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Pre-Exposure Prophylaxis (PrEP) Use and Condomless Anal Sex: Evidence of Risk Compensation in a Cohort of Young Men Who Have Sex with Men

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Abstract

Background—Young men who have sex with men (YMSM) are disproportionately impacted by HIV. Pre-exposure prophylaxis (PrEP) is highly effective at preventing HIV acquisition. It remains unclear if PrEP use increases rates of condomless sex (i.e., risk compensation), which may increase risk of infection if PrEP adherence is not optimal. This study aimed to examine whether PrEP use and PrEP adherence were associated with change in sexual risk behaviors in a large longitudinal cohort of YMSM reporting on multiple sexual partnerships over time.

Method—Data came from the first three visits of an ongoing cohort study of YMSM in Chicago (analytic $N=953$; 14.1% HIV-positive at baseline). Participants reported up to four sexual partnerships at each visit, including sexual behavior, PrEP use and PrEP adherence within partnerships.

Results—YMSM reported higher rates of receptive condomless anal sex (CAS) in partnerships during which they were on PrEP compared to those when they were not on PrEP. This association was consistent across both HIV-negative and HIV-positive participants reporting on partnerships with perceived HIV-negative/unknown and HIV-positive partners. The rate of receptive CAS was higher in PrEP non-adherent partnerships compared to non-PrEP partnerships. The rate of receptive CAS was higher in PrEP non-adherent than adherent partnerships, but this was not statistically significant.

Conclusions—These analyses provide compelling data suggesting that YMSM are engaging in risk compensation when on PrEP. If rates of receptive CAS are highest amongst YMSM who are PrEP non-adherent, PrEP as a prevention strategy could fail to curb HIV incidence among YMSM.

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Conflicts of Interest

The authors have no known conflicts of interest to disclose.

Keywords

young men who have sex with men; HIV/AIDS; pre-exposure prophylaxis; condom use; medication adherence; risk compensation

Men who have sex with men (MSM) accounted for 70% of new HIV diagnoses in 2015¹, and young MSM (YMSM) are the demographic group in which rates of new infections are increasing the most². Recent developments in biomedical prevention have led to novel strategies to reduce HIV incidence, including pre-exposure prophylaxis (PrEP) for HIV-negative individuals^{3,4}. Existing data suggest that PrEP is extremely effective at reducing HIV acquisition; randomized controlled trials indicate that once-daily oral PrEP can reduce the likelihood of acquisition by more than 90%^{3,5}. While uptake remains low among both YMSM⁶ and adult MSM⁷, its use is likely to increase over time as PrEP awareness and knowledge continue to improve among both patients⁸ and providers⁹.

Despite enthusiasm, concern has been raised that PrEP use could lead to increased condomless anal sex (CAS), also known as risk compensation¹⁰⁻¹². To the extent that PrEP use is indeed highly effective, then decreased condom use is not necessarily problematic for the onward transmission of HIV¹³. However, PrEP efficacy is dependent upon high levels of adherence, and studies have found variable rates of adherence¹⁴. This calls into question the real-world effectiveness of PrEP at consistently preventing HIV acquisition in the absence of another prevention strategy (e.g., condom use), and as such, risk compensation may have the potential to maintain, or even increase, HIV incidence¹³. Further, condomless sex may increase the transmission of other sexually transmitted infections (STIs)¹⁵, though the evidence on this association is mixed and a topic of intense debate^{16,17}.

Evidence that PrEP use is associated with change in condom use is mixed. Several earlier studies of MSM and heterosexuals in Africa have observed either no change or an increase in condom use among PrEP users in randomized trials^{3,18-21}. In contrast, qualitative data from domestic samples suggest that MSM believe their condom use would decrease while on PrEP^{22,23}. Furthermore, a handful of more recent studies that collected data after the completion of these initial PrEP trials provide quantitative evidence of risk compensation. Several studies have found that both HIV-negative and HIV-positive MSM are making decisions to forego condom use when a sex partner discloses PrEP use^{24,25}. Further, data from two clinic-based samples found that MSM increased their number of condomless sex partners after PrEP initiation^{26,27}. While risk compensation may not occur in highly controlled trials with intensive monitoring and risk reduction counseling, PrEP use may lead to risk compensation in real-world settings.

