectable (CAS with 7.1% of these partners; ie., biomed *sorted*), and when partners were HIV-positive but detectable/unknown (CAS with 2.9% of these partners).

As with casual male sex partners, there was strong evidence of biomed matching among participants in relationships ($n = 2027$). For example, 35.4% of HIV-positive and undetectable participants said their partner was HIV-positive and undetectable (versus 22.4% among HIV-negative men on PrEP, 20.0% among HIV-positive and detectable, 4.1% among HIV-negative men not on PrEP, and 4.1% among men who did not know their HIV status, $p < .001$). Similarly, 32.9% of men on PrEP said their partner was on PrEP (versus 12.9% among HIV-positive undetectable, 8.0% among HIV-positive and detetable men, 1.6%

among HIV-negative men not on PrEP, and 1.0% among men who did not know their status). And 40.2% of men who said they were unsure of their status said their partner was also unsure of his status (versus 14.0% among men who were HIV-negative and not on PrEP, 12.9% among HIV-positive undetectable men, 8.0% among HIV-positive and detectable men, and 7.9% among HIV-negative men on PrEP). Full results are shown in Table 3.

DISCUSSION

We found strong evidence that not only were participants engaging in serosorting (having sex with partners of the same perceived HIV status), but also—for those taking advantage of a biomedical strategy—engaging in biomed matching. That is, HIV-positive undetectable participants comprised 14.1% of the sample, yet they indicated that 28% of their casual partners were HIV-positive undetectable. Meanwhille, 35% of HIV-positive undetectable participants who were in relationships said their partner was also HIV-positive undetectable. Similarly, men on PrEP comprised 11.9% of participants, yet reported that 41% of their casual male partners were on PrEP. And, 33% of the participants on PrEP who were in a relationship said their partner was also on PrEP. Meanwhile, compared with others, men not utilizing a biomedical strategy more often partnered with men also not using a biomedical strategy. Among men on PrEP and those who were HIV-undetectable, there was also some evidence to suggest these participants dually engaged in biomed matching as well as biomed sorting. Both biomed sorting and biomed matching may compound their effectiveness for those using it (i.e., both partners bring biomedical protection).[47] However, this also means that men *not* using a biomedical strategy may be *less likely* to benefit from a partner's use of the strategy—potentially further driving disparities in HIV infections in certain subpopulations with lower access to or uptake of biomedical prevention.

We also found that, in addition to partnering with men who shared the same HIV status, participants also tended to report engaging in CAS more so with partners who were believed to share the same HIV status. For men using a biomedical strategy, the risk for HIV transmission during these encounters may be negligible; however, for those *not* using a biomedical strategy, there may be additional risk for HIV transmission. Compared to other groups, HIV-negative men not on PrEP were the least likely to report CAS; however, when CAS did occur among these participants, it was most often with a partner believed to be HIV-negative and also not on PrEP. If undiagnosed and untreated HIV infection is higher among this group, this could significantly potentiate HIV transmission during CAS. Some research has suggested that serosorting is not as effective at reducing HIV transmission as condom use, and some evidence suggests that serosorting may actually increase HIV acquisition.[33] This may be due to low HIV testing rates/frequency,[33] yet partners still report they are HIV-negative.

We also reported demographic differences by the venue in which participants were surveyed. Similar to what others have reported,[56,58–63] participant characteristics were associated with where participants were recruited. For both providers and researchers, these findings further highlight the need to focus efforts (whether for recruitment, interventions, health education messages) within different venues to reach diverse populations. In our study, men of color were most likely to have been identified via clinic settings (likely an artifact of who the

clinics served), men via gay neighborhood settings (e.g., bars) were youngest on average, the greatest proportion of men who did not know their HIV status were identified via the social-sexual networking app, and the greatest proportion of men who did not identify as gay were enrolled via the hook-up website. Researchers and providers seeking to reach younger MSM might be well served to conduct outreach in gay neighborhood settings. Likewise, those seeking to engage with MSM who do not know their HIV status might be well served to conduct outreach via social-sexual networking apps, and those seeking to engage with non-gay-identified MSM might be well served to conduct outreach via hook-up websites. In addition to knowing which venue to go to in order to engage a particular population (e.g., *where* to go), these findings also inform the types of messages that might be more appropriate in different venues (e.g., *how* to market one's message).

