Sexually Transmitted Infection Prevalence, Partner Notification, and Human Immunodeficiency Virus Risk Perception in a Cohort of Women Completing Sexually Transmitted Infection Screening as Part of a Safer Conception Study

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Background: Integrating sexually transmitted infection (STI) and preexposure prophylaxis (PrEP) care may optimize sexual and reproductive health.

Methods: We nested an STI substudy within a human immunodeficiency virus (HIV) prevention cohort (parent study) of 18- to 35-year-old women from South Africa, planning pregnancy with a partner with HIV or of unknown serostatus. Parent-study women completed annual surveys regarding HIV-risk perceptions and were offered oral PrEP. Preexposure prophylaxis initiators completed quarterly plasma tenofovir (TFV) testing. Substudy women completed STI screening at enrollment, 6 months, onset of pregnancy, and in the third trimester via examination, vaginal swabs tested via PCR for *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, *Trichomonas vaginalis*, *Mycoplasma genitalium*, and blood tested for *Treponema pallidum*. Follow-up was 6 months. Women with STIs were treated, offered partner notification (PN) cards, and surveyed regarding PN practices. We describe STI prevalence and incidence, and model factors associated with prevalent infection. Sexually transmitted infection substudy and parent study-only participants were matched on age and number of days on study to assess HIV-risk perception scores between the 2 groups and the proportion with detectable TFV.

Results: Among 50 substudy participants, 15 (30%) had prevalent STI. All 13 completing follow-up reported PN. Most did not prefer assisted PN. Mean HIV risk perception scores and proportion with detected plasma TFV were similar across groups.

Conclusions: High STI prevalence supports the importance of laboratory screening to optimize sexual health for women planning pregnancy. Rates of self-reported PN are reassuring; low interest in assisted PN suggests the need for alternative approaches. Enhanced STI care did not affect HIV-risk perception or PrEP adherence, however both were relatively high in this cohort.

Over 7 million people with human immunodeficiency virus (HIV) (PWH) live in South Africa.[1] Ten percent to 15% are in HIV-serodifferent relationships.[2,3] For individuals whose partners have HIV, periconception and pregnancy are associated with HIV acquisition risks.[4] Women engaging in condomless sex may acquire curable sexually transmitted infections (STIs), which can confer morbidities to the woman and her future infant,[5,6] and increase chances of acquiring HIV.[7]

Curable, particularly asymptomatic, STI prevalence is high among women in South Africa.[8–11] Among 96 HIV-uninfected adolescent girls and young women (AGYW) from Durban, 18% had *Chlamydia trachomatis* (CT), 7% had *Neisseria gonorrhoeae* (NG), 10% had *Mycoplasma genitalium* (MG) and 8% had *Trichomonas vaginalis* (TV); the sensitivity of symptoms was 14%.[8] Among women with and without HIV, including pregnant women, in Cape Town, CT, TV, and NG were observed among 20%, 15%, and 6%, respectively with less than 10% of women with STI identified and managed syndromically during antenatal care.[10] A recent study among women in Uganda who were planning pregnancy with a partner found a curable STI prevalence of 24%.[9] Importantly, because syndromic management is the standard of care in these settings, these women were only diagnosed by enrolling in STI research studies.

Effective partner notification (PN) and treatment are integral to end STI transmission and acquisition cycles.[12] South Africa's national STI management strategic plan includes developing and implementing effective STI PN strategies, however data on how to do this are limited.[13] STI care may present opportunities to promote understandings of HIV acquisition given that STIs are more common but increase vulnerability to HIV.[11,14–16] A study conducted in South Africa observed that point-of-care STI testing increased PrEP initiation.[17]

Given that women attempting pregnancy are at high risk for STIs that increase HIV acquisition risk, understanding STI prevalence and PN practices among periconception women can inform policy

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Conflict of interest: Gilead Sciences provided operational support and study drug for the parent study.

Sources of support/funding: NIMH MH108412, R01MH108412-05S1, Gilead Sciences provided study drug and operational support.

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Received for publication August 15, 2023, and accepted February 6, 2024.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text, and links to the digital files are provided in the HTML text of this article on the journal's Web site (http://www.stdjournal.com).