To our knowledge, all prior studies tested risk compensation with questions that collapsed PrEP and condom use behaviors across multiple sexual partnerships within persons within a discrete period of time. This is problematic because analyses of global associations assume, to varying degrees, that individuals are stable in their sexual behaviors over time (i.e., individuals always or never use condoms) and across partnerships. For example, cross-sectional designs that compare condom use behaviors between PrEP users and non-users are unable to disentangle the effects of third variables that might explain observed differences.

Furthermore, longitudinal studies that collapse behaviors across sexual partnerships are unable to examine how PrEP and condom use may change within persons across partnerships. Prior research has not found high stability to characterize condom use across partners or time²⁸, including studies of YMSM^{29,30}. To understand fully whether PrEP use is associated with increased sexual risk behavior, it is necessary to model patterns of condom use within-persons over time, across multiple partnerships, and at times when individuals are both on and off PrEP. This design allows the participant to serve as their own control by comparing their behavior across different sexual relationships when they were or were not using PrEP.

The present study aimed to examine whether PrEP use was associated with change in sexual risk behaviors in a large longitudinal cohort of YMSM. By collecting data on multiple sexual partnerships across multiple time points, we examined whether PrEP use was associated with change in: a) total number of anal sex acts, split by insertive and receptive acts; and b) total number of CAS acts, split by insertive and receptive acts. Furthermore, we examined whether PrEP adherence and non-adherence among HIV-negative participants were associated with change in rates of total anal sex acts and CAS acts. Among HIV-negative participants, we hypothesized that YMSM would report higher rates of sexual risk in partnerships during which they were on PrEP and were PrEP adherent. Among HIV-positive participants, we hypothesized that YMSM would report higher rates of sexual risk in partnerships during which their HIV-negative partners were on PrEP.

Methods

Participants, Procedures and Design

Data were collected between February 2015 and April 2017 as part of RADAR (current $N=1060$), an ongoing longitudinal cohort study of HIV-negative and HIV-positive YMSM living in the Chicago area^{31,32}. We utilized multiple recruitment methods to achieve the multiple cohort accelerated longitudinal design³³. First, a subset of participants from two cohorts of YMSM, Project Q2 ($N=67$) and Crew 450 ($N=162$), first recruited in 2007 and 2010 respectively, enrolled. In 2015, we recruited a third cohort of YMSM (current $N=468$). At the time of original cohort enrollment, all participants were 16–20 years of age, born male, spoke English, and had a sexual encounter with a man in the previous year or identified with a sexual minority label. Participants also recruited their serious romantic partners and up to three peers into RADAR ($N=363$). Serious romantic partner and peer recruits had to be YMSM and aged 16–29.

Data were taken from the first three assessment time points, each separated by six months (i.e., 18-month reporting window). At the time of analysis, all participants had completed the baseline assessment ($N=1,060$), 835 had completed 6-month follow-up, and 578 had completed 12-month follow-up. We report longitudinal analyses from all available data from these three time points. Amongst those eligible for follow-up visits, the cohort had 87.8% and 84.9% retention at 6- and 12-month follow-up, respectively. Data were collected using a computer assisted self-interview (CASI). All procedures were approved by the Institutional Review Board with waivers of parental permission³⁴.

Measures

Demographics—The demographics questionnaire assessed participant age, birth sex, race/ethnicity, and self-reported sexual orientation. Participants self-reported their HIV status at each visit and HIV-negative participants received HIV testing at the end of each visit. Participants who self-reported HIV-negative but received a reactive test result at that study visit were coded HIV-negative in analyses because perceived status was most relevant to analyses.

Sexual Risk Behavior—The HIV-Risk Assessment for Sexual Partnerships³⁵ (H-RASP) is a computerized self-administered interview that assesses sexual behavior and associated situational/contextual variables at the level of the sexual partnership. Participants reported on up to four partnerships during the preceding six months. We excluded partnerships with individuals assigned female at birth and utilized the following partnership-level outcome variables: total number of anal sex acts, total number of CAS acts, total number of insertive anal sex acts, total number of insertive CAS acts, total number of receptive anal sex acts, and total number of receptive CAS acts.