Limitations

The findings of this study should be understood in light of its limitations. The B-SAT is a self-administered assessment tool that can be used in both research and clinical settings to assess for HIV risk among MSM. However, it focuses on sexual behavior in the prior 3 months, whereas CDC recommendations for PrEP indication assesses for sexual behavior over the prior 6 months.[64] Thus although the B-SAT could be used to identify men who would be appropriate candidates for PrEP, it is limited in that there could be men whose behavior between 3 and 6 months ago would suggest PrEP is indicated, but their more recent behavior (within the last 3 months, as captured on the B-SAT) could suggest that PrEP is not indicated. In addition, the B-SAT does not capture motivation or intent, only past behavior. In an effort to be brief, it also does not capture withdrawal before ejaculation during CAS, nor does it capture behavior with female or transgender partners.

Responses on our survey were self-report and, for many of our participants, anonymous. We believe we found evidence of serosorting as well as biomed matching, both of which have been documented in prior research.[9–14,22–27,47] However, we do not know the actual HIV statuses of participants' partners, and it may be that participants *believed* their partners shared the same status. In online venues, our ads were targeted to reach MSM, but it is possible that some responses were collected from participants who might have misrepresented their data. Our survey was programmed to record IP address as well as block multiple submissions from a given IP address and our incentives were low and not guaranteed (i.e., a raffle) such to disincentivize fraudulent participants. Next, our analyses did not control for confounders. Finally, we are unable to calculate a response rate for our survey and cannot attest as to whether those who chose to participate characteristically differed from those who did not.

Conclusion

As opposed to picking partners at random (i.e., regardless of a partners' HIV status/biomedical strategy), our findings indicate that participants gravitated toward partners who share the same HIV status and—in the case of those using a biomedical prevention strategy—the same biomedical HIV prevention or treatment strategy. Furthermore, CAS events were also more common when a partner shared the same HIV status. When two partners both use a biomedical HIV prevention strategy, its effectiveness could be compounded (i.e., both

partners bring biomedical protection). One consequence of biomed matching, however, is that men not using a biomedical strategy would be less likely to benefit from the protection that a partner using a biomedical strategy would bring to the sexual encounter. With the continued rollout of PrEP as well as the dissemination of new data regarding untransmisibility of HIV among HIV-positive and undetectable individuals,[36,39] our findings highlight the need for researchers to investigate both serosorting and biomedical sorting/matching as well as their impact on ongoing HIV disparities. That is, an unintended consequence of biomedical prevention strategies is that they may further contribute to racial disparities in HIV. Public health campaigns might be well served to highlight not only the benefits that biomedical HIV prevention strategies provide for their users (e.g., "being on PrEP protects me from getting HIV"), but also the benefits that a user brings to his partners (e.g., "my use of PrEP means my partners are protected from HIV"), and the benefits of being with a partner who is using a biomedical strategy (e.g., "my partner's use of PrEP/TasP protects me from HIV").

