Prevalence, symptomology, and correlates of curable sexually transmitted infections among pregnant women in Eastern Cape, South Africa

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Short Summary: A study of pregnant women in the Eastern Cape, South Africa found a high prevalence of curable STIs. Prevalence was higher among women living with HIV and most cases were asymptomatic.

Abstract

Background: Curable sexually transmitted infections (STIs) contribute to adverse maternal and neonatal outcomes. Syndromic management is standard care in South Africa. We evaluated prevalence, symptomology, and correlates of curable STIs, among pregnant women in Eastern Cape, South Africa.

Methods: We conducted a cross-sectional analysis using baseline data from a randomized controlled trial of pregnant women attending their first antenatal care visit at public clinics in Buffalo City Municipality (2021–2024). Participants were tested for *Chlamydia (C.) trachomatis*, *Neisseria (N.) gonorrhoeae*, *Trichomonas (T.) vaginalis* using GeneXpert point-of-care tests and for syphilis using Alere Determine TP rapid test. Symptoms were self-reported and clinically-observed. Adjusted prevalence ratios were estimated using Poisson regression models with robust standard errors.

Results: Among 1491 participants (median age: 28 years (IQR: 24–33); gestational age: 13 weeks (IQR: 8–18); HIV prevalence: 30%), STI prevalence was 27.6% (95% CI: 25.3–29.9): *C. trachomatis* 14.7%, *N. gonorrhea* 5%, *T. vaginalis* 10.2%, syphilis 3.4%. Women with HIV had higher STI prevalence (32.8% vs 25.3%, $p = .003$), particularly for *T. vaginalis* (17% vs 7.3%, $p < .001$); 20.1% of women with C*. trachomatis*, *N. gonorrhea*, and/or *T. vaginalis* were symptomatic, and 63% of symptomatic women tested STI-negative. Younger age, lower education, multiple sex partners and unknown HIV-serostatus of partners were associated with increased STI prevalence.

Conclusion: We observed a high prevalence of STIs, particularly among women with HIV, with many asymptomatic cases; emphasizing the need for integrated point-of-care testing to ensure timely treatment, reduce antibiotic overuse, and improve maternal and neonatal outcomes.

Key Words: Sexually Transmitted Infections; Antenatal Care; Aetiological Testing; South Africa

Introduction

Globally, an estimated 374 million new cases of curable sexually transmitted infections (STIs), including *Neisseria (N.) gonorrhoeae, Chlamydia (C.) trachomatis*, *Trichomonas (T.) vaginalis*, and syphilis occurred in 2020, with the World Health Organization (WHO) African Region bearing a disproportionate burden of disease.(1) Women of reproductive age are particularly vulnerable to STIs and their sequelae.(2) STIs are associated with severe maternal and neonatal complications, including stillbirth, low-birth weight, preterm birth, conjunctivitis, and pneumonia.(3–7) The presence of STIs also increase the risk of HIV acquisition and transmission.(8,9)

Prevalence of STIs among pregnant women, especially among women with HIV, is high in South Africa, with 50-76% of cases reported to be asymptomatic.(10–14) Syndromic management, recommended by the WHO(15) and South African STI Management Guidelines,(16) is linked to both undertreatment and overtreatment.(17) While syphilis screening is routine in antenatal care in South Africa,(18) screening for *C. trachomatis, N. gonorrhoeae*, and *T. vaginalis* infections is not, despite their high burden and potential to cause adverse pregnancy outcomes.

Most epidemiological data on STIs in South Africa come from the Western Cape (Cape Town),(10,11) Gauteng (Johannesburg and Pretoria),(10,13,14) and Kwa-Zulu Natal (Durban)(12) provinces, leaving a research gap in the Eastern Cape, a historically disadvantaged region.(19) This limits our understanding of the STI burden in and hinders the development of targeted interventions for pregnant women in the province.

This study aims to describe the prevalence, symptomology, and correlates of curable STIs among pregnant women with and without HIV in the Eastern Cape, providing insights to support the integration of routine diagnostic STI screening in antenatal care to reduce unnecessary antibiotic use and improve maternal and neonatal outcomes.

Methods

Study design and setting

We conducted a cross-sectional analysis of baseline data from a three-arm randomized controlled trial among pregnant women attending their first antenatal care visit at government clinics in Eastern Cape, South Africa.(20) The trial aimed to assess the impact of STI screening strategies on adverse birth outcomes and STI prevalence at delivery, as well as evaluate cost-effectiveness per STI and disability-adjusted life-year (DALY) averted.(20)

The trial was conducted at four antenatal care clinics in Buffalo City Municipality from March 2021 to May 2024. Eligibility criteria included pregnant women aged ≥18, <27 weeks' gestation confirmed by ultrasound, and planning delivery at hospital within Buffalo City Municipality. Exclusion criteria included planned relocation or participation in another antenatal study. Eligible women provided informed consent in their preferred language (isiXhosa or English) before randomization. This cross-sectional analysis included all 1,491 women enrolled in the intervention cohort for diagnostic STI screening at their first antenatal visit. Ethical approval was granted by the University of Cape Town's Faculty

of Health Sciences Research Ethics Committee (UCT-HREC, reference number 676/2019). This analysis adhered to the STROBE reporting guidelines for cross-sectional studies.(21)

Data collection and management

Study data were collected and managed using Research Electronic Data Capture (REDCap).(22) Participants were interviewed by study staff using a standardized questionnaire that gathered socio-demographic and clinical information (sexual health and obstetric history, participant self-report of abnormal vaginal discharge, co-morbidities, HIV treatment details). Research nurses performed pelvic exams on all participants to detect abnormal vaginal discharge. Each participant was assigned a unique identifier upon enrolment, and all electronic communications were securely handled through password-protected and encrypted files.