PrEP Use and Adherence—Participants who had taken PrEP during the past six months were asked the following question for each partnership reported in the H-RASP: “During the past 6 months when you were having anal or vaginal sex with [partner name], were you taking any pre-exposure prophylaxis (PrEP) medication such as Truvada to reduce your risk of HIV transmission?” We also assessed whether each sexual partner was perceived to be using PrEP: “During the past 6 months when you were having sex with [partner name], were they taking any pre-exposure prophylaxis (PrEP) medication such as Truvada to reduce their risk of HIV transmission?”

PrEP adherence was measured at the level of the sexual partnership: “Which of the following answer options best represents the frequency in which you have taken PrEP while having anal or vaginal sex with [partner name]?” Response options included: 1) “I was using PrEP before I started having anal or vaginal sex with [partner name] and I have not missed any recommended doses”, 2) “I was using PrEP before I started having anal or vaginal sex with [partner name], but I have missed some recommended doses”, 3) “I started using PrEP after I already was having anal or vaginal sex with [partner name] and I have not missed any recommended doses”, or 4) “I started using PrEP after I already was having anal or vaginal sex with [partner name], but I have missed some recommended doses”. Response options 1 and 3 were considered adherent. PrEP adherence in sexual partners was not assessed.

Other Partnership Characteristics—Participants categorized each partnership as: serious, casual, sleeping with this person, a one night stand, or a stranger. Serious partnerships were coded 1 and all others were coded 0 (not serious). Partner HIV status was assessed with the item: “What was the HIV status of [partner name] the last time you had sex?” Response options were HIV-positive, HIV-negative, and Don’t Know.

Analyses

Analyses were conducted in R version 3.4 using the ‘glmmTMB’ package^{36,37}, which models count data accounting for dependencies in a nested/multilevel data structure. Sexual partnerships and related characteristics (Level 1) were nested within participants (Level 2) to examine whether PrEP use or PrEP adherence in a partnership was associated with sexual risk behaviors in that partnership. All models included a random participant-level (Level 2) intercept to account for nesting. Each outcome variable was modeled using a negative binomial distribution accounting for the skewed and overdispersed nature of the outcome. Results are presented as incidence-rate ratios (IRRs), or change in the rate of the outcome for each unit change in the independent variable. PrEP use within a relationship was entered as a binary categorical variable (1=on PrEP, 0=not on PrEP) for both participant and partner PrEP use (i.e., separate variables). PrEP adherence was dummy coded to examine PrEP adherent and PrEP non-adherent relative to no PrEP use.

We conducted analyses separately based on the HIV status arrangement of the partnership, because perceptions of sexual risk differ by HIV status. We analyzed HIV-negative seroconcordant (cohort member HIV negative, partner perceived negative/unknown), cohort HIV-negative serodiscordant (cohort member HIV-negative, partner known HIV-positive), and cohort HIV-positive serodiscordant (cohort member HIV-positive, partner perceived HIV-negative/unknown) separately. In HIV-negative seroconcordant and HIV-negative serodiscordant partnerships, we examined the influence of participant PrEP use in partnerships on CAS. In HIV-positive serodiscordant partnerships, we examined the influence of partner PrEP use on CAS. We were only able to examine the effect of PrEP adherence on sexual risk behaviors in HIV-negative seroconcordant relationships; we did not have sufficient power to do so in cohort HIV-negative serodiscordant partnerships, and we did not assess partner PrEP adherence in the cohort HIV-positive serodiscordant relationships. Finally, to assess whether the relationship between PrEP use and sex acts was moderated by relationship status (serious vs non-serious), we tested for relationship status \times PrEP use interactions, and retained significant interaction terms in analyses. All models adjusted for race/ethnicity, age at each visit, sexual orientation, gender identity and relationship status (serious versus non-serious). Following prior convention^{29,38}, relationships that had been reported at previous visits were flagged as repeat partnerships, and this variable was included as a covariate at time points after the partner was first reported.

