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## Sexual behavior and perceived HIV risk among HIV-negative members of serodiscordant couples in East Africa

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### Abstract

HIV risk perception may influence the use of HIV prevention interventions. Using data from HIV-negative adults enrolled in a study of pre-exposure prophylaxis (PrEP) and antiretroviral therapy for HIV-serodiscordant couples in Kenya and Uganda, we examined associations between: 1) condom use and risk perception and 2) risk perception and PrEP adherence. Two-thirds of HIV-negative partners reported condomless sex with their HIV-positive partner or another partner in the month prior to study enrollment. Compared to those who reported no condomless sex, participants who reported condomless sex during the month prior to study visit had 5-fold higher odds of reporting “high risk” vs “no risk” perception (36.3 versus 10.9%: aOR=4.9, 95% CI: 3.4–6.9). Reporting condomless sex in the most recent sex act was associated with increased odds of perceiving some HIV risk (aOR for high risk=7.3, 95% CI 4.9–10.8; aOR for moderate risk=4.8, 95% CI 3.5–6.7; aOR for low risk=3.5, 95% CI 2.7–4.6). We found no significant association between risk perception and PrEP adherence. Sexual behavior aligned with perceived HIV risk, which can facilitate an HIV-negative individual’s decisions about PrEP use.

### Keywords

HIV; risk perception; serodiscordant; condomless sex; PrEP

## INTRODUCTION

Risk perception is an important factor in the uptake of HIV prevention interventions, but studies have found mixed results on HIV prevention behaviors that influence of risk

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perception [1]. Some factors that have been significantly associated with perception of high risk for HIV among people living in high-burdened settings in East and Southern Africa include single marital status, not knowing a partner's HIV status, gender, having multiple partners, and being in an age-disparate partnership [2–5]. Substantial evidence supports the idea that sexual behavior also influences HIV risk perception – people reporting condomless sex or more frequent sex often have higher risk perception [2, 3, 5–9]. However, among serodiscordant couples, misconceptions about HIV serodiscordance have been associated with lower perception of risk and inconsistent or no condom use [10, 11]. Other barriers to condom use include male partners' reluctance to use condoms, women's difficulties in negotiating condom use, alcohol use, and the desire to have children [11]. These findings highlight the need to further investigate the association between risk perception and sexual behavior among serodiscordant couples and other at-risk populations.

In 2015, the World Health Organization (WHO) issued its first recommendation for pre-exposure prophylaxis (PrEP) to be used by people with substantial risk of acquiring HIV as a HIV prevention strategy [12]. By March 2019, an estimated 465,000–475,000 individuals were using PrEP globally, including 55 countries [13]. Adherence is strongly correlated with the level of protection afforded by PrEP [14], and challenges with adherence have been identified, especially among young women, limiting the individual benefit of PrEP for HIV prevention [15, 16]. In addition to factors such as pregnancy and breastfeeding status [17, 18], age <25 years [15, 17, 19, 20], being single [15], partner awareness and support [2, 21], social stigma [22], mobility patterns [23], and side effects [15, 20, 22, 24], multiple studies have found associations between risk perception and PrEP adherence, with individuals who report moderate to high HIV risk perception also having higher PrEP adherence [2, 21, 25–28].

Most studies to date which evaluated the association between sexual behavior and risk perception have been cross-sectional and unable to determine temporal relationships. Furthermore, the assessment of the association between perceived HIV risk and PrEP adherence is still not widely studied. In the current study, we used longitudinal data to prospectively assess the associations between sexual behavior and risk perception, as well as risk perception and PrEP adherence among high risk HIV-serodiscordant couples participating in an open-label evaluation of PrEP for HIV-negative partners during antiretroviral therapy (ART) initiation by HIV-positive partner with follow-up to 24 months.

## METHODS

### Study Population

Participants were HIV serodiscordant couples from the Partners Demonstration Project, an implementation science-driven evaluation of PrEP delivery integrated with ART in Kenya (Kisumu and Thika) and Uganda (Kabwohe and Kampala) between November 2012 and January 2015 [29, 30] – full eligibility criteria and study procedures have been reported elsewhere [31]. Following enrollment, participants attended visits one month after enrollment then 2 months later, then quarterly thereafter for a maximum of 24 months. At enrollment, HIV-negative partners were offered PrEP (as a daily regimen of oral emtricitabine/tenofovir disoproxil fumarate (FTC/TDF)), and PrEP discontinuation was

encouraged once the partner living with HIV had used ART for at least 6 months if there was no indication of poor adherence, outside partners, or immediate plans for the woman to become pregnant. All HIV-positive partners were ART-naïve at enrollment and initiated ART according to national guidelines.