Specimen collection, testing, and treatment

At the first antenatal care visit, trained research nurses collected vaginal swab specimens using GeneXpert CT/NG Vaginal/Endocervical Specimen Collection Kits (Cepheid, Sunnyvale, California) for point-of-care testing of *C. trachomatis*, *N. gonorrhoeae*, and *T. vaginalis*. Participants received same-day results and immediate treatment per South African guidelines,(16) including oral Azithromycin (two 500mg tablets) single dose for *C. trachomatis*, Ceftriaxone 500mg intramuscular (IM) single dose for *N. gonorrhoeae*, and Metronidazole 400mg twice a day for 7 days for *T. vaginalis*. Those unable to wait were telephonically contacted and requested to return for results and treatment following the

same regimen as those treated same-day. Women testing positive were counselled on safe partner disclosure, including intimate partner violence risks, and provided notification slips for partner treatment. Participants received routine services per National Basic Antenatal Care Plus,(23) including testing for HIV and syphilis.(18) Syphilis testing was conducted using rapid treponemal tests performed onsite. Syphilis test type data was available for 802 participants, most of whom (n=796) were tested with Alere Determine TP test (Abbott Laboratories, Inc., U.S.A). Six participants were tested with SD Bioline HIV/Syphilis Duo test (Standard Diagnostics, Inc., Gyeonggi-do, South Korea). Laboratory-based RPR testing was used for confirmation of positive results. Treatment for syphilis followed the National Guidelines for Prevention of Vertical Transmission(18), including 2.4 MU of benzathine penicillin IM x 3 doses, at weekly intervals, with the first dose administered immediately upon a positive rapid test result. HIV testing was conducted by clinic staff in line with the National HIV Testing Algorithm(24). One Step Rapid HIV 1/2 [Guangzhou Wondfo Biotech Co., Ltd, Guangzhou, China] rapid tests were used for initial screening with reactive results followed by confirmatory testing with Colloidal Gold test kits [Kehua Bio-engineering Co., Ltd, Shanghai, China]. All pregnant women who test positive for HIV are immediately started on lifelong antiretroviral therapy (ART), in line with national guidelines on the prevention of vertical transmission.(18)

Outcome measures

Any curable STI: A composite variable for prevalence of any curable STI was calculated as the proportion of women with a positive diagnostic test result for *C. trachomatis, N. gonorrhoeae, T. vaginalis*, or syphilis out of all women tested.

C. trachomatis/N. gonorrhoeae/T. vaginalis infection: Prevalence for each organism was calculated as the proportion of women with a positive test result for the respective organism out of all women tested.

Syphilis infection: Prevalence was calculated as the proportion of women with a positive rapid treponemal test result out of all women tested, regardless of RPR titre. Due to limited clinical history data, we could not differentiate between active and past infection.

Symptomatic infection: A symptomatic STI case was defined as a positive diagnostic test for *C. trachomatis*, *N. gonorrhoeae*, or *T. vaginalis* with self-reported or clinically-observed abnormal vaginal discharge. Vaginal discharge is not aetiologically linked to syphilis, and thus women with syphilis monoinfection were not included in vaginal discharge symptom assessment. Variables on syphilis-associated symptoms (e.g., chancre, maculopapular rash, condylomata lata) were not tracked as a part of the parent trial. As this is a secondary analysis of baseline data, we were unable to assess symptomology among syphilis cases. Thus symptom assessment is limited to *C. trachomatis*, *N. gonorrhoeae*, and *T. vaginalis*. Pregnant women with reported or clinically-observed abnormal vaginal discharge who had negative test results for *C. trachomatis*, *N. gonorrhoeae*, and *T. vaginalis* were included in assessment of the overall prevalence of vaginal discharge syndrome, however, were excluded from the analysis of symptomatic infection.

Statistical analysis

Statistical analysis was performed using R Studio version 4.3.0 (2023-04-21). Participant characteristics were analyzed using Chi-squared, Fisher's exact, or Kruskal-Wallis tests, as appropriate. STI prevalence and 95% confidence intervals (CI) were calculated for any curable STI and each organism, stratified by HIV serostatus. Prevalence ratios (PR) and adjusted prevalence ratios (aPR) with 95% CI were estimated using Poisson regression models with robust standard errors. Covariates with significant differences ($p<0.05$) and *a priori* confounders identified through literature review and directed acyclic graphs(25) were included in adjusted models. Models were conducted overall and stratified by HIV serostatus and STI organism.

Results

Participant Characteristics

Among 1491 pregnant women in the intervention cohort, the median age was 28 years (IQR: 24–33) and median gestational age at enrolment was 13 weeks (IQR: 8–18). Most women were multigravida (n=1,055; 70.6%), 42% were married or cohabitating, 41.4% completed < grade 12 education, 57% were unemployed, and 29% reported consuming alcohol during the current pregnancy. Sixteen percent (n=244) self-reported receiving treatment for a STI in the past year, with 72% (n=178/246) treated for abnormal vaginal discharge, 10.6% (n=26/244) treated for genital ulcers, 8.6% (n=21/244) treated for genital warts, and 7.7% (n=19/244) were asymptomatic but received STI notification from partner. Of the 1491 participants enrolled in the study, 448 (30%) were living with HIV, 83% (n=372/448) of whom were on ART at the first antenatal care visit. Among 364

women with HIV and available data, 15.4% (n=56/364) were diagnosed within the past week. Of 325 women with HIV who had viral load results available, 84% (n=272/325) had undetectable viral loads (< 50 copies/mL). [Table 1]. Prevalence of HIV differed by research site, with site 3 having the highest prevalence (41%, n=67/161), followed by site 1 (34%, n=151/444), site 2 (32%, n=148/460), and site 4 (19.2%, n=82/426) (p <0.001).

STI Prevalence

The prevalence of any curable STI was 27.6% (n=411, 95% CI: 25.4 – 30). Prevalence of *C. trachomatis* was 14.7% (n=219, 95% CI: 12.9-16.6), *N. gonorrhoeae* was 5% (n=73, 95% CI: 4-6.1), and *T. vaginalis* was 10.2% (n=152, 95% CI: 8.7-11.8), and syphilis was 3.4% (n=51, 95% CI: 2.6-4.5). [Figure 1 and Table 2]. Among the women with a positive syphilis test, 20% (n=10) had RPR titres < 1:1, 32% (n=15) between 1:1-1:4, 32% (n=16) between 1:4-1:16, and 18% (n=9) had values > 1:16. One participant with a positive syphilis rapid test result did not have an RPR titre value available. Coinfection with two or more curable organisms (*C. trachomatis*, *N. gonorrhoeae*, *T. vaginalis*, and/or syphilis) was found in 5.1% of all women (n=76)). No women were infected with all four organisms. [Table 2]. Of the 379 women with *C. trachomatis, N. gonorrhoeae,* or *T. vaginalis*, 94.5% (n=358) received treatment, 50.6% (n=181) of whom received treatment on the same day. All 51 (100%) women with a positive syphilis rapid test result received same-day treatment of a first dose of benzathine penicillin G 2.4 MU and were requested to return for subsequent doses.