Results

Participants were removed from analyses if they did not report any male sexual partners ($N=107$). The remaining 953 participants reported a total of 4,524 male sexual partnerships: 3,870 HIV-negative seroconcordant, 518 cohort HIV-positive serodiscordant, and 132 cohort HIV-negative serodiscordant partnerships. See Table 1 for the demographic breakdown of the analytic sample and Table 2 for descriptive data on of sexual partnerships. PrEP use was nearly five times more likely for HIV-negative YMSM in serodiscordant partnerships compared to those in HIV-negative seroconcordant partnerships (OR=4.96, $p<.01$), controlling for both partner type (i.e., serious, casual) and repeated partners across waves.

As indicated by the intraclass correlation coefficients, a substantial amount of variance in sexual behaviors and PrEP use occurred within-persons across partnerships.

HIV-Negative Seroconcordant Partnerships

Among HIV-negative cohort members with partners perceived HIV-negative or unknown status, PrEP use was associated with a significantly higher rate of receptive anal sex (IRR=1.27, $p<.05$) and receptive CAS acts (IRR=1.49, $p<.05$) but was not associated with insertive anal sex acts, insertive CAS acts, total anal sex acts, or total CAS acts within-persons (see Table 3). Participant PrEP adherence was associated with total CAS (IRR=1.62, $p<.05$) and receptive CAS acts (IRR = 1.79, $p < .05$), such that rates of CAS were higher in partnerships in which participants were PrEP non-adherent relative to those in which they were not on PrEP. Adherence was not associated with total anal sex acts, insertive anal sex acts, insertive CAS acts, or receptive anal sex acts. Sexual behavior did not differ between PrEP adherent partnerships and non-PrEP partnerships. Post-hoc tests run in separate models found no differences between PrEP adherent and PrEP non-adherent partnerships. Relationship status did not moderate the effects of PrEP use or PrEP adherence on sexual risk behaviors. We conducted sensitivity analyses in which we removed data from participants who were PrEP adherent but began taking PrEP after the sexual partnership began. The overall pattern of effects remained the same, and we observed no changes in statistical significance.

Cohort HIV-Negative Serodiscordant Partnerships

Participant PrEP use was associated with a trend for a higher rate of total anal sex acts (IRR=1.66, $p=.082$) and a significantly higher rate of total CAS (IRR=2.97, $p<.05$) with HIV-positive partners (see Table 4). PrEP use was also significantly associated with a higher rate of receptive anal sex (IRR=2.66, $p<.05$) and receptive CAS acts (IRR=5.6, $p<.01$) with HIV-positive partners. PrEP use was not associated with insertive anal sex or insertive CAS acts. Relationship status did not moderate any of the effects of PrEP use on sexual risk outcomes.

Cohort HIV-Positive Serodiscordant Partnerships

Among HIV-positive participants, partner PrEP use was associated with a significantly higher rate of total anal sex acts (IRR=1.51, $p<.05$) and a trend for a higher rate of total CAS acts (IRR=1.75, $p=.097$) (see Table 5). Partner PrEP use was also associated with a significant higher rate of insertive anal sex acts (IRR=2.30, $p<.01$) but was not associated with rate of insertive CAS acts. Partner PrEP use was associated with a significantly higher rate of receptive anal sex acts (IRR=1.97, $p<.01$) but was not associated with receptive CAS acts. Relationship status moderated the effect of partner PrEP use on receptive CAS acts (IRR=14.27, $p<.01$) among HIV-positive participants; partner PrEP use was not associated with rate of receptive CAS acts in serious relationships but was associated with a higher rate of receptive CAS acts in non-serious partnerships. As expected for an interaction term, the confidence interval was wide for this effect.

Discussion

These analyses provide compelling evidence for risk compensation among YMSM taking PrEP. Our within-persons analyses revealed that YMSM engaged in higher rates of receptive CAS in partnerships during which they were on PrEP compared to those when they were not on PrEP. Further, this association between PrEP use and receptive CAS was consistent across all models; HIV-negative YMSM showed an increased rate of receptive CAS in the context of PrEP use with partners who were both HIV-negative/unknown and known HIV-positive. HIV-positive YMSM also showed an increased rate of receptive CAS with casual (as opposed to serious) HIV-negative/unknown partners who were on PrEP. Of particular concern for HIV acquisition, the highest rates of receptive CAS occurred amongst YMSM who were on PrEP but not adherent to their medication regimen.