### Data Collection

Demographic, clinical, and sexual behavior data were collected via self-report using standardized interviewer administered questionnaires. At enrollment and annually, the 16-item Hopkins Symptoms Checklist for Depression (HSCL-D) [32], the 4-item Rapid Alcohol Problems Screen (RAPS4) [33], and the 10-item Duke-UNC Functional Social Support Scale Screening [34] were used to screen for depression, alcohol dependence, and social support, respectively. PrEP adherence was monitored using medication event monitoring system (MEMS) caps, which electronically monitor the time and date of pill-bottle closings. Adherence was calculated during follow up for each study period with MEMS cap data as actual openings divided by the expected number of openings since the last visit – a value  $\geq 80\%$  was considered high adherence [35].

### Statistical Analyses

Descriptive methods were used to summarize cohort characteristics. The primary outcome of interest was a self-reported perceived risk of HIV acquisition, which was measured quarterly by asking the following: “In general, what do you think is your risk of getting HIV from your partner?” Responses included: “high risk”, “moderate risk”, “low risk”, “no risk”, and “don’t know”. The key behavioral exposures assessed for an association with risk perception (collected quarterly) were: 1) any condomless sex with study or non-study partner in the past month and 2) condom use during the most recent sexual intercourse with a study partner. Any condomless sex was calculated based on the number of times the participant had sex in the past month; if the difference between this and the number of times the participant used a condom was  $>0$ , then the participant was categorized as having had condomless sex. If this difference was zero (i.e. 100% condom use) or if a participant reported no sex, then the participant was categorized as having had no condomless sex.

Generalized logistic regression was used to compare the odds of being in one category of HIV risk perception relative to perceiving no HIV risk dependent on condom use. Separate models for each measure of condom use were adjusted for time in study, age category, gender, whether married/cohabiting with study partner, social support index, years that their serodiscordant status was known, abuse (verbally, physically or emotionally) by study partner, alcohol dependence, probable depression, and PrEP adherence based on *a priori* knowledge of the association of each factor with sexual behavior and risk perception [2, 3, 5–9]. Based on commonly seen differences in the ways men and women report sexual behavior [3, 4], we conducted analyses stratified by gender. To evaluate the effect of risk perception on PrEP adherence, we repeated the adjusted models above with PrEP adherence as the outcome and risk perception as the exposure.

All analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC) and significance level evaluated at an alpha level of 0.05.

**Ethical statement**—The study protocol was approved by the Human Subjects Division at the University of Washington (#STUDY00001674) and Ethics Review Committees overseeing each study site: Scientific Ethics Review Unit at the Kenya Medical Research Institute (SSC No. 2441), the Ethics Review Committee of Kenyatta National Hospital (P286/05/2012), and the AIDS Research Committee of the Uganda National Council of Science and Technology (ARC 135 and ARC126). All participants provided written informed consent.

## RESULTS

### Participant characteristics

A total of 908 seronegative participants were included in this study, 89% of individuals had 24 months of follow up and the median duration of PrEP use was 12 months [interquartile range (IQR): 6, 18]. At enrollment, the median age of the population was 30 years [IQR: 26, 36], and 8.6% of female participants and 13.6% of male participants had a partner living with HIV who was virally suppressed (<1,000 copies/mL, Table I). Participants reported knowing their serodiscordant status for a median of 3.0 months [IQR: 3.0, 9.1] and having cohabited with their study partner for a median of 2.8 years [IQR: 0.8, 7.0].

### Trends in risk perception and sexual behavior

During follow-up, men tended to report perception of no risk more frequently than women (38% vs 24% of observations,  $\Pi^2 = 87.2$ ,  $p < 0.001$ ) (Figure I). The frequency of condomless sex declined from 66% at enrollment to 31% at the first month of follow up and then fluctuated between 31% and 37% from month 3 to month 24 (Figure II). There was evidence of a linear increase in the proportion of reporting condomless sex over time ( $\Pi^2 = 102.8$ ,  $p < 0.001$ ), which was driven by changes between enrollment and the first month of follow up.