***Table 1**: Characteristics of Pregnant Women Who Underwent STI Screening at First Antenatal Visit, Buffalo City Municipality, South Africa, 2021–2024*

	Overall[1]	No STI[1]	Any Curable STI[1]
Characteristic	**N = 1491**	**N = 1080**	**N = 411**
Maternal Age Years	28 (24-33)	29 (25-33)	26 (22-30)
Gestational weeks	13 (8-18)	13 (8-18)	13 (8-19)
Gravidity			
Primigravida	437 (29.4)	291 (27)	146 (35.7)
Multigravida	1,054 (70.6)	789 (73)	265 (64.3)
History of adverse birth outcome*			
No	635 (62.3)	466 (61)	169 (66)
Yes	385 (37.7)	298 (39.0)	87 (34)
Missing[2]	*471*	*316*	*155*
Research site			
Site 1	444 (29.7)	321 (29.7)	123 (29.9)
Site 2	460 (30.9)	336 (31.1)	124 (30.1)
Site 3	161 (10.8)	101 (9.3)	60 (14.8)
Site 4	426 (28.6)	322 (29.9)	104 (25.2)
Education Level			
Higher education	186 (12.5)	150 (13.9)	36 (8.7)
Gr 10-12	1,198 (80.4)	866 (80.3)	332 (80.8)
Less than gr 10	106 (7.1)	63 (5.8)	43 (10.4)
Refused to answer	1 (0.1)	1 (0.1)	0
Employment			
Employed	546 (36.5)	409 (37.8)	137 (33.3)
Self employed	93 (6.2)	72 (6.7)	21 (5.1)
Not employed	852 (57.2)	599 (55.5)	253 (61.7)
Income-level*			
>10 000 ZAR (> $555 USD[3]) per month	31 (4.9)	30 (6.2)	1 (0.6)
5001 – 10 000 ZAR ($277-$555 USD[3]) per month	124 (19.4)	104 (21.6)	20 (12.7)
1001 – 5000 ZAR ($55-$227 USD[3]) per month	414 (64.8)	303 (63)	111 (70.3)
< 1000 ZAR (< $54 USD[3]) per month	65 (10.2)	40 (8.3)	25 (15.8)
None	5 (0.8)	4 (0.8)	1 (0.6)
Missing[2]	*852*	*599*	*253*
Primary Source of Income			

Personal income from employment/self-employment	560 (37)	416 (38)	144 (35)
Grants	213 (14)	146 (14)	67 (16)
Income from partner	341 (23)	268 (25)	73 (18)
Other	377 (25)	250 (23)	127 (31)
Relationship Status			
Married	268 (17.9)	231 (21.3)	37 (9)
Steady partner	1,117 (75)	781 (72.4)	336 (81.8)
Steady partner and casual partner(s)	30 (2)	15 (1.4)	15 (3.6)
Casual Partner(s)	35 (2.3)	22 (2)	13 (3.2)
No relationship	41 (2.7)	31 (2.9)	10 (2.4)
Cohabitating with partner§	602 (42)	483 (46)	119 (29.6)
Suspects partner of having other sex partner(s)±			
No	798 (56.4)	606 (59.0)	192 (49.4)
Unsure	217 (15.3)	149 (14.5)	68 (17.5)
Yes	399 (28.3)	271 (26.5)	128 (33.2)
Number of sexual partners in past 6 months			
One	1,306 (87.6)	978 (90.6)	328 (79.6)
More than one	185 (12.4)	102 (9.4)	83 (20.4)
Used condom at last sex*			
Yes	151 (10.1)	106 (9.8)	45 (10.9)
No	1339 (89.9)	973 (90.2)	366 (89.1)
Missing[2]	*1*	*1*	*0*
Feelings about having a baby before becoming pregnant*			
I wanted to have a baby	452 (38)	352 (41)	101 (30)
I had mixed feelings about having a baby	358 (30)	249 (29)	109 (32)
I did not want to have a baby	388 (32)	260 (30)	128 (38)
Missing[2]	*293*	*219*	*74*
Reported experiencing forced, coerced, or transactional sex in past 6 months	142 (9.5)	103 (9.5)	39 (9.5)
Reported consuming alcohol during the current pregnancy	425 (28.5)	290 (26.8)	135 (33)
Reported using substances during current pregnancy (Tik, Dagga, Grandpa, Other)	178 (11.9)	116 (10.7)	62 (15)
Partner's HIV status±			

Negative	653 (46)	506 (49)	147 (38)
Positive	142 (10)	110 (11)	32 (8.2)
Unknown	620 (44)	411 (40)	209 (54)
Partner living with HIV is on ART†	122 (86)	96 (87)	26 (81)
Reported being treated for an STI in past year	244 (16)	179 (16.6)	65 (16)
Would disclose to partner if test-positive for an STI			
No	21 (1.4)	16 (1.5)	5 (1.2)
Yes, to steady partner	1462 (98)	1059 (98)	403 (98)
Yes, to casual partner	7 (0.5)	5 (0.5)	2 (0.5)
Yes, to all steady and casual partners	1 (<0.1)	0 (0)	1 (0.2)
Reported any urogenital symptom(s) at the first ANC	181 (12.1)	115 (10.6)	66 (16)
Abnormal vaginal discharge	124 (68.5)	78 (67.8)	46 (69.7)
Pain during urination	11 (6.1)	7 (6.1)	4 (6.1)
Lower abdominal pain	31 (17.1)	16 (13.9)	15 (22.7)
Pain related to intercourse	1 (0.6)	0 (0.0)	1 (1.5)
Vaginal bleeding related to intercourse	4 (2.2)	2 (1.7)	2 (3)
Genital itchiness	19 (10.5)	12 (10.4)	7 (10.6)
Any skin abnormality	22 (12.2)	13 (11.3)	9 (13.6)
Urogenital symptoms identified during clinical examination	254 (17)	155 (14.3)	99 (24)
Abnormal vaginal discharge	201 (79.1)	120 (77.4)	81 (81.8)
Lower abdominal pain	17 (6.7)	8 (5.2)	9 (9.1)
Genital scratch marks	10 (3.9)	7 (4.5)	3 (3)
Skin conditions	47 (18.5)	27 (17.4)	20 (20.2)
Inguinal lymphadenopathy	3 (1.2)	1 (0.6)	2 (2)
HIV status			
Living without HIV	1,046 (70)	781 (72.2)	265 (64.3)
Living with HIV	448 (30)	301 (27.8)	147 (35.7)
On ART at first visit‡	372 (83)	253 (84.1)	119 (81)
Viral load at first ANC*‡			
Detectable (≥ 50 copies/mL)	53 (16.3)	32 (15.1)	21 (18.6)
Undetectable (< 50 copies/mL)	272 (83.7)	180 (84.9)	92 (81.4)
***Missing*[2]**	*123*	*89*	*34*

[1] Median (IQR); n (column %)

[2] *"Missing"* row indicates the number of participants without available data for each variable