DOI: 10.1097/OLQ.0000000000001951

and care. We explored STI prevalence, and PN preferences and practices among women in South Africa without HIV who were planning pregnancy with a partner whose HIV-serostatus was positive or unknown. In exploratory analyses, we also explored the impact of receiving enhanced STI counseling and testing on HIV risk perception and PrEP adherence.

METHODS

Parent-Study Design and Population

The ZINK study (Zivikele ngaphambi kokukhulelwa; "Protecting yourself before pregnancy" in isiZulu) was a longitudinal cohort study conducted in Durban, South Africa that enrolled 330 women aged 18 to 35 years, without HIV, from 2017 to 2020. Women were offered HIV prevention including daily, oral PrEP with the primary aim to evaluate PrEP uptake and adherence. Women were screened and treated for syndromic STIs according to the standard of care in South Africa.[18] Detailed study procedures are published.[19]

STI Substudy Design and Population

We nested a descriptive longitudinal substudy within the ZINK study to evaluate STI prevalence, incidence, and PN practices among a subset of women. Nonpregnant women enrolled in the ZINK study were eligible for the substudy if they were without HIV, had completed the first study follow-up visit and had not yet completed the month-6 follow-up visit. Women who became pregnant were eligible for the substudy if they were without HIV and in the first trimester of pregnancy.

STI Substudy Procedures

At STI substudy enrollment, a study clinician conducted a vaginal examination for signs of STIs; vaginal swabs and blood were collected for STI testing. Swabs were tested for CT, NG, MG, and TV using PCR testing. Blood was tested for syphilis using *Treponema pallidum* Hemagglutination Assay (TPHA) and positive samples were confirmed by rapid plasma reagin (RPR).

Women with clinical signs and/or a laboratory diagnosis of curable STIs were offered counseling and treated at the research site or referred for treatment, and offered PN letters.

Repeat examination and testing were conducted approximately 6 months after the initial sample collection, at pregnancy diagnosis and during the second/third trimester.

Measures

Women completed a baseline questionnaire to assess sociodemographic, reproductive, and other health-related history.

Women in the STI substudy group completed an enrolment questionnaire to assess STI history, sexual activity, substance use, and partner STI history.

A follow-up questionnaire was collected at approximately 6 months after STI diagnosis among women who were diagnosed and treated for STIs to assess STI treatment and PN practices and preferences.[20]

Human immunodeficiency virus risk perception was assessed at baseline, 6-month, and 12-month follow-up visits among all women using the 7-item perceived risk of HIV scale.[21]

Preexposure prophylaxis adherence was assessed with plasma tenofovir (TFV) concentrations collected 3 months after PrEP initiation, and at quarterly visits and processed as previously described.[22–24]

Analysis

Participant characteristics for STI substudy enrollees were described. We estimated univariable and multivariable-adjusted prevalence ratios (95% confidence intervals) for prevalent STI using modified Poisson regression. Partner notification practices and preferences are described.

Impacts of STI substudy participation on HIV risk perception and adherence to PrEP: By completing the additional substudy consent, questionnaires about STIs, and routine counseling at sample collection and upon STI diagnosis, women in the STI substudy were exposed to additional counseling compared with women in the parent study-only. We hypothesized that women in the STI substudy might have increased HIV risk perception and/or adherence to PrEP. Participants in the STI substudy group were matched to Parent-study-only participants based on age at enrollment (±2.5 years), and number of days on study (±30 days). In total, 47 women who participated in the STI substudy were matched to 47 Parent-study-only participants. Fisher's exact test/χ^2 was used to examine differences in baseline characteristics between those enrolled in the STI substudy group compared with those enrolled in the parent study-only group.

Mean HIV risk perception scores at 12 months of follow-up were compared among STI substudy and Parent-study-only participants using independent t-tests. Participants with missing HIV risk perception data and their corresponding matched participants were excluded from the analysis.

We compared proportion of women with plasma TFV levels ≥10 ng/mL, corresponding to TFV-based PrEP use in the past days,[22–24] at the timepoint corresponding to the first quarterly visit after STI substudy enrollment among participants enrolled into the STI substudy to participants enrolled in the parent study-only, limited to PrEP users, using Fisher's exact test.

All analyses were conducted using SAS 9.4

Ethics

This substudy was approved by the relevant ethics committees. Women completed written informed consent to participate in this substudy.

RESULTS

We approached 69 women from the parent study to participate in the STI substudy and enrolled 50 women (Table 1).