### Association between sexual behavior and risk perception

Individuals who reported any condomless sex had almost five-fold higher odds of reporting themselves as “high risk” for HIV acquisition than those who reported no condomless sex (adjusted odds ratio [aOR]=4.7; 95% CI: 3.4–6.9, Table II). Correspondingly, condomless sex was associated with ~4-fold higher odds of reporting “moderate risk” (aOR=4.4; 95% CI: 3.3–5.9) and ~3-fold higher odds of reporting “low risk” (aOR=2.9; 95% CI: 2.3–3.6). Not using a condom during the most recent sex with study partner was significantly associated with nearly three to seven-fold increase in odds of perceiving some risk of HIV acquisition (aOR for high risk=7.3, 95% CI 4.9–10.8; aOR for moderate risk=4.8, 95% CI 3.5–6.7; aOR for low risk=3.5, 95% CI 2.7–4.6).

Although there was no interaction between sexual behavior and risk perception ( $p > 0.05$ ), in gender-stratified models, we observed a stronger association of condomless sex and perceiving HIV risk among women than men (e.g. aOR=7.2, 95% CI 3.9–13.2 in women versus aOR=4.3, 95% CI 2.7–6.9 in men for the association of high risk perception and reporting condomless sex). In all models with any condomless sex as the exposure, the effect

estimates of associations comparing the “don’t know” versus “no” risk perception category fell between those of moderate and low risk perception categories.

### **Association between risk perception and PrEP adherence**

Among all HIV negative partners enrolled in the Partners Demonstration project, 97% initiated PrEP. Tenofovir was detected in 81% of plasma samples and 71% of individuals had high adherence by MEMS caps data [36]. Overall, compared to those who reported a risk perception of none, those who reported high, moderate, and low risk perception had 8% lower odds, 12% higher odds and 17% higher odds, respectively, of having high PrEP adherence, but these associations were not statistically significant (Table III). We found similar results in separate models for women and men.

## **DISCUSSION**

In a PrEP demonstration study in Kenya and Uganda, we evaluated the effect of 1) sexual behavior on HIV risk perception and 2) HIV risk perception on PrEP adherence among HIV-negative participants. Reporting condomless sex (either in general or at the last sex act specifically) was associated with having greater HIV risk perception, yet HIV risk perception was not associated with PrEP adherence. Condom use was also associated with the likelihood of reporting moderate/great risk perception of HIV in a recent study in South Africa [5]. In our study, men reported having no perceived risk for HIV more frequently than women. These results are consistent with studies in Zambia and Mozambique where men were more likely to have multiple sex partners and to report lower risk perception than women [3, 6], and condom use at last sex was more prevalent among men and women whose perceived risk aligned with past and current sexual behavior [4].

Contrary to results from a quantitative study that found a positive association between risk perception (small/moderate/high vs. none) and good adherence (OR: 2.0; 95% CI: 1.1–3.5) [2], we did not find that the level of risk perception was associated with PrEP adherence. In addition to being in mutually disclosed serodiscordant partnerships, the HIV-negative individuals in this study received considerable PrEP counseling [37], likely greater than that received by those who attend public health facilities. This increased awareness of HIV risk possibly contributed to high PrEP adherence regardless of what risk perception was reported during visits and may explain our null findings.

Although our study and others show evidence that having condomless sex is associated with greater odds of perceiving that one has risk for HIV, measuring risk perception remains a challenge. Presently, three studies have investigated the accuracy and validity of HIV risk perception scales and individual items. The first evaluated the “perceived risk of HIV infection scale”, which measures perceived risk using likelihood estimates, intuitive feelings about risk, and the salience of the risk of HIV infection [38]. In the second study, risk perception scales were developed from items measuring perceived risk and perceived vulnerability [39]. The third study assessed risk using four questions: two about general perceived risk, and two about partner-specific perceived risk [40]. The scales developed in these studies demonstrated good reliability and validity. However, their use in other settings

is still limited since they were conducted in specific settings and populations in Ethiopia [39] and the US [38, 40].