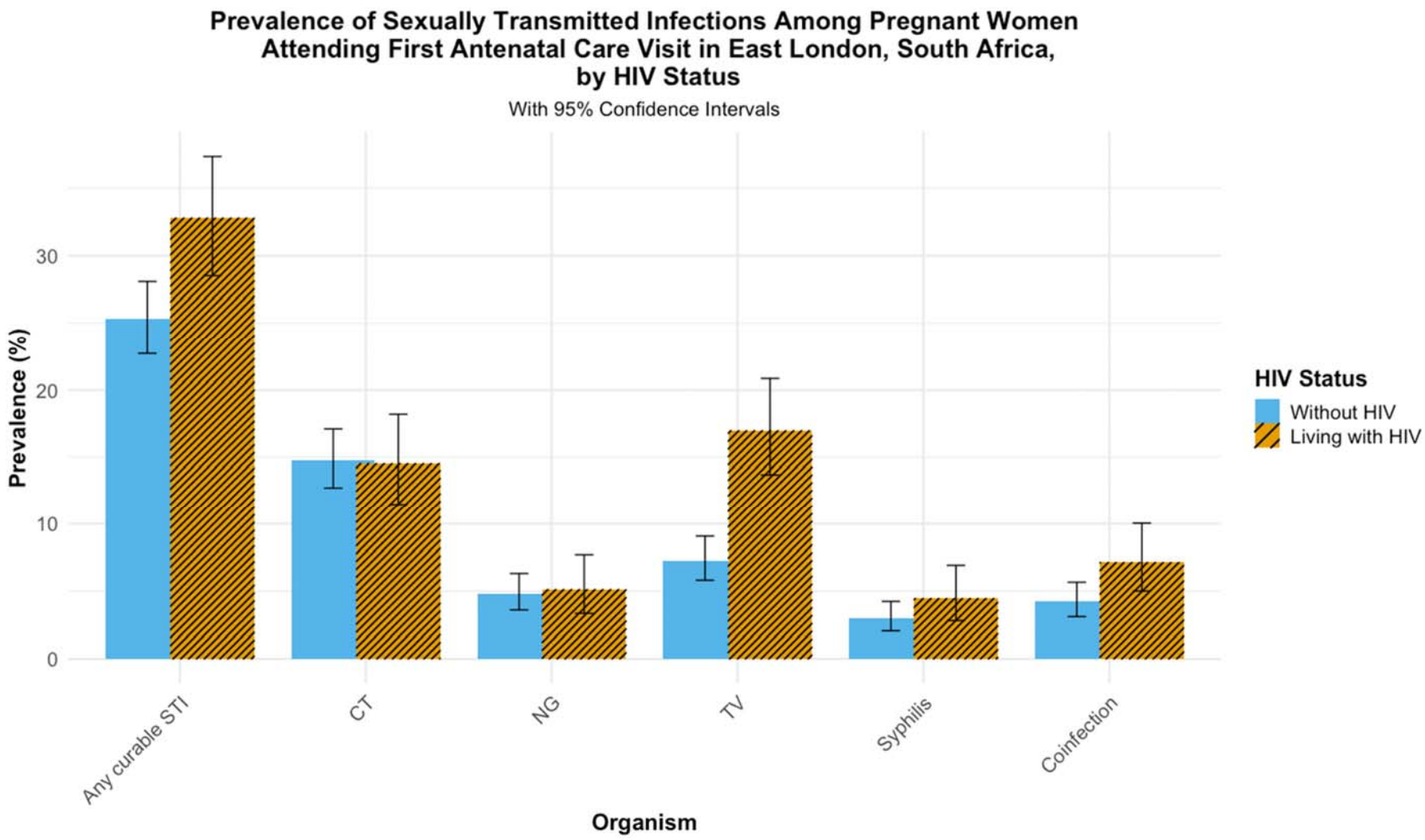
[3] Based on an exchange rate of USD 18 to R1.

***Denominator adjusted due to missing data. Percentages are calculated based on available data**
§ Data only obtained from participants who reported being in a casual relationship, steady relationship, or married
± Data only obtained from participants who reported being married or in a steady partnership
†Only includes data from participants who reported their partner to be living with HIV
‡Only includes data from participants living with HIV

ANC, antenatal care; ART, antiretroviral therapy; HIV, Human Immunodeficiency Virus; STI, sexually transmitted infection; ZAR, South African Rand.

In analysis stratified by HIV status, prevalence of any curable STI was 32.8% (n=147, 95% CI: 28.5-37.4) among women with HIV and 25.3% (n=264, 95% CI: 22.7-28.1) among women without HIV (p=0.003). *T. vaginalis* prevalence was higher among women with HIV (16.9% vs. 7.3%, p<0.001) as was coinfection with two or more STIs (7.1% vs. 4.2%, p=0.025), while *C. trachomatis*, *N. gonorrhoeae, and* syphilis prevalence did not differ significantly by HIV status. [Table 2; Figure 1].

Figure 1: *Prevalence of curable sexually transmitted infection among pregnant women seeking antenatal care services, Buffalo City Municipality, South Africa, 2021-2024, stratified by organism, stratified by HIV status*



CT, Chlamydia trachomatis; NG, Neisseria gonorrhoeae; TV, Trichomonas vaginalis

Table 2: *Prevalence Estimates, overall and HIV stratified among pregnant women seeking antenatal care services, Buffalo City Municipality, South Africa, 2021-2024.*

STI Organism	**Overall Prevalence Estimates[1]**	**HIV Stratified Prevalence Estimates[1]**		
	Overall N = 1,491[1]	**Living with HIV** N = 448[1]	**Without HIV** N = 1,043[1]	**Bivariate p-value[2]**
Any curable STI	411 (27.6) (25.4-29.9)	147 (32.8) (28.5-37.4)	264 (25.3) (22.7-28.1)	**0.003**
C. trachomatis	219 (14.7) (12.9 – 16.6)	65 (14.5) (11.4 – 18.2)	154 (14.7) (12.7 – 17)	0.98
N. gonorrhoea	73 (5) (3.9 – 6.2)	23 (5.1) (3.4 – 7.7)	50 (4.8) (3.6 – 6.3)	0.94
T. vaginalis	152 (10.2) (8.7 – 11.8)	76 (17) (13.7 – 20.8)	76 (7.3) (5.8 – 9.1)	**<0.001**
Syphilis	*51 (3.4) (2.6 – 4.5)*	*20 (4.5 (2.8 – 6.9)*	*31 (2.9) (2.05 – 4.2)*	0.16
Coinfection (two or more curable STIs)	76 (5.1) (4.1-6.4)	32 (7.1) (5-10)	44 (4.2) (3.1-5.7)	**0.025**
CT & NG[3]	23 (30.3)	5 (15.6)	18 (40.9)	-
CT & Syphilis[3]	8 (10.5)	4 (12.5)	4 (9.1)	-
CT & TV[3]	24 (31.6)	12 (37.5)	12 (27.3)	-
NG & Syphilis[3]	2 (2.6)	0 (0)	2 (4.5)	-
NG & TV[3]	6 (7.9)	3 (9.4)	3 (6.8)	-
TV & Syphilis[3]	5 (6.6)	3 (9.4)	2 (4.5)	-
CT & NG & Syphilis[3]	1 (1.3)	0 (0)	1 (2.3)	-
CT & NG & TV[3]	4 (5.3)	2 (6.3)	2 (4.5)	-
CT & TV & Syphilis[3]	2 (2.6)	2 (6.3)	0 (0)	-
NG & TV & Syphilis[3]	1 (1.3)	1 (3.1)	0 (0)	-