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Table 1

Demographic differences by recruitment source

	Hook-up website *N* = 934		Facebook *N* = 454		NYC gay neighborhood settings *N* = 292		Geo-social App *N* = 1891		Adult websites *N* = 454		*One Thousand Strong* cohort *N* = 834		Clinic settings *N* = 162			
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	**χ^2 or F**	***p***
Age (M, SD)	46.1	12.79	38.4	14.98	32.3	8.8	35.0	12.1	40.7	13.8	41.7	13.7	34.3	11.7	102.8	< .001
Race[1]															320.77	< .001
Black	79	8.5	33	7.3	63	21.6	186	9.8	44	9.7	64	7.7	41	25.3		
Latino	117	12.5	91	20.0	54	18.5	386	20.4	59	13.0	95	11.4	67	41.4		
White	668	71.5	285	62.8	136	46.6	1077	57.0	312	68.7	600	71.9	26	16.0		
All other	70	7.5	42	9.3	37	12.7	241	12.7	39	8.6	75	9.0	28	17.3		
Education															250.93	< .001
High School	154	16.5	103	22.7	30	10.3	259	13.7	59	13.0	47	5.6	48	29.6		
Some college	359	38.4	196	43.2	58	19.9	729	38.6	161	35.5	258	34.2	71	43.8		
4-year college degree	237	25.4	101	22.2	131	44.9	549	29.0	122	26.9	259	31.1	32	19.8		
Graduate school	184	19.7	54	11.9	73	25.0	355	18.8	112	24.7	243	29.1	11	6.8		
Sexual identity as gay[3]																
No	269	28.8	46	110.1	25	8.6	338	17.9	90	19.8	42	5.0	–	–	213.74	< .001
Yes	665	71.2	408	89.9	267	91.4	1553	82.1	364	80.2	792	95.0	–	–		
Currently in a relationship																
No	586	62.7	230	50.7	172	59.9	1321	69.9	217	47.8	385	46.2	82	50.6	195.83	< .001
Yes	348	37.3	224	49.3	120	41.1	570	30.1	237	52.2	449	53.8	80	49.4		
HIV status[2]																
HIV-Positive, undetectable	192	20.6	74	16.3	24	8.2	274	14.5	71	15.6	0	0.0	72	44.4	545.01	< .001
HIV-positive, detectable or unknown viral load	11	1.2	8	1.8	0	0.0	23	1.2	5	1.1	0	0.0	8	4.9		
HIV-negative on PrEP	75	8.0	46	10.1	66	22.6	232	12.3	38	8.4	104	12.5	38	23.5		
HIV-negative	585	62.6	297	65.4	191	65.4	1192	63.0	316	69.6	725	86.9	40	24.7		
Unknown/unsure	71	7.6	29	6.4	11	3.8	170	9.0	24	5.3	4	0.5	4	2.5		
STI diagnosis in prior 6 months																

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	Hook-up website *N* = 934		Facebook *N* = 454		NYC gay neighborhood settings *N* = 292		Geo-social App *N* = 1891		Adult websites *N* = 454		*One Thousand Strong* cohort *N* = 834		Clinic settings *N* = 162			
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	**χ^2 or F**	***p***
Chlamydia	19	2.0	16	3.5	23	7.9	109	5.8	15	3.3	41	4.9	17	10.5	41.05	< .001
Gonorrhea	27	2.9	15	3.3	21	7.2	114	6.0	8	1.8	34	4.1	17	10.5	41.91	< .001
Genital warts, anal warts, HPV	13	1.4	11	2.4	5	1.7	40	2.1	4	0.9	40	4.8	7	4.3	32.9	< .001
Genital herpes, HSV1, HSV2	14	1.5	5	1.1	4	1.4	42	2.2	9	2.0	42	5.0	5	3.1	33.36	< .001
Syphilis	21	2.2	14	3.1	10	3.4	62	3.3	7	1.5	23	2.8	24	14.8	77.79	< .001
Hepatitis C	6	0.6	2	0.4	1	0.3	12	0.6	2	0.4	1	0.1	3	1.9	–	
Hepatitis B	4	0.4	7	1.5	1	0.3	7	0.4	3	0.7	8	1.0	2	1.2	–	
Urethritis	2	0.2	4	0.9	4	1.4	16	0.8	1	0.2	14	1.7	1	0.6	–	

Note:

[1] *n* = 6 men did not provide responses on their race/ethnicity

[2] *n*= 1 Participant in One Thousand Strong was HIV-positive, but his viral load was not asked.

[3] Due to a programming error, sexual identity was not assessed in clinic settings; however, all participants were men who reported sex with men