Most studies, including ours, have evaluated risk perception using a single question about the likelihood of getting HIV at a past or future time and a Likert scale with 4–5 response options [2–5, 41, 42]. Some have grouped scale responses to formulate a binary variable (“high vs low” or “some vs none”) [3, 5, 41], which limits assessment of the effect of different levels of risk perception. Another limitation to a one-question approach for assessing risk perception is the inability to evaluate drivers of risk perception such as partner’s or own sexual behavior and whether participants understand the HIV risk posed by that behavior. This “imperfect” measurement of risk perception may also explain our inability to detect a significant association with PrEP adherence. Some studies have used qualitative methods to assess risk perception in greater detail [8]. One strength of our study is that we assessed risk perception quarterly over a 24-month period, creating frequent opportunities for individuals to evaluate their personal HIV risk and sexual behavior.

The observed alignment of sexual behavior and risk perception in our study suggests that some individuals understand how certain behaviors influence their risk of HIV infection. While this finding is encouraging, studies that have indicated a misalignment between risk perception and actual risk, particularly among men [3, 4] and young women [5], highlight the need to assess the alignment of true HIV risk (or exposure) and risk perception. This relationship is particularly important in the context of PrEP, because if measured more comprehensively, risk perception, among other factors, could influence uptake and adherence to PrEP. Identification of times when risk perception is misaligned with PrEP adherence would present opportunities to potentially increase adherence to PrEP through HIV counseling or to promote alternative HIV prevention strategies [43].

Results from our study highlight the potential role for HIV risk perception to influence use of PrEP and other prevention strategies. As discussed in recommendations for programmatic success of global PrEP roll-out [44], it is essential for PrEP implementers and providers to conduct holistic sexual health assessments, such as high quality measurement of risk perception and the evaluation of actual HIV risk and the salience of HIV risk, to guide conversations about PrEP as a HIV prevention option for clients. As PrEP becomes more available, there is an opportunity for its delivery to incorporate counseling for HIV risk perception, sexual behavior, and PrEP adherence, which integrates the complexities and dynamics of a client’s life. Understanding how these factors are linked, through research, can aid in developing and improving guidelines and programmatic tools available to providers.

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Data availability

Data are available upon request to the authors' research center by icrc@uw.edu.