NG & CT & TV & Syphilis[3]	0 (0)	0	0 (0)	-

[1] n (%) (95% Confidence Interval)

[2] Chi-square test

[3] Denominator is the total number of women infected with two or more organisms

CT, Chlamydia trachomatis; HIV, Human Immunodeficiency Virus; NG, Neisseria gonorrhoeae; STI, sexually transmitted infection; TV, Trichomonas vaginalis

Symptomology

Of the 379 women diagnosed with *C. trachomatis*, *N. gonorrhoeae*, and/or *T. vaginalis*, 20.1% (n=76) were symptomatic, with similar proportions for each organism (*C. trachomatis*: 20.5%, n=45/219; *N. gonorrhoeae*: 16.4%, n=12/73; *T. vaginalis*: 21.1%, n=32/152). No significant difference was observed in the proportion of symptomatic infections between women with HIV and those without (22.6% vs 18.6%, p=0.4). Reported vaginal discharge was not significantly associated with STI diagnosis (PR 1.34, 95% CI: 0.95-1.82), but clinically-observed discharge was associated (aPR 1.45, 95% CI: 1.1-1.87), with a strong association for *T. vaginalis* (aPR: 1.68, 95% CI: 1.1-2.49). [Table 3 and Table 4].

Of the 1,491 participants, 205 (13.7%) were symptomatic, with 120/205 (59%) reporting and having clinically-observed vaginal discharge, 81/205 (40%) having clinically-observed discharge without reporting symptoms, and 4/205 (2%) reporting abnormal discharge with no clinical signs. Among the 205 symptomatic women, 63% (n=129) tested negative for *C. trachomatis*, *N. gonorrhoeae*, and/or *T. vaginalis* (p<0.001).

***Table 3**: Factors Associated with Curable Sexually Transmitted Infections Among Pregnant Women Undergoing STI Screening, Stratified by HIV Status, Buffalo City Municipality, South Africa, 2021-2024*

Correlate	Overall		HIV stratified			
			Living with HIV		Without HIV	
	N = 1491		N = 448		N = 1043	
	PR (95% CI)	aPR (95% CI)	PR (95% CI)	aPR (95% CI)	PR (95% CI)	aPR (95% CI)
Maternal age †	**0.96 (0.93-0.96)**	**0.94 (0.93-0.96)**	**0.95 (0.92-0.98)**	**0.95 (0.93-0.98)**	**0.93 (0.91-0.95)**	**0.94 (0.92-0.96)**
Gestational age	1 (0.98-1.02)		1 (0.97-1.03)		0.99 (0.98-1.02)	
Research site†						
Site 1	Ref	Ref	Ref	Ref	Ref	Ref
Site 2	0.97 (0.78-1.2)	0.98 (0.78-1.26)	1.11 (0.74-1.65)		0.9 (0.65-1.24)	
Site 3	**1.4 (1.05-2.7)**	1.3 (0.94-1.8)	1.53 (0.97-2.39)		1.17 (0.76-1.78)	
Site 4	0.88 (0.7-1.1)	0.94 (0.71-1.23)	0.67 (0.37-1.14)		0.97 (0.71-1.32)	
Education †						
≥ Grade 12 (reference)	Ref	Ref	Ref	Ref	Ref	Ref
< Grade 12	**1.36 (1.16-1.6)**	**1.42 (1.15-1.76)**	**1.5 (1.08-2.1)**	**1.64 (1.16-2.34)**	1.2 (0.96-1.6)	**1.3 (1.01-1.68)**
Employment status †						
Employed[1] (reference)	Ref	Ref	Ref	Ref	Ref	Ref
Unemployed	**1.2 (0.99-1.5)**	0.9 (0.73-1.1)	1.23 (0.88-1.7)		1.2 (0.94-1.54)	
Married or cohabitating†						
Yes (reference)	Ref	Ref	Ref	Ref	Ref	Ref
No	**1.62 (1.32-2)**	**1.43 (1.15-1.78)**	**1.46 (1.05-2.06)**	1.39 (0.98-1.99)	**1.76 (1.35-2.31)**	**1.62 (1.17-2.24)**
Number of sex partners in the past 6 months ±						
More than one	**1.8 (1.4-2.3)**	**1.5 (1.2-1.9)**	**1.72 (1.12-2.6)**	1.47 (0.94-2.21)	**1.86 (1.38-2.47)**	**1.55 (1.13-2.08)**
One (reference)	Ref	Ref	Ref	Ref	Ref	Ref
Condom use at last sex						
Yes (reference)	Ref		Ref		Ref	
No	0.92 (0.7-1.3)		1.1 (0.72-1.78)		0.85 (0.57-1.34)	