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Table 2

Demographic differences by participants' HIV statusn

	Participant's HIV status 1												
	HIV-positive and undetectable Group A		HIV-positive, but detectable (or "I do not know my viral load") Group B		HIV-negative, and on PrEP Group C		HIV-negative, but not on PrEP Group D		I do not know,or I am unsure Group E				
	n	%	*n*	%	*n*	%	*n*	%	*n*	%			
	707	**14.1**	**55**	**1.10**	**599**	**11.9**	**3346**	**66.6**	**313**	**6.2**	**χ^2 or F**	***p***	**Post hoc**
Age (M, SD)	43.11	11.53	38.22	11.27	37.04	12.27	38.73	13.96	33.83	13.43	31.79	< .001	A ≠ C, D, E; C ≠ D, E; D ≠ E
Race													
Black	139	19.7	18	32.7	66	11.1	259	7.7	28	8.9	152.07	< .001	A, B ≠ C, D, E; C ≠ D ≠ E
Latino	142	20.1	10	18.2	97	16.3	546	16.3	74	23.6			
White	360	51.0	21	38.2	370	62.1	2810	65.2	173	55.3			
All other	65	9.2	6	10.9	63	10.6	359	10.7	38	12.1			
Education													
High School	135	19.1	19	34.5	50	8.3	409	12.2	87	27.8	217.65	< .001	A ≠ B; B ≠ C, D; A ≠ C ≠ D ≠ E
Some college	320	45.3	26	47.3	162	27	125	36.6	126	40.3			
4-year college degree	156	22.1	9	16.4	232	38.7	976	29.2	57	18.2			
Graduate school	96	13.6	1	1.8	155	25.9	736	22	43	13.7			
Sexual identity as gay													
No	45	7.0	5	10.6	60	10.6	618	18.7	86	27.8	96.139	< .001	E ≠ A, B, C, D; D ≠ A, C, E
Yes	597	93.0	42	89.4	504	89.4	2694	81.3	223	72.2			
Currently in a relationship													
No	436	61.7	30	54.5	371	61.9	1940	58.0	216	69.0	18.359	0.001	D ≠ E
Yes	271	38.3	25	45.5	228	38.1	1406	42.0	97	31.0			
STI diagnosis in prior 6 months													
Chlamydia	40	5.7	6	10.9	85	14.2	104	3.1	5	1.6	149.76	< .001	A ≠ C, D, E; B ≠ E; C ≠ D, E

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	Participant's HIV status 1												
	HIV-positive and undetectable Group A		HIV-positive, but detectable (or "I do not know my viral load") Group B		HIV-negative, and on PrEP Group C		HIV-negative, but not on PrEP Group D		I do not know,or I am unsure Group E				
	n	%	*n*	%	*n*	%	*n*	%	*n*	%			
	707	**14.1**	**55**	**1.10**	**599**	**11.9**	**3346**	**66.6**	**313**	**6.2**	**χ^2 or F**	***p***	**Post hoc**
Gonorrhea	47	6.6	6	10.9	71	11.9	103	3.1	8	2.6	102.391	< .001	A ≠ C, D, E; B ≠ E; C ≠ D, E
Genital warts, anal warts, HPV	21	3	7	12.7	24	4.0	63	1.9	5	1.6	37.45	< .001	A ≠ B; B ≠ C, E; C ≠ D
Genital herpes, HSV1, HSV2	12	1.7	1	1.8	30	5.0	74	2.2	4	1.3	21.06	< .001	A ≠ C; C ≠ D, E
Syphilis	48	6.8	9	16.4	40	6.7	60	1.8	4	1.3	108.43	< .001	A ≠ B, D, E; B ≠ C, E; C ≠ D, E
Hepatitis C	8	1.1	1	1.8	5	0.8	10	0.3	3	1.0	–		
Hepatitis B	9	1.3	0	0	8	1.3	14	0.4	1	0.3	–		
Urethritis	5	0.7	0	0	12	2.0	23	0.7	2	0.6	11.48	0.02	C ≠ D

Note: n = 1 participant from *One Thousand Strong* indicated he was HIV-positive, but his viral load was not assessed

