Routine Testing for *Chlamydia trachomatis* and *Neisseria gonorrhoeae* Infections within an HIV Pre-Exposure Prophylaxis Program in Hanoi, Vietnam: Implications for Low- and Middle-Income Countries

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Summary: Our study found a high prevalence of *Neisseria gonorrhoeae* and *Chlamydia trachomatis*, particularly pharyngeal and rectal infections, within an HIV PrEP program in Hanoi, Vietnam. Our findings highlight the need for evidence-based screening guidelines in PrEP programs in low-resource settings.

Abstract

Background: Data on *Neisseria gonorrhoeae* (NG) and *Chlamydia trachomatis* (CT) infections within HIV pre-exposure prophylaxis (PrEP) programs in low- and middle-income countries (LMICs) are limited. Our study reports the prevalence, anatomical distribution, and correlates of NG and CT infections within an HIV PrEP program in Hanoi, Vietnam.

Methods: From January-December 2022, HIV PrEP program clients who were male at birth, ≥16 years old, reported ≥1 male sex partner in the prior 12 months, were enrolled. A questionnaire collected sociodemographics, sexual behaviors, and clinical data. CT/NG testing was performed on self-collected urine, rectal, and pharyngeal specimens. Multivariate logistic regression was used to identify factors associated with CT and NG infections.

Results: There were 529 participants enrolled, the median age was 25.1 years. The overall prevalence of CT or NG was 28.9% (153/529). The prevalence of NG was 14.3% and highest for pharyngeal infections (11.7%), while for CT, the prevalence was 20.4% and highest for rectal infections (14.0%). Symptoms in the prior week were reported by 45.8% (70/153) of those with CT or NG infections. Condomless anal sex (aOR= 1.98; 95% CI: 1.27, 3.08) and sexualized drug use in the prior 6 months (aOR= 1.68; 95% CI: 1.07, 2.65) were associated with CT/NG infections.

Conclusions: Our study found a high prevalence of NG and CT infections, including pharyngeal and rectal infections, within an HIV PrEP program in Hanoi, Vietnam. The findings underscore the need for further research on CT/NG prevention and the development of evidence-based guidelines for CT/NG screening in HIV PrEP programs in LMIC settings.

Introduction

Sexually transmitted infections (STIs) are a significant public health challenge globally. *Neisseria gonorrhoeae* and *Chlamydia trachomatis* are the two most common bacterial STIs. Men who have sex with men (MSM) are disproportionately affected by STIs. (2, 3) MSM on HIV pre-exposure prophylaxis (PrEP) have high frequencies of bacterial STIs. [1–3] Thus, major HIV PrEP guideline groups recommend routine screening for *C. trachomatis* and *N. gonorrhoeae* among MSM on HIV PrEP, including testing at multiple anatomic sites of infection.

In low- and middle-income coutries (LMICs), HIV PrEP programs are expanding, yet data on STIs among MSM in HIV PrEP programs are limited.[3] Understanding the epidemiology of STIs in these setttings is important for planning and implementation of HIV PrEP programs. Morever, in many LMIC settings, the availability of molecular *C. trachomatis* and *N. gonorrhoeae* testing is limited and the costs associated testing remain significant barriers for testing.[4,5] Identifying clinical and behavioral risk factors associated with those infections can help optimize diagnosis and prevention of STIs, particularly in LMIC settings where resources might be limited and there is ongoing rapid scale-up of HIV PrEP services.

Vietnam is a LMIC where HIV PrEP became available in 2018. Prior to that, baseline data from the Hanoi-MSM (HIM) study found a high prevalence of *C. trachomatis* (22%) and *N. gonorrhoeae* (12%) among HIV-uninfected MSM, who subsequently were enrolled into the pilot HIV PrEP project.[6] The aims of this study are to fill gaps in research on STIs among MSM on HIV PrEP in Vietnam, since the rollout of HIV PrEP. The study objectives were to determine the prevalence of urethral, rectal, and pharyngeal *N. gonorrhoeae* and *C. trachomatis* infections within an HIV PrEP program in Hanoi, Vietnam, as well as to determine behavioral and clinical factors associated with *N. gonorrhoeae* and *C. trachomatis* infections.

Methods:

Study design and population

This was a observational, cross-sectional study from January 2022 to December 2022. The study was conducted within the HIV PrEP program at the Sexual Health and Promotion (SHP) Clinic at Hanoi Medical University. Study participants were eligible if they were male sex at birth, aged 16 years or older, reported having sex with men or transgender women in prior 12 months, and were enrolled in, or presenting for enrollment into, the HIV PrEP program; exclusion criteria were if they had *C. trachomatis* or *N. gonorrhoeae* testing done in the prior 3 months, unless they reported acute STI symptoms on the day of enrollment. Eligible participants were approached in the clinic and the study's objectives and procedures were explained by study research staff.

Data collection

Demographic, behavioral, and clinical characteristics were collected through the use of a tablet self-administered survey. Sexual behaviors were self-reported and included: number of sex partners in the prior month as the combined number of male, female, and transgender sex partners, anal sex position(s), condomless anal intercourse in the prior month, group sex (defined as having more than one sex partner at the same encounter), or having sex with partners met via mobile apps in the prior 6 months. Sexualized drug use was considered if the participant reported using a substance (heroine, ketamine, ecstasy, methamphetamine, cannabis, gamma hydroxybutyrate or gamma butyrolactone, poppers, or prostaglandin E medications) in the prior 6 months to enhance sexual pleasure. History of STIs in the prior three months was obtained by self-report.