In contrast to prior research¹⁸⁻²¹, we found higher rates of HIV risk behavior (i.e., receptive CAS) in partnerships during which YMSM were on PrEP compared to those when they were not on PrEP. These findings may differ from prior studies for several reasons. First, many prior studies of these effects collapsed PrEP use and sexual behaviors across multiple partnerships. Our data observed multiple partnerships within-persons over time and modeled how individuals' behaviors differed when they were on and off PrEP. This within-persons approach offers an important methodological advantage of examining how an individual's behavior changes, rather than comparing groups of individuals who differ in their PrEP use. Second, several randomized trials examining PrEP efficacy have been able to examine change in sexual behaviors over time and have not observed decreases in condom use¹⁸⁻²¹. However, these trials were well-controlled and provided participants with substantial counseling for maintaining condom use while on PrEP. Our observational cohort data are likely a better reflection of real-world behavior patterns.

These analyses are also among the first to examine the influence of PrEP on specific positioning of anal sex behaviors (i.e., insertive vs. receptive). We found that PrEP use was associated with an increase in receptive CAS but not insertive CAS. This has important ramifications for transmission. For HIV-negative individuals, receptive CAS carries a substantially higher risk of HIV acquisition relative to insertive CAS³⁹. HIV-negative YMSM may be making strategic decisions about condom use in the context of PrEP based on knowledge of the relative risk of different sexual positions and may be reserving receptive CAS for times they are on PrEP. However, the protective effect of PrEP is dependent upon high levels of adherence, and if YMSM are non-adherent, they may be placing themselves at high risk for acquisition by increasing receptive CAS when on PrEP.

These analyses also indicate that higher rates of receptive CAS occurred during partnerships when YMSM were on PrEP but not consistently adherent. If indeed YMSM are engaging in higher rates of receptive CAS when they are not adherent, then PrEP as a prevention strategy may fail for these individuals and the risk compensation we observed may indeed perpetuate new HIV infections. In fact, a recent modeling study found that risk compensation in the context of non-adherent PrEP use may lead to increased incidence at the population level¹³. It is important to note, however, that the rate of receptive CAS did not significantly differ between partnerships in which YMSM were PrEP adherent and PrEP non-adherent.

Analysis of these effects requires that enough participants differ in their levels of adherence across partnerships, and we may have been underpowered to detect these effects. Furthermore, we were only able to examine the influence of PrEP adherence on condom use in the models in which HIV-negative YMSM reported on partnerships with perceived HIV-negative/unknown status partners because we did not have the power to do so in serodiscordant partnerships. It is possible that the effect of PrEP adherence on condom use may differ with known HIV-positive partners in which the risk of HIV acquisition may be more salient. Finally, relationship status did not moderate the effects of PrEP use or PrEP adherence on HIV risk behaviors. However, we were unable to examine how PrEP use may change within a given partnership over time, which is an important topic for future research. For example, PrEP use, PrEP adherence, and condom use may change as relationships shift in their monogamy or non-monogamy arrangements, which would have important implications for HIV acquisition.

Among HIV-positive participants in partnerships with HIV-negative or unknown status partners, we found that their rate of receptive CAS increased when their partners were on PrEP. Importantly, an HIV-positive person taking the receptive role during condomless anal sex has lower risk of transmission than taking the insertive role³⁹. HIV-positive YMSM may still engage in strategic positioning with partners who are on PrEP in order to further reduce transmission risk. Further, this association between partner PrEP use and increased receptive CAS was confined to casual partnerships rather than serious relationships. This is potentially problematic given that knowledge of casual partner PrEP use relies on the self-report of the sex partner and it is not possible to know for certain whether the individual is on PrEP and adherent to their medication regimen. In contrast, the factors influencing decisions about condom use in serodiscordant serious relationships are likely more complex, including more nuanced decisions based on the HIV-positive partner's viral load²⁴.