Alcohol use during the current pregnancy ‡						
Yes	**1.23 (1.0-1.5)**	1.12 (0.91-1.4)	**1.47 (1.06-2.04)**	1.27 (0.91-1.77)	1.06 (0.8-1.38)	
No (reference)	Ref	Ref	Ref	Ref	Ref	
Substance use during the current pregnancy (excluding alcohol) ‡						
Yes	1.31 (0.99-1.7)		1.41 (0.89-2.12)		1.24 (0.86-1.73)	
No (reference)	Ref	Ref	Ref		Ref	
Suspect partner of having another sex partner[2] ±						
No (reference)	Ref	Ref	Ref	Ref	Ref	Ref
Yes	**1.34 (1.07-1.67)**	1.18 (0.94-1.48)	1.4 (0.97-2)		1.26 (0.95-1.68)	
Unsure	**1.3 (0.98-1.7)**	1.22 (0.92-1.6)	1.25 (0.76-1.98)		1.32 (0.92-1.84)	
Partner's HIV serostatus[2] ±						
Negative (reference)	Ref	Ref	Ref	Ref	Ref	Ref
Positive	0.99 (0.67-1.44)	0.86 (0.55-1.3)	0.76 (0.46-1.26)		0.83 (0.25-1.96)	0.89 (0.27-2.13)
Unknown	**1.48 (1.2-1.8)**	**1.32 (1.06-1.65)**	1.28 (0.86-1.95)		**1.47 (1.14-1.88)**	**1.42 (1.1-1.84)**
Gravida ‡						
Primigravid (reference)	Ref	Ref	Ref		Ref	Ref
Multigravida	**0.75 (0.61-0.92)**	**0.78 (0.62-0.96)**	0.79 (0.55-1.18)		**0.67 (0.54-0.88)**	**0.77 (0.59-0.99)**
Treated for STI in the past year						
Yes	0.97 (0.74-1.13)		1.22 (0.78-1.8)		0.85 (0.6-1.8)	
No (reference)	Ref		Ref		Ref	
Reported vaginal discharge at first ANC visit[4] *						
Yes	**1.34 (0.95-1.82)**		1.42 (0.86-2.23)		1.2 (0.75-1.84)	
No (reference)	Ref		Ref		Ref	Ref
Abnormal vaginal discharge identified during clinical exam[4] *						
Yes	**1.53 (1.18-1.96)**	**1.45 (1.1-1.87)**	**1.62 (1.06-2.4)**	1.47 (0.95 – 2.2)	**1.45 (1.03-2)**	**1.39 (0.98-1.92)**
No (reference)	Ref	Ref	Ref	Ref	Ref	Ref
HIV serostatus †						
Positive	**1.45 (1.14-1.84)**	**1.43 (1.15-1.77)**	-	-	-	-
Negative (reference)	Ref	Ref				

On ART at first ANC[3]					
Yes (reference)	**-**	**-**	Ref		
No	**-**	**-**	1.15 (0.75-1.7)	-	-

Confidence intervals in bold had sufficient evidence to conclude that the groups were statistically significantly different

[1] Includes those who reported being self-employed
[2] out of those who reported being married or in a steady partnership
[3] out of women living with HIV
[4] Only includes participants with CT, NG, or TV as per South African STI Screening Algorithm

† model adjusted for age, education, employment, married/cohabitating, HIV status, research site *(HIV stratified models were not adjusted for HIV status)*
± model adjusted for age education, married/cohabitating, HIV status, research site*(HIV stratified models were not adjusted for HIV status)*
‡ model adjusted for age, education, employment, research site *(age excluded from adjusted model for gavidity due to collinearity)*
*** model adjusted for age, HIV status, research site*(HIV stratified models were not adjusted for HIV status)***

ANC, antenatal care; ART, antiretroviral therapy; aPR, adjusted prevalence ratio; PR, prevalence ratio

Correlates of curable STIs

Correlates of any curable STI, overall and by HIV serostatus, are shown in Table 3. In multivariate analysis, older maternal age (aPR: 0.95, 95% CI: 0.93–0.96), lower education (aPR: 1.42, 95% CI: 1.15–1.76), being married/cohabitating with partner (aPR: 1.43, 95% CI: 1.15-1.78), unknown HIV serostatus of partner(s) (aPR: 1.32, 95% CI: 1.06–1.65), reporting multiple sex partners (aPR: 1.5, 95% CI: 1.2–1.9), multigravidity (aPR: 0.78, 95% CI: 0.62–0.96), and HIV serostatus (aPR: 1.43, 95% CI: 1.15–1.77) were independently associated with any curable STI. Associations strengthened or attenuated when stratified by HIV serostatus.

***Table 4**: Factors Associated with curable sexually transmitted Infections Among Pregnant Women Undergoing STI Screening, Stratified by Sexually Transmitted Organism, Buffalo City Municipality, South Africa, 2021-2024*

Risk Factors	CT N = 219		NG N = 73		TV N = 152		Syphilis N = 51	
	PR (95% CI)	aPR (95% CI)	PR (95% CI)	aPR (95% CI)	PR (95% CI)	aPR (95% CI)	PR (95% CI)	aPR (95% CI)
Maternal age †	**0.92 (0.89-0.94)**	**0.92 (0.92-0.95)**	**0.88 (0.84-0.92)**	**0.89 (0.85-0.94)**	0.99 (0.97-1.03)		**0.9 (0.85-0.94)**	**0.91 (0.86-0.96)**
Gestational age	0.99 (0.98-1.02)		1.02 (0.98-1.06)		0.99 (0.97-1.03)		1.01 (0.96-1.06)	
Research site †								
Site 1	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Site 2	1.04 (0.74-1.46)		0.8 (0.43-1.45)		0.92 (0.6-1.4)		1.1 (0.54-2.29)	1.16 (0.56-2.45)
Site 3	1.39 (0.91-2.1)		1.03 (0.45-2.13)		1.56 (0.94-2.52)		**2.94 (1.4-6.15)**	**2.49 (1.18-5.24)**
Site 4	0.82 (0.56-1.75)		0.91 (0.5-1.63)		0.97 (0.63-1.48)		0.45 (0.16-1.11)	0.51 (0.18-1.27)
Education †								
≥ Grade 12 (reference)	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
< Grade 12	1.19 (0.91-1.55)		1.2 (0.76-1.9)		**1.79 (1.31-2.48)**	**1.74 (1.24-2.45)**	**1.86 (1.07-3.28)**	**1.79 (1.01-3.22)**
Employment status †								
Employed[1] (reference)	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Unemployed	**1.38 (1.05-1.83)**	0.97 (0.72-1.32)	**1.77 (1.1-2.97)**	1.11 (0.65-1.92)	0.88 (0.64-1.21)		**2.71 (1.44-5.56)**	1.53 (0.77-3.27)
Married or cohabitating †								
Yes (reference)	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
No	**1.65 (1.25-2.23)**	1.31 (0.97-1.78)	**2.4 (1.43-4.24)**	**1.75 (1.01-3.18)**	1.34 (0.96-1.88)	**1.43 (1.01-2.04)**	**2.6 (1.38-5.31)**	**2.04 (1.05-4.27)**
Number of sex partners in the past 6 months ±								