– Chi-Square could not be calculated due to low expected cell counts

Table 3

HIV serosorting and biomed matching among gay and bisexual men

	Participant's HIV status												
	HIV-positive and undetectable Group A		**HIV-positive, but detectable (or "I do not know my viral load") Group B**		**HIV-negative, and on PrEP Group C**		**HIV-negative, but not on PrEP Group D**		**I do not know, or I am unsure Group E**				
	Mdn	**IQR**	**Mdn**	**IQR**	**Mdn**	**IQR**	**Mdn**	**IQR**	**Mdn**	**IQR**	**K-W**		**post hoc**
Total Casual Male Partners < 3 months (Mdn, IQR), valid *n* = 3641[1]	**6.0**	**3 to 11**	**5.0**	**2.75 to 15**	**6.0**	**3 to 12**	**3.0**	**1 to 6**	**4.0**	**2 to 8**	**249.54**	**< .001**	**A, B, C # D, E**
	M	SD	M	SD	M	SD	M	SD	M	SD	*F*	*P*	
Sexual behavior with casual male partners, < 3 months													
Proportion that were HIV-positive and Undetectable	**0.28**	**0.28**	0.20	0.27	*0.12*	*0.18*	*0.07*	*0.19*	0.08	0.18	109.6	< .001	A ≠ B ≠ C ≠ D; E ≠ A
Proportion that were HIV-positive and viral load was unknown or detectable	0.06	0.13	0.16	0.20	0.02	0.07	0.01	0.07	0.02	0.07	64.8	< .001	A ≠ B, C, D, E; B ≠ C
Proportion that were on PrEP	*0.24*	*0.26*	0.14	0.21	**0.41**	**0.29**	*0.22*	*0.30*	0.14	0.21	55.9	< .001	A ≠ C, E; B ≠ C; C ≠ D,
Proportion that were HIV-negative, but not on PrEP (or PrEP not discussed)	0.15	0.23	0.21	0.35	0.28	0.28	0.44	0.38	0.28	0.32	86.3	< .001	A ≠ C, E, E; B ≠ D; C ≠ I
Proportion whose HIV status was unknown/not discussed	0.27	0.33	0.28	0.29	0.17	0.25	0.26	0.36	0.48	0.39	34.8	< .001	A ≠ C, E; B ≠ E; C ≠ D,]
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*Chi-Sq*	*p*	
Sexual behavior[2] with casual male partners, < 3 months													
Condomless anal sex (CAS) with HIV-positive and Undetectable, valid *n* = 1375	**127**	**35.4**	10	45.5	*52*	*19.4*	*47*	*7.1*	13	21.7	128.9	< .001	A, B ≠ C, D, E; C ≠ D; D ≠
CAS with HIV-positive and viral load was unknown or detectable, valid *n* = 725	41	30.8	7	35.0	12	9.4	12	2.9	9	33.3	105.98	< .001	A, B ≠ C, D; C ≠ D, E; D ≠
CAS with partners on PrEP, valid *n* = 2126	*106*	*31.2*	6	31.6	**138**	**29.4**	*131*	*11.0*	27	26.0	119.65	< .001	A, B, C, E ≠ D
CAS with HIV-negative, but not on PrEP (or PrEP not discussed), valid *n* = 2221	45	21.6	5	38.5	85	23.5	195	12.9	29	22.3	39.2	< .001	A, B, C, E ≠ D
CAS with partners whose HIV status was unknown/not discussed, valid *n* = 1901	70	24.0	8	36.4	37	12.2	90	8.2	30	16.6	68.98	< .001	A ≠ C, D; B ≠ C, D, E; C ≠

	Participant's HIV status												
	HIV-positive and undetectable Group A		HIV-positive, but detectable (or "I do not know my viral load") Group B		HIV-negative, and on PrEP Group C		HIV-negative, but not on PrEP Group D		I do not know, or I am unsure Group E				
	Mdn	IQR	Mdn	IQR	Mdn	IQR	Mdn	IQR	Mdn	IQR	K-W		post hoc
Total Casual Male Partners < 3 months (Mdn, IQR), valid *n* = 3641[1]	**6.0**	**3 to 11**	**5.0**	**2.75 to 15**	**6.0**	**3 to 12**	**3.0**	**1 to 6**	**4.0**	**2 to 8**	**249.54**	**< .001**	**A, B, C # D, E**
Main partner's HIV status, valid *n* = 2027 [3]													
HIV-positive, undetectable	**96**	**35.4**	5	20.0	*51*	*22.4*	*57*	*4.1*	4	4.1	866.07	< .001	A ≠ B ≠ C ≠ D ≠ E
HIV-positive, viral load detectable/ unknown	11	4.1	8	32.0	3	1.3	14	1.0	1	1.0			
HIV status uncertain or unknown	35	12.9	2	8.0	18	7.9	197	14.0	39	40.2			
HIV-negative, on PrEP	*35*	*12.9*	2	8.0	**75**	**32.9**	*23*	*1.6*	1	1.0			
HIV-negative, not on PrEP or PrEP unknown	94	34.7	8	32.0	81	35.5	1115	79.3	52	53.6			

[1] *n*= 3641 (72.5%) participants reported at least one casual male sex partner in the 3 months prior.

[2] Nested among men who reported that type of partner (e.g., CAS with partners on PrEP (yes/no), nested among the 2126 participants who reported having a partner on PrEP)

[3] Nested among those with a main male partner

Values in **bold** indicate biomed matching. Values in *italics* indicate biomed sorting.