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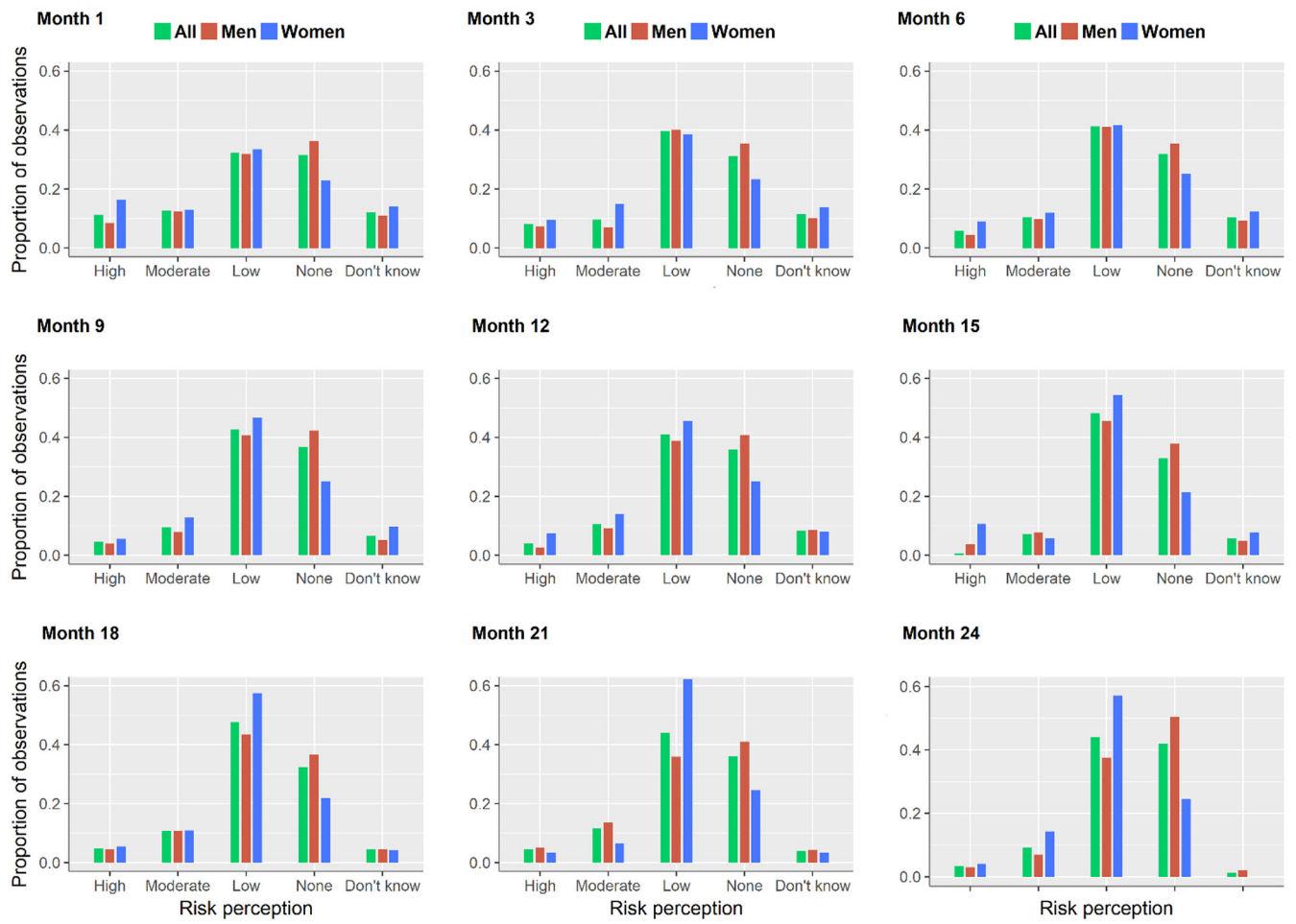
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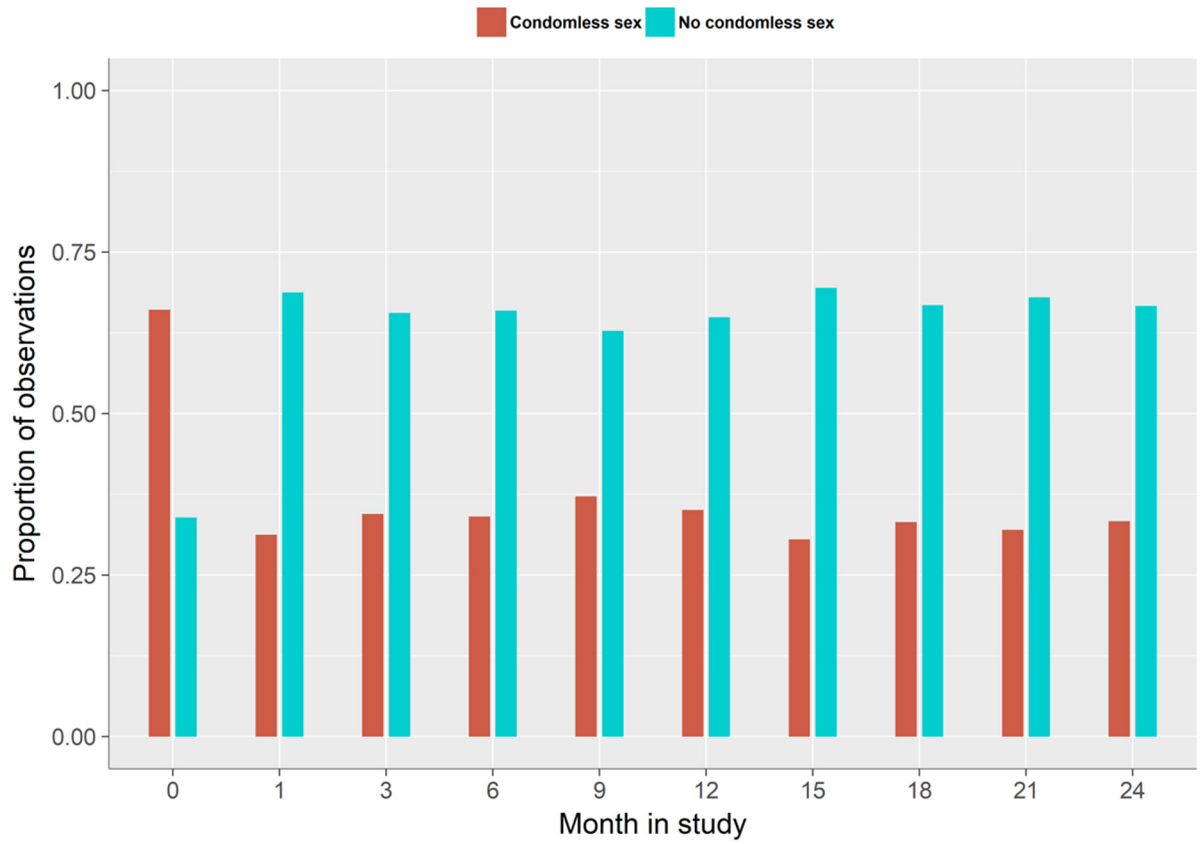
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**Figure I.**  
Frequency of risk perception by month: overall and by gender