More than one	**1.82 (1.3-2.5)**	**1.48 (1.05-2.05)**	**2.4 (1.43-4.25)**	**1.83 (1.05-3.06)**	**1.73 (1.4-2.54)**	**1.57 (1.03-2.33)**	**3.21 (1.73-5.7)**	**2.23 (1.18-4.03)**
One (reference)	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Condom use at last sex								
Yes (reference)	Ref		Ref	Ref	Ref		Ref	
No	0.91 (0.61-1.43)		0.53 (0.3-1)		1.03 (0.59-1.8)		0.71 (0.34-1.72)	
Alcohol use during the current pregnancy ‡								
Yes	1.01 (0.75-1.35)		0.53 (0.3-1)		1.19 (0.84-1.67)		1.49 (0.83-2.6)	
No (reference)	Ref		Ref	Ref	Ref		Ref	
Substance use during the current pregnancy (excluding alcohol) ‡								
Yes	1.13 (0.75-1.63)		1.43 (0.73-2.56)		**1.74 (1.14-2.57)**	**1.63 (1.06-2.44)**	1.18 (0.48-2.44)	
No (reference)	Ref		Ref		Ref	Ref	Ref	
Suspect partner of having another sex partner[2] ±								
No (reference)	Ref		Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.16 (0.85-1.56)		**2.06 (1.23-3.45)**	**1.76 (1.04-2.98)**	1.23 (0.83-1.8)	1.09 (0.73-1.6)	**2.43 (1.31-4.59)**	**1.98 (1.05-3.81)**
Unsure	0.95 (0.62-1.41)		1.65 (0.83-3.12)	1.58 (0.78-3.02)	**1.62 (1.04-2.47)**	1.45 (0.93-2.23)	1.63 (0.67-3.64)	1.34 (0.54-3.05)
Partner's HIV serostatus[2] ±								
Negative (reference)	Ref	Ref	Ref	Ref	Ref	Ref	Ref	
Positive	0.89 (0.5-1.47)	0.96 (0.52-1.7)	0.53 (0.13-1.51)	0.57 (0.13-1.81)	1.18 (0.6-2.14)	0.59 (0.29-1.12)	1.72 (0.62-4.19)	
Unknown	**1.36 (1.02-1.81)**	1.31 (0.97-1.76)	**1.74 (1.08-2.86)**	1.56 (0.95-2.62)	**1.81 (1.27-2.61)**	1.38 (0.95-2.02)	1.71 (0.92-3.25)	
Gravida ‡								
Primigravid (reference)	Ref	Ref	Ref	Ref	Ref		Ref	Ref
Multigravida	**0.74 (0.56-0.98)**	0.81 (0.61-1.09)	**0.58 (0.37-0.92)**	0.67 (0.41-1.09)	0.9 (0.65-1.28)		**0.43 (0.25-0.75)**	**0.46 (0.26-0.83)**
Treated for STI in the past year								

Yes	0.81 (0.54-1.16)		0.7 (0.33-1.34)		0.99 (0.64-1.5)		1.73 (0.95-3.49)	
No (reference)	Ref		Ref		Ref		Ref	
Reported vaginal discharge at first ANC visit[4] *								
Yes	1.42 (0.92-2.11)		0.97 (0.38-2.1)		1.48 (0.88-2.4)		-	-
No (reference)	Ref		Ref		Ref	Ref	-	-
Abnormal vaginal discharge identified during clinical exam[4] *								
Yes	**1.53 (1.1-2.1)**	1.36 (0.96-1.9)	1.25 (0.64-2.2)		**1.65 (1.1-2.4)**	**1.68 (1.1-2.5)**	-	**-**
No (reference)	Ref	Ref	Ref		Ref	Ref	-	-
HIV serostatus †								
Positive	0.99 (0.73-1.31)		1.05 (0.62-1.7)		**2.33 (1.7-3.21)**	**2.25 (1.62-3.18)**	1.5 (0.84-2.62)	
Negative (reference)	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
On ART at first ANC[3]								
Yes (reference)	Ref	Ref	Ref		Ref		Ref	
No	1.72 (0.97-2.95)		1.35 (0.45-3.41)		1.01 (0.53-1.78)		0.86 (0.2-2.57)	

Confidence intervals in bold had sufficient evidence to conclude that the groups were statistically significantly different

[1] Includes those who reported being self-employed
[2] out of those who reported being married or in a steady partnership
[3] out of women living with HIV
[4] Only includes participants with CT, NG, or TV as per South African STI Screening Algorithm

† model adjusted for age, education, employment, married/cohabitating, HIV status, research site
± model adjusted for age education, married/cohabitating, HIV status, research site
‡ model adjusted for age, education, employment, research site *(age excluded from adjusted model for gravidity due to collinearity)*
*** model adjusted for age, HIV status, research site**

ANC, antenatal care; ART, antiretroviral therapy; CT, Chlamydia trachomatis; NG, Neisseria gonorrhoeae; TV, Trichomonas vaginalis; aPR, adjusted prevalence ratio; PR, prevalence ratio

Correlates of individual STIs are detailed in Table 4. Multivariable analysis showed strong associations between lower education and *T. vaginalis* (aPR: 1.74, 95% CI: 1.24–2.45) and syphilis (aPR: 1.79, 95% CI: 1.01–3.22). Reporting multiple sex partners was strongly associated with syphilis (aPR: 2.23, 95% CI: 1.18–4.03), *N. gonorrhoeae* (aPR: 1.83, 95% CI: 1.05–3.06), and *T. vaginalis* (aPR: 1.57, 95% CI: 1.03–2.33). Not being married or cohabitating with partner was also strongly associated with syphilis (aPR: 2.04, 95% CI: 1.05-4.27) and *N. gonorrhoeae (aPR: 1.75, 95% CI: 1.01-3.18).* Suspecting partner of having other partner(s) was also associated with syphilis (aPR: 1.98, 95% CI: 1.05–3.81) and *N. gonorrhoeae* (aPR: 1.76, 95% CI: 1.04–2.98). HIV serostatus was strongly associated with *T. vaginalis*, showing a 125% higher prevalence in women with HIV (aPR: 2.25, 95% CI: 1.6–3.2). Geographical variation was also observed, with a 149% higher prevalence of syphilis at research site 3 (aPR: 2.49, 95% CI: 1.18–5.24).

Discussion

Our study identified a high prevalence of curable STIs among pregnant women in Eastern Cape, South Africa, which was elevated among women with HIV. Most women with STIs were asymptomatic, while women without STIs were more likely to report symptoms. Although treatment rates were high, same-day treatment following point-of-care tests for *C. trachomatis*, *N. gonorrhoeae*, and *T. vaginalis* was moderate compared to syphilis rapid tests. We observed strong associations between curable STIs and several individual, behavioural, geographical, and partner characteristics. Our findings highlight the need to

strengthen STI care for pregnant women and their partners, ensuring timely detection, treatment, and comprehensive care to improve maternal and neonatal health outcomes.