STI Prevalence and Factors Associated With Prevalent STI

At enrolment into the STI substudy (n = 50), 6 women (12%) had CT and 5 (10%) had TV, 2 (4%) had NG and 1 (2%) had MG. (Table 2). No cases of syphilis were detected. Two women had >1 STI organism. Overall, 12 women (24%) had curable STIs on testing. Of these (n = 12), 9 (75%) had a normal vaginal examination and 3 (25%) had vaginal discharge suggestive of STI. An additional 3 women (6%) were treated for STI based on examination findings (vaginal discharge); however, laboratory testing was negative. In adjusted analyses, demographics, condom use, PrEP use, perceived HIV risk, and other factors were not associated with prevalent STI (Supplementary Table 1, http://links.lww.com/OLQ/B67).

STI Incidence

In total, 40 (80%) women (37 nonpregnant women and 3 pregnant women) returned for follow-up and had repeat STI testing (Table 2). Of these (n = 40), 4 women (10%) had curable STI on laboratory testing. All women with laboratory diagnosed STI at follow-up were nonpregnant. Three did not have enrolment STIs, and 1 woman had a different STI at follow-up (TV and then MG). Two of the 4 women (50%) had abnormal findings on vaginal examination (vaginal discharge). An additional 3 women (8%), 2 nonpregnant, and 1 pregnant, were treated for STI on clinical findings (vaginal discharge), however, laboratory testing was negative. All 3 pregnant women tested negative for STI at the initial pregnancy visit.

TABLE 1. STI Substudy Participant Characteristics of Women With and Without STI Diagnosis

Characteristics[a]	STI Diagnosis[b] (n = 15)	No STI Diagnosis (n = 35)	Overall (N = 50)
		n (%)	
Age, years			
≤24 years	9 (60%)	15 (43%)	24 (48%)
>24 years	6 (40%)	20 (57%)	26 (52%)
Race			
Black	14 (93%)	35 (100%)	49 (98%)
Other	1 (7%)	0 (0.0%)	1 (2%)
Education			
Primary school (< Grade 12)	1 (7%)	7 (20%)	8 (16%)
High School (Grade 12) and above	14 (93%)	28 (80%)	42 (84%)
Income			
0–1999 South African Rands	2 (29%)	7 (25%)	9 (25%)
2000–3999 South African Rands	4 (57%)	8 (29%)	12 (34%)
≥4000 South African Rands	1 (14%)	13 (46%)	14 (40%)
Pregnancy partnership type			
Main partner less than 6 months	0 (0%)	1 (3%)	1 (2%)
Long-term partner (≥6 months)	15 (100%)	34 (97%)	49 (98%)
Employed	3 (20.0%)	6 (17%)	9 (18%)
Prior pregnancy outcomes			
No prior pregnancies	7 (49%)	16 (46%)	23 (46%)
Prior live birth	8 (100%)	18 (95%)	26 (96%)
Prior miscarriage	0 (0%)	4 (21%)	4 (15%)
Prior stillbirth	0 (0%)	1 (5%)	1 (4%)
Number sex partners in the last 3 months			
1	11 (73%)	31 (89%)	42 (84%)
≥2	4 (27%)	4 (11%)	8 (16%)
Consumed alcohol, past 3 months	12 (80.0%)	23 (66%)	35 (70%)
Drunk on alcohol during sex in the past 3 months	4 (33%)	9 (41%)	13 (38%)
Ever physically abused by a sexual partner	0 (0%)	3 (9%)	3 (6%)
Ever emotionally abused by a sexual partner	5 (33%)	12 (34%)	17 (34%)
Partner HIV-serostatus			
Negative	0 (0%)	1 (3%)	1 (2%)
Positive	0 (0%)	2 (6%)	2 (4%)
Unknown	15 (100%)	32 (91%)	47 (94%)
Condomless sex during the last sexual encounter with primary partner	13 (87%)	30 (86%)	43 (86%)
Sexual Relationship Power Scale[c]			
Mean scores (SD)	2.74 (0.20)	2.57 (0.35)	2.62 (0.32)
Median (IQR)	2.72 (2.61, 2.86)	2.49 (2.35, 2.75)	2.61 (2.36, 2.81)
HIV risk scores[d]			
Mean (SD)	19.23 (3.03)	20.48 (2.80)	20.13 (2.89)
Median (IQR)	19.0 (18.0, 21.0)	20.0 (18.0, 23.0)	20.0 (18.0, 23.0)
PrEP use (any timepoint during study)	8 (53%)	18 (51%)	26 (52%)
Pregnancy (any timepoint during study)	2 (13%)	3 (9%)	5 (10%)

[a] Refers to characteristics at enrolment into the Parent-study or STI substudy unless otherwise indicated.