Condomless sex:	600	260	260	236	223	155	106	83	64	50
No condomless sex:	308	572	495	457	377	287	241	167	136	100
	0	1	3	6	9	12	15	18	21	24

No. of observations per month

**Figure II.**  
Distribution of observations over time by condomless sex

**Table I.**

## Baseline characteristics of participants by gender

Variable	Female (n = 317) n (%) or median [IQR]	Male (n = 591) n (%) or median [IQR]
Age in years		
24	82 (25.9)	99 (16.8)
25–29	89 (28.1)	177 (29.9)
30–34	64 (20.2)	117 (19.8)
35–39	45 (14.2)	75 (12.7)
40	37 (11.7)	123 (20.8)
Married or cohabiting with partner	315 (99.4)	575 (97.3)
Years serodiscordant status known	0.1 [0.1, 0.6]	0.1 [0.1, 0.2]
Years cohabiting with partner	5.0 [1.5, 10.3]	2.0 [0.6, 5.0]
Social support, mean score <sup>a</sup>	3.6 [3.2, 3.9]	3.7 [3.2, 4.0]
Number of sex acts, past month	4.0 [3.0, 8.0]	6.0 [3.0, 12.0]
Number of condomless sex acts, past month	1.0 [0.0, 4.0]	2.0 [0.0, 6.0]
Reporting any partners outside of the study partner, past month	4 (1.3)	69 (11.7)
Abuse by study partner, last 3 months <sup>b</sup>	1 (0.3)	1 (0.2)
Alcohol dependence, last 1 year <sup>c</sup>	49 (15.5)	133 (22.5)
Probable depression, last 1 year <sup>d</sup>	39 (12.3)	51 (8.6)
HIV viral load (copies/ml) of the partner living with HIV		
<1000	27 (8.6)	79 (13.6)
< 10,000	60 (18.9)	196 (33.2)
10,000–49,999	74 (23.3)	191 (32.3)
50,000	183 (57.7)	204 (34.5)
Circumcised (men only)		
Circumcised	-	393 (66.5)
Uncircumcised	-	198 (33.5)
Effective contraception (women only) <sup>e</sup>		
Yes	110 (34.7)	-
No	207 (65.3)	-
STI Symptoms <sup>f</sup>	16 (5.1)	7 (1.2)

n = number; IQR = interquartile range;

<sup>a</sup>Social support measured using the Duke-UNC Social Support Scale

<sup>b</sup>Abuse = verbally, physically or economically;

<sup>c</sup>Alcohol dependence screened using the Rapid Alcohol Problems Screen (RAPS4);

<sup>d</sup>Depression screened using the Hopkins Symptoms Checklist for Depression (HSCL-D);

<sup>e</sup>Effective contraception = oral, implant, IUD, surgical, injectable);

<sup>f</sup>STI symptoms = genital ulcer disease, vaginitis, cervicitis, pelvic inflammatory disease, urethritis.