The prevalence of any curable STI in our study was lower than in other South African regions,(10,11) but higher than reports from Botswana,(26,27) Kenya,(28) and Ethiopia.(29) Syphilis prevalence was lower than a recent South African study,(30) but higher than earlier reports from the country(31–33) and exceeds rates reported in Tanzania(34) and Zimbabwe.(35) Heterogeneity of syphilis prevalence between studies may reflect differences in case definitions and diagnostic methods. In our study, half of women with a positive syphilis rapid test had low titres (≤1:4), but due to lack of clinical history, we could not distinguish between those with past-treated infections and those with active infection.

Women living with HIV had a 40% higher prevalence of curable STIs compared to those without HIV, consistent with findings from both high- and low-income countries.(36,37) STIs increase HIV risk by disrupting mucosal barriers and promoting inflammation,(8) and women with HIV are more susceptible to other STIs.(38) Furthermore, overlapping demographic, socioeconomic, behavioural, and structural risk factors for HIV and other STIs have been reported in both high-and low-income countries.(39–42) We observed a 125% higher prevalence of *T. vaginalis* among women with HIV, contributing to the elevated STI burden. Limited studies have reported associations between HIV infection and *T. vaginalis* among pregnant women in Brazil(43) and Uganda(39) and non-pregnant

women in the United States(44) and Kenya.(45) A 2022 meta-analysis by Jarolimova et al. found a higher relative risk of *T. vaginalis* in women with HIV in sub-Saharan Africa, especially in antenatal care settings, with increasing risk over time.(36) Further research is needed to understand the epidemiological and clinical implications of HIV and *T. vaginalis* co-infection on reproductive and maternal-neonatal health.

We observed a high proportion (80%) of asymptomatic *C. trachomatis*, *N. gonorrhoeae*, and/or *T. vaginalis* cases – higher than previous reports from South Africa,(10–13) Botswana,(27) and Kenya.(28) Variability in symptomatic case definitions and methods used for symptom screening between studies may explain observed differences in rates of asymptomatic cases.(46) Clinically-observed abnormal vaginal discharge was independently associated with higher prevalence of these STIs, but reported abnormal vaginal discharge was not, highlighting the importance of combining verbal report and provider-initiated screening. Additionally, most women who reported or had clinical signs of abnormal vaginal discharge were not diagnosed with an STI, underscoring the need for more accurate diagnostic approaches. Studies in South Africa,(47) Botswana,(48) and Papua New Guinea(49) have found point-of-care testing for curable STIs in antenatal care to be highly feasible and acceptable. Epidemiological research on the impact of diagnostic testing and treatment for curable STIs on adverse birth outcomes combined with cost-effectiveness and implementation science studies are needed to inform adoption, implementation, and maintenance of point-of-care testing within resource-constrained settings. The primary and secondary outcomes from the parent trial of this cross-sectional

study will address these gaps. Data on syphilis-associated symptoms (i.e., chancre, maculopapular rash, condylomata lata) were not available for our study, which limited our ability assess symptomology; however, standard care for antenatal syphilis screening in South Africa relies on diagnostic testing rather than symptom-based screening.(18)

Nearly all women diagnosed with *C. trachomatis*, *N. gonorrhoeae*, or *T. vaginalis* received treatment, however only half were treated on the day of diagnosis, compared to 100% same-day treatment for syphilis. Similar moderate same-day treatment rates following point-of-care testing for STIs in antenatal care have been reported in South Africa.(50) These findings suggest that the 60–90-minute turnaround time of current molecular tests presents barriers to timely treatment. Further implementation research is needed to identify these barriers and to inform test-and-treat strategies.

Younger age, lower education, unknown partner HIV serostatus, and multiple recent sex partners were strongly associated with STI diagnosis at the first antenatal care visit, consistent with previous studies.(10,12,27,29,35) Variations in risk profiles by sexually transmitted organism suggest social determinants and behavioural factors may impact STI risk differently. However, these differences should be interpreted with caution. Small sample sizes when stratified by organism may have impacted our ability to detect meaningful associations. STI prevalence also varied by research site, with a 149% higher prevalence of syphilis at site 3, which is based in a rural settlement. This site also experienced a 39% higher prevalence of *C. trachomatis* and a 56% higher prevalence of *T.*

vaginalis, although not statistically significant. These findings support the influence of hyperlocal epidemiological factors, such as household and neighbourhood characteristics and social networks, on STI transmission dynamics.(51,52). Smaller communities, with a limited pool of sex partners and frequent sexual mixing, may experience increased STI risk.(53) HIV prevalence at site 3 (41%) was higher than the other sites, which also may contribute to elevated STI burden within this catchment population. Research from KwaZulu-Natal also identified spatial clustering of high-risk sexual behaviours and overlapping HIV/STI prevalence in areas with shared risk factors.(54) These results highlight the need for comprehensive STI and HIV care that integrates individual and structural interventions and robust surveillance to tailor prevention strategies to community-specific needs.

Limitations

There are few limitations to note. The cross-sectional design of our study restricts our ability to draw causal inferences between the identified risk factors and the prevalence of STIs. Further, the use of self-reported data for most participant characteristics and clinical history may have introduced recall or reporting bias. As previously discussed, we were unable to assess symptomology among syphilis cases due to lack of symptom-specific data captured in the parent study. Finally, our study was conducted in a specific geographic region within South Africa and only included women who were at least 18 years of age, less than 27 weeks' gestation at their initial antenatal care visit, and who consented to

participate in a clinical trial, which may limit the generalizability of the findings to other populations and settings with differing healthcare systems and demographics.

Conclusion

To our knowledge, this is the first study to report *C. trachomatis*, *N. gonorrhoeae*, *T. vaginalis*, and syphilis prevalence among pregnant women with and without HIV in the Eastern Cape, South Africa. STI prevalence was higher in women with HIV, emphasizing the need for integrated HIV and STI interventions, robust surveillance, and enhanced antenatal care. The high rate of asymptomatic infections and abnormal vaginal discharge in women without STIs highlight gaps in care. While point-of-care testing prevented most STI cases from going undetected and untreated, moderate same-day treatment rates suggest implementation challenges with turnaround times of current molecular tests. We recommend incorporating diagnostic tests, with optimized turnaround times, at point-of-care to enable timely, accurate treatment and reduce unnecessary antibiotic use. Further research on cost-effective and optimal implementation strategies for delivering timely results and treatment are critical, ultimately reducing transmission and improving maternal and neonatal outcomes.

Statements and declarations

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Ethical considerations

Ethical approval was provided by the Institutional Review Boards at the University of Cape Town's Faculty of Health Sciences Research Ethics Committee (UCT-HREC, reference number 676/2019).

Consent to participate

Eligible women provided written informed consent in their preferred language (isiXhosa or English) prior to randomization.

Consent for publication

Not applicable

Declaration of conflicting interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request

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