[b] STI diagnosis includes those with laboratory STI (n = 12) and clinical signs of STI (n = 3) at enrolment into the STI substudy.

[c] Higher score indicates more power in relationship including average of relationship control and decision-making dominance scores (23 item scale, scored from 1–4 for items 1–15, and 1–3 for items 16–23.).

[d] Sum of 7 individual questions related to perceived risk of acquiring HIV (Score range: 4 to 31, with higher scores indicating higher perceived risk).

Three pregnant women had follow-up samples collected during the second/third trimester of pregnancy. Of these, 2 had CT. Both women with CT at pregnancy follow-up, also had CT detected at STI substudy enrolment and were treated. One woman had a vaginal discharge suggestive of STI.

Ten women enrolled in the STI substudy were lost to follow-up, exited or did not have repeat samples collected.

PN Practices and Preferences Among Women With Enrolment STI

Of the 15 women with enrolment STI, 13 (87%) completed a follow-up questionnaire (Fig. 1). All 13 reported notifying their partners of STI diagnosis. Ten women (77%) reported being offered a PN card by study staff, 9 accepted, and all 9 reported sharing the card with their partner. Nine women reported their partner(s) received STI treatment.

Most women did not prefer assisted PN via email, text messaging and/or health care provider (Fig. 2), however the majority (n = 12, 92%) felt receiving a note from the clinic stating the woman had an STI and outlining instructions for her partner to get care for a potential STI would be helpful. Most women (n = 11, 85%) felt that receiving medication from the clinic/research site to deliver to their partner for treatment of STI would be helpful.

Exploratory Comparisons Between Participants Enrolled in the STI Substudy and Parent-Study-Only Participants

We found no significant differences in demographics, STI factors, HIV risk perception, PrEP use, and other factors between

TABLE 2. STI Substudy STI Prevalence and Incidence Data

Variables	Timepoint, n (%)				
	STI Substudy Enrolment	6-Month Follow-Up			Second/Third Trimester Pregnancy Follow-Up
		All	Nonpregnant	Pregnant	
Total number	50	40	37	3	3
Curable STI[a]	12 (24)	4 (10)	4 (11)	0 (0)	2 (67)
CT	6 (12)	1 (3)	1 (3)	0 (0)	2 (67)
NG	2 (4)	0 (0)	0 (0)	0 (0)	0 (0)
TV	5 (10)	1 (3)	1 (3)	0 (0)	0 (0)
MG	1 (2)	3 (8)	3 (8)	0 (0)	0 (0)
Syphilis	0 (0)	0	0 (0)	0 (0)	0 (0)
Clinical signs of STI and tested positive for curable STI	3 (6)	2 (5)	2 (5)	NA	1 (33)
Clinical signs of STI and tested negative for curable STI	3 (6)	3 (8)	2 (5)	1 (33)	0 (0)
STI diagnosed[b]	15 (30)	7 (18)	6 (16)	1 (33)	2 (67)

[a] Number with curable STI may be less than the individual diagnoses due to women having multiple STI diagnoses.
[b] Women with curable STI on laboratory testing and/or clinical signs of STI on clinical examination.

groups (Supplementary Table 2, http://links.lww.com/OLQ/B67). Mean HIV risk perception scores at follow-up among those enrolled in the STI substudy versus parent study-only group was 18.68 (95% confidence interval [CI], 16.82–20.54) versus 20.32 (95% CI, 18.95–21.69).

Among PrEP users, the proportion of women with plasma TFV ≥10 ng/mL was 28.0% among STI substudy (n = 7) and 52.0% among parent study-only matched participants (n = 13).