The current findings should be interpreted in the context of several limitations. First, these data relied on the one-sided report of participants in a longitudinal cohort of YMSM, and we were unable to collect certain data about partner behaviors that are relevant to condom use (e.g., partner PrEP adherence, HIV-positive partner's viral load). Dyadic would be necessary to examine these more nuanced associations with condom use⁴⁰ and is an important topic for future research. For example, condomless sex may be especially likely when both members of the dyad are using biomedical prevention (either PrEP use or suppressed viral load), which has been referred to as "biomed-matching"²⁴. Additionally, while measuring PrEP use at the level of the sexual partnership enhanced our ability to understand how PrEP use influences condom use within-persons over time, this partner-level approach is not ideal for measuring adherence. Our partner-level measure of adherence did not assess the number or pattern of missed doses, both of which are important for understanding transmission risk. It is also unclear from these data whether PrEP use increases risk for acquisition of other STIs. However, an analogous within-persons longitudinal approach that links STI infections to periods of PrEP use would help to clarify mixed findings in the literature^{16,17}. Finally, while these data come from a large ethnically-diverse sample of YMSM across multiple time points, these data from YMSM in Chicago may not generalize to other areas of the country.

Despite limitations, these analyses provide compelling data suggesting that YMSM are engaging in risk compensation when on PrEP. By using a within-persons design in which each participant served as their own control, we revealed that YMSM had an increased rate of receptive CAS in sexual partnerships during which they were on PrEP compared to non-PrEP partnerships. While risk compensation in and of itself does not necessarily lead to increased risk of infection, we also observed that rates of receptive CAS were highest amongst YMSM who were on PrEP and non-adherent. If YMSM have the highest rates of receptive CAS when non-adherent to PrEP, this would create an opportunity for the continued spread of HIV, even if PrEP uptake continues to rise. More research is clearly needed in order to understand how YMSM make decisions about condom use in the context of biomedical prevention in order to maximize the efficacy of these new and promising prevention strategies.

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Protection of Human Subjects

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. Participants provided their consent/assent to participate in the study.

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Table 1

Baseline Demographic Characteristics of the Analytic Sample (N=953)

Demographic Characteristic	Mean	SD
Age	21.5	3.5
	N	%
Gender Identity		
Male	880	92.3
Transgender/female/other	73	7.7
Sexual orientation		
Gay	678	71.1
Bisexual	193	20.3
Other	82	8.6
Race/ethnicity		
White	244	25.6
Black/African American	324	34
Hispanic/Latino/a	280	29.4
Other	105	11
HIV Status		
HIV-Negative	819	85.9
HIV-Positive	134	14.1

NOTE: SD = standard deviation.

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Table 2

Descriptive Characteristics of Sexual Risk Behaviors and Relationship Characteristics

Study Variables	Mean	SD	%	ICC
HIV-Negative Seroconcordant Partnerships (N=3870)				
Insertive sex	3.55	11.04	–	0.304
Insertive CAS	2.4	9.31	–	0.277
Receptive sex	4.12	11.25	–	0.264
Receptive CAS	2.83	9.74	–	0.245
Total anal sex	7.66	18	–	0.235
Total CAS	5.23	15.57	–	0.226
Serious	–	–	25.78%	–
Participant on PrEP	–	–	8.83%	0.575
PrEP Adherent	–	–	5.42%	0.545
PrEP Non-Adherent	–	–	3.41%	0.542
Cohort HIV-Positive Serodiscordant Partnerships (N=518)				
Insertive sex	5.06	12.69	–	0.248
Insertive CAS	2.21	8.6	–	0.224
Receptive sex	2.88	10.07	–	0.254
Receptive CAS	0.79	3.67	–	0.14
Any anal sex	7.94	18.07	–	0.268
Any CAS	3	9.4	–	0.215
Serious	–	–	53.68%	–
Partner on PrEP	–	–	13.82%	0.318
Cohort HIV-Negative Serodiscordant Partnerships (N=132)				
Insertive sex	10.86	20.32	–	0.453
Insertive CAS	6.6	15.58	–	0.381
Receptive sex	8.74	17.62	–	0.52
Receptive CAS	4.69	12.47	–	0.337
Any anal sex	19.6	31.32	–	0.604
Any CAS	11.28	22.57	–	0.542
Serious	–	–	28.76%	–
Participant on PrEP	–	–	22.72%	0.663

NOTE: HIV-negative seroconcordant refers to partnerships in which the participant is HIV-negative and partner is perceived HIV-negative/unknown. Cohort HIV-positive serodiscordant refers to partnerships in which the participant is HIV-positive and the partner is perceived HIV-negative/unknown. Cohort HIV-negative serodiscordant refers to partnerships in which the participant is HIV-negative and the partner is known HIV-positive. SD = standard deviation; ICC = intraclass correlation coefficient; CAS = condomless anal sex; PrEP = pre-exposure prophylaxis.