**Table II.**

Adjusted associations between sexual behavior and perceived risk of getting HIV

	N <sup>d</sup> (%) Any condomless sex	N <sup>d</sup> (%) No condomless sex	Adjusted OR (95% CI) Any condomless sex <sup>b</sup>	N <sup>d</sup> (%) No condom use in last sex with study partner	N <sup>d</sup> (%) Condom use in last sex with study partner	Adjusted OR (95% CI) No condom use during most recent sex with study partner <sup>b</sup>
<b>Risk perception: Overall</b>						
High	143 (36.3)	143 (10.9)	4.7 (3.4, 6.9)	107 (46.9)	129 (11.8)	7.3 (4.9, 10.8)
Moderate	210 (45.6)	233 (16.6)	4.4 (3.3, 5.9)	152 (55.7)	254 (20.8)	4.8 (3.5, 6.7)
Low	667 (72.7)	1058 (47.4)	2.9 (2.3, 3.6)	472 (79.6)	1033 (51.6)	3.5 (2.7, 4.6)
Don't know	164 (39.5)	211 (15.2)	3.7 (2.7, 5.0)	116 (48.9)	195 (16.8)	4.9 (3.4, 7.0)
None	251 (5)	1174 (5)	-	121 (5)	968 (5)	-
<b>Risk perception: Women</b>						
High	66 (62.3)	68 (18.7)	7.2 (3.9, 13.2)	51 (68.0)	63 (21.1)	8.2 (3.9, 17.3)
Moderate	80 (66.7)	94 (24.2)	6.5 (3.7, 11.5)	58 (70.7)	106 (31.0)	5.3 (2.8, 10.3)
Low	223 (84.8)	391 (23.6)	3.8 (2.4, 6.1)	162 (87.1)	368 (60.9)	3.8 (2.1, 6.9)
Don't know	64 (61.5)	85 (22.4)	5.4 (3.0, 9.7)	52 (68.4)	79 (25.1)	6.3 (3.2, 12.3)
None	40 (5)	295 (5)	-	24 (5)	236 (5)	-
<b>Risk perception: Men</b>						
High	77 (26.7)	75 (7.9)	4.3 (2.7, 6.9)	56 (36.6)	66 (8.3)	7.1 (4.3, 11.7)
Moderate	130 (38.1)	139 (13.7)	4.0 (2.9, 5.7)	94 (49.2)	148 (16.8)	4.9 (3.3, 7.2)
Low	444 (67.8)	667 (43.1)	2.8 (2.1, 3.6)	310 (76.2)	665 (47.6)	3.5 (2.6, 4.8)
Don't know	100 (32.2)	126 (12.5)	3.3 (2.2, 4.8)	64 (39.8)	116 (13.7)	4.3 (2.8, 6.8)
None	211 (5)	879 (5)	-	97 (5)	732 (5)	-

<sup>a</sup>N = number of observations over the duration of the study

<sup>b</sup>OR (95% CI) adjusted for time, age, gender (only in overall model), married/cohabiting, mean social support, years serodiscordant status known, abuse by study partner, alcohol dependence, probable depression and PrEP adherence; all p-values < 0.001.

<sup>c</sup>percent varies with comparison, e.g., for "high" vs. "none" risk perception, the OR compares 63.7% of observations with any condomless sex versus 89.1% with no condomless sex.

**Table III.**

Adjusted associations between perceived risk of getting HIV and 80% PrEP adherence

Risk perception	Overall		Women		Men	
	N <sup>d</sup> (%) with adherence to PrEP <sup>c</sup>	Adjusted OR (95% CI)	N <sup>d</sup> (%) with adherence to PrEP <sup>c</sup>	Adjusted OR (95% CI)	N <sup>d</sup> (%) with adherence to PrEP <sup>c</sup>	Adjusted OR (95% CI)
High <sup>b</sup>	40 (83.3)	0.9 (0.7, 1.3)	20 (90.9)	0.8 (0.4, 1.3)	20 (76.9)	1.0 (0.7, 1.6)
Moderate <sup>b</sup>	69 (92.0)	1.1 (0.8, 1.5)	34 (97.1)	1.2 (0.7, 2.0)	35 (87.5)	1.1 (0.8, 1.5)
Low <sup>b</sup>	213 (87.7)	1.2 (1.0, 1.4)	88 (88.9)	1.0 (0.7, 1.5)	125 (86.8)	1.3 (1.0, 1.6)
Don't know <sup>b</sup>	49 (84.5)	0.9 (0.7, 1.2)	30 (96.8)	0.9 (0.5, 1.8)	19 (70.4)	0.8 (0.6, 1.2)
None	210 (89.0)	Reference	58 (89.2)	Reference	152 (88.9)	Reference

<sup>a</sup>N = number of observations over the duration of the study

<sup>b</sup>OR (95% CI) adjusted for any condomless sex, age, gender (only in overall model), married/cohabiting, mean social support, years serodiscordant status was known, abuse by study partner, alcohol dependence and probable depression.

<sup>c</sup>Adherence to PrEP = observed divided by expected number of MEMS cap openings 80%