DISCUSSION

We observed a high prevalence of curable STIs among South African women planning pregnancy, with 1 in 4 women having a curable STI on laboratory testing at STI substudy enrolment. Three-quarters of women with curable STI had neither signs nor symptoms of infection. Encouragingly, we found that all women with STIs self-reported sharing their STI diagnosis with their partner, more than two-thirds reported their partner received STI treatment. There was little preference for assisted PN via email, text messaging or health care providers. Strengths of this study include a unique and important population, laboratory testing to diagnose STIs, longitudinal follow-up and data on PN behaviors and preferences.

The high prevalence of curable STIs observed in our study is consistent with studies that evaluated STI prevalence among African women.[8–10] These studies enrolled AGYW, women planning

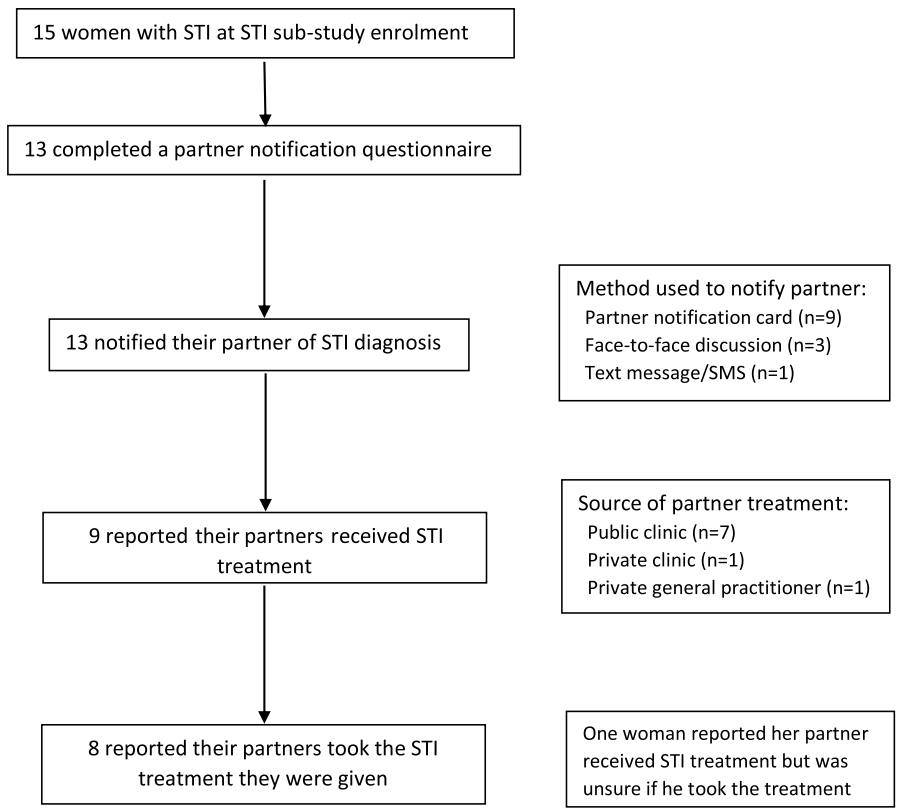

Figure 1. Self-reported partner notification outcomes among 15 women diagnosed with enrolment STI.

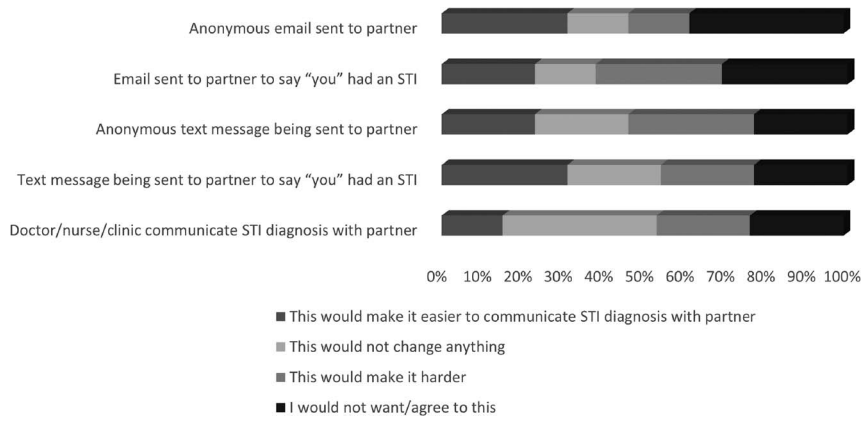

Figure 2. Preferences for STI partner notification methods among women diagnosed with enrolment STI who completed a follow-up survey (n = 13).