Table 3

Effects of PrEP Use and Adherence on Condomless Anal Sex in HIV-Negative Seroconcordant Partnerships

Outcome	Predictor	IRR	Confidence Interval (95%)	p-value
Insertive sex	Participant on PrEP	0.89	0.68 – 1.16	0.388
	Non-Adherent	1.03	0.71 – 1.52	0.864
	Adherent	0.8	0.57 – 1.11	0.175
Insertive CAS	Participant on PrEP	1.16	0.79 – 1.71	0.451
	Non-Adherent	1.53	0.89 – 2.63	0.122
	Adherent	0.94	0.59 – 1.51	0.807
Receptive sex	Participant on PrEP	1.27	1 – 1.61	0.049
	Non-Adherent	1.33	0.95 – 1.88	0.101
	Adherent	1.24	0.94 – 1.62	0.129
Receptive CAS	Participant on PrEP	1.49	1.05 – 2.12	0.025
	Non-Adherent	1.79	1.09 – 2.93	0.021
	Adherent	1.33	0.88 – 2.01	0.177
Total anal sex	Participant on PrEP	1.07	0.9 – 1.28	0.441
	Non-Adherent	1.12	0.86 – 1.45	0.392
	Adherent	1.04	0.85 – 1.29	0.683
Total CAS	Participant on PrEP	1.32	1 – 1.76	0.052
	Non-Adherent	1.62	1.09 – 2.42	0.018
	Adherent	1.16	0.83 – 1.62	0.399

NOTE: HIV-negative seroconcordant refers to partnerships in which the participant is HIV-negative and the partner is perceived HIV-negative/unknown. PrEP = pre-exposure prophylaxis; IRR = incidence-rate ratio; CAS = condomless anal sex.

Table 4

Effects of PrEP Use on Condomless Anal Sex in Cohort HIV-Negative Serodiscordant Partnerships

Outcome	Predictor	IRR	Confidence Interval (95%)	p-value
Insertive sex	Participant on PrEP	1.25	0.62 – 2.53	0.538
Insertive CAS	Participant on PrEP	1.79	0.62 – 5.19	0.281
Receptive sex	Participant on PrEP	2.66	1.12 – 6.3	0.026
Receptive CAS	Participant on PrEP	5.6	1.86 – 16.86	0.002
Total anal sex	Participant on PrEP	1.66	0.94 – 2.94	0.082
Total CAS	Participant on PrEP	2.97	1.22 – 7.24	0.017

NOTE: Cohort HIV-negative serodiscordant refers to partnerships in which the participant is HIV-negative and the partner is known HIV-positive. PrEP = pre-exposure prophylaxis; IRR = incidence-rate ratio; CAS = condomless anal sex.

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Table 5

Effects of PrEP Use on Condomless Anal Sex in Cohort HIV-Positive Serodiscordant Partnerships

Outcome	Predictor	IRR	Confidence Interval (95%)	p-value
Insertive sex	Partner on PrEP	2.3	1.3 – 4.05	0.004
Insertive CAS	Partner on PrEP	1.66	0.81 – 3.4	0.17
Receptive sex	Partner on PrEP	1.97	1.19 – 3.26	0.008
Receptive CAS	Partner on PrEP	0.41	0.11 – 1.58	0.194
	Partner on PrEP*Serious	14.27	2.62 – 77.56	0.002
Total anal sex	Partner on PrEP	1.51	1.07 – 2.13	0.018
Total CAS	Partner on PrEP	1.75	0.9 – 3.38	0.097

NOTE: Cohort HIV-positive serodiscordant refers to partnerships in which the participant is HIV-positive and the partner is perceived HIV-negative/unknown. Partner on PrEP*Serious refers to the interaction between partner PrEP status and relationship type (serious vs. non-serious). PrEP = pre-exposure prophylaxis; IRR = incidence-rate ratio; CAS = condomless anal sex.