for or with pregnancy, and in all 3 studies the most frequent occurring STI pathogen was CT, ranging from 13% to 20%.[8–10] Data from a meta-analysis of HIV prevention studies, including STI testing from more than 37,000 women from sub-Saharan Africa, also found a high prevalence of curable STI.[25] The prevalence of CT and NG among South African women aged 15 to 24 years was 15% and 5%, respectively.[25] We found no cases of syphilis in our cohort consistent with other studies among pregnant South African women.[10,26] We also present data on the prevalence of MG, an important but infrequently studied pathogen in South Africa[10,11,25] that can be associated with cervicitis, pelvic inflammatory disease, preterm delivery, spontaneous abortion, and infertility.[27] Only 4 women were pregnant during STI substudy participation limiting generalizability to pregnancy. Current public sector STI guidelines in South Africa recommend a syndromic approach to assess and manage STIs with no etiologic testing,[18] consequently, many STIs, which are asymptomatic and/or have no clinical signs, are missed. Recent Southern African HIV Clinicians Society HIV guidelines recommend diagnostic screening and testing for STIs where resources are available.[28] This is particularly important for women planning for and with pregnancy given the potential impact of STI diagnosis on maternal and child morbidity.

It is possible that PN and treatment outcomes for male partners were over-reported due to social desirability bias, or receipt of treatment by the male partner was underreported where women were not aware if their partners received treatment. Indeed, 2 of the women with CT diagnosed at later trimester follow-up had been diagnosed with CT at enrollment (and treated), suggesting possible failure of partner treatment. This supports recommendations for retesting in 3 to 6 months after infection to detect repeat infections.[27] High rates of PN of STIs (74%–93%) have been observed in Uganda and South Africa among pregnant women, HIV-exposed women planning pregnancy, as well as AGYW, consistent with our findings.[20,29,30] Reported rates of male partner treatment have been lower than notification rates.[20,29,30] In our study, most women preferred to notify their partners face to face which is consistent with qualitative research from Botswana and South Africa.[31,32] Unlike our study, where most women felt delivering medication to the partner would be helpful, no women preferred to bring STI treatment home to their partners in the Botswana study.[31] Current South African STI guidelines do not include partner-delivered STI treatment, however, other countries such as Uganda permit patient-delivered medication to partners with potential STI exposure.[9] This is worth considering in the South African context and could improve partner treatment rates. It is possible that PN methods such as text messaging, email, and health care provider assisted methods were generally not preferred since these methods are unfamiliar and not available in the public health sector in South Africa.

We hypothesized that enrolment in the STI substudy, along with STI care and testing, may be associated with increased PrEP adherence and HIV risk perception, however we observed no significant differences in PrEP adherence and mean HIV risk perception scores among women that were enrolled in the STI substudy versus those enrolled in the Parent-study-only. In both groups 28% and 52% of women had TFV concentrations greater than or equal to 10 ng/mL indicating drug use in the past week. We measured plasma TFV which only provides a measure of adherence over a few days—longer-term measures of adherence might have been more informative. Although we did not find an association between enrolment in the STI substudy and increased HIV risk perception, overall, we found that mean perceived HIV risk scores were high. This may have been due to the HIV prevention and sexual health counseling that all women received as part of the parent study. Similarly, in a study conducted in Uganda that enrolled HIV-exposed women planning pregnancy and used a similar HIV risk perception scale, perceived HIV risk scores using a 6-item scale were high.[33]

CONCLUSIONS AND RECOMMENDATIONS

We observed high prevalence of curable STIs among South African women not living with HIV, and planning pregnancy with a partner with HIV or whose serostatus was unknown. Seventy-five percent of women with STIs were not identified based on syndromic screening, inclusive of physical examination. This supports the need for policy change in South Africa to include STI testing for pregnant women and those planning pregnancy. Encouragingly, all women reported to notifying their partners of their STI diagnosis, and many partners reportedly received STI treatment. Strategies to support partner treatment are important to prevent reinfection and interrupting STI transmission cycles. Although we did not find an association between STI substudy enrolment and HIV risk perception or PrEP adherence in exploratory analyses, the sample sizes for these comparisons were small and limited and are hypothesis generating findings. High prevalence of asymptomatic STIs highlights the importance of STI screening as part of PrEP care.

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