Participants were asked about any genitourinary, rectal, or pharyngeal symptoms in the prior one week. Genitourinary symptoms were classified as any of the following: pain with urination, discharge, bleeding, pruritis, testicular pain, lymphadenopathy, or ulcers. Rectal symptoms were classified as any of the following: tenesmus, dyschezia, pruritis, bleeding, discharge, ulcers, or diarrhea. Pharyngeal symptoms included pain or itching in the throat.

Sample collection, testing, and treatment

Study participants received instructions on providing specimens for testing by study staff and with visual aids. Clinician-collected samples were obtained if participants preferred or were unable to perform self-collection. Study specimens were collected using either the Alinity m multi-Collect Specimen Collection Kits (Abbott Molecular, USA) or cobas PCR Urine or Swab Sample Kits (Roche Diagnostics, Branchburg, NJ, USA). Specimens were stored in the clinic and transported daily to the laboraty. Testing was performed using either the Alinity m STI Assay (Abbott Molecular, USA) or the cobas 4800 CT/NG assay (Roche Diagnostics, Branchburg, NJ, USA) according to manufacturer's instructions. Test results for *C. trachomatis* and *N. gonorrhoeae* were either positive, negative, or inconclusive, in the event of failed internal controls or the presence of inhibitors. Participants were informed of their test results. For those found to have infections, free treatment was offered. For *C. trachomatis* infections, doxycycline 100mg by mouth twice daily for 7 days was provided. For *N. gonorrhoeae* infections, ceftriaxone 500mg intramuscular injection once was the preferred treatment offered; cefixime 800mg by mouth once was provided as an alternative treatment.

Data analysis

The primary outcome was the prevalence of *C. trachomatis* or *N. gonorrhoeae* infections at different anatomic sites. Descriptive statistics were performed for demographic, behavioral and clinical data; percentages for categorical variables, or median and interquartile range for

115 continuous variables, were reported. Categorical variables between those with and without C.
116 trachomatis or *N. gonorrhoeae* infections were compared using Pearson's Chi-squared test and
117 Fisher's exact test, and nonparametric continuous variables were compared using Wilcoxon
118 rank-sum tests.
119 Logistic regression modeling was used to evaluate factors associated with *N. gonorrhoeae* and
120 *C. trachomatis* infections separately as well as the outcome of having either infection. Variables
121 with p-values < 0.2 in univariate comparisons were included in the multivariable logistic
122 regression models; except for age, which was included in the final models. The number of sex
123 partners in the prior month was dichotomized to above or below the median (0-1 and ≥2) to
124 improve interpretation and model fit. Variables with missing data were excluded from the logistic
125 regression models. P-values ≤ 0.05 was defined as statistical significance. All data analyses
126 were performed using STATA version 18 (StataCorp LLC, College Station, TX, USA).
127
128 ***Ethics***
129 The study was approved by the Institutional Review Boards (IRB) of Hanoi Medical University
130 (HMUIRB580), the University of California, Los Angeles, and the University of Southern
131 California. All study participants provided written informed consent.
132
133 **Results**
134 *Participant Characteristics*
135 From January to December 2022, there were 529 participants enrolled into the study
136 among 775 approached and 538 screened. The primary reasons for refusal of those who were
137 approached, but who did not undergo screening, was "too busy/not enough time" or "will
138 consider next time." Among the study participants, 81.6% (432/529) identified as a man, 1.7%
139 (9/529) identified as transgender woman, and 16.6% (88/529) identified as gender non-

conforming. The median age among all participants was 25.1 years (IQR: 21.7-29.5). There were 29.1% (154/529) currently undergoing university or post-secondary training, while 61.1% (323/529) had completed university or post-secondary training.

In the prior six months, 95.8% (507/529) reported only male sex partners; the median number of sex partners in the prior month was 1 (IQR: 1-2). Anal sex in the prior 6 months was reported by 88.4% (396/529), of which 51.2% reported condomless anal sex. In the prior 6 months, group sex was reported by 12.3% (65/529) and sexualized substance use was reported by 45.4% (240/529). A history of a STI in the prior 3 months was reported by 5.5% (29/529), with 69.0% (20/29) of those being syphilis. Additional sexual bevavior data are shown in Table 1.

C. trachomatis and N. gonorrhoeae infections

In total, 28.9 % (153/529) participants had *C. trachomatis* or *N. gonorrhoeae* infections at any anatomical site. The prevalence of *C. trachomatis* was 20.4% (108/529) and 14.3% (76/529) for *N. gonorrhoeae*; 5.9% (31/529) of participants had *C. trachomatis* and *N. gonorrhoeae* co-infections (Table 1). Among the 153 participants with either *C. trachomatis* or *N. gonorrhoeae* infections, the median age was 25.1 years (IQR: 21.5 – 28.3). The median number of sex partners in the prior month was 2 (IQR: 1-3), 14.2% (22/155) reported group sex in the prior month, and 60.1% (94/155) reported sexualized substance use. Of the 153 with C. trachomatis or *N. gonorrhoeae* infections, 45.8% (70/153) reported any symptoms in the prior week; 33 (21.6%) reported pharyngeal symptoms, 29 (19.0%) reported rectal symptoms, and 26 (17.0%) reported urethral symptoms. More participants with *C. trachomatis* or *N. gonorrhoeae*

infections reported having symptoms on the day of enrollment, compared to those without infections (9.2% vs. 3.0%, p=0.001).

C. trachomatis and *N. gonorrhoeae* infections by anatomic site are shown in Table 2. The prevalence of *C. trachomatis* was highest in the rectum (14.0%; 74/529) and 3.4% (18/529) had infections in multiple anatomic sites. For *N. gonorrhoeae*, pharyngeal site infections were most prevalent (11.7%; 62/529) and 6.0% (32/529) had infections at multiple anatomic sites. Among participants with either *C. trachomatis* or *N. gonorrhoeae*, the prevalence of rectal infections was 17.8% (94/529) and 9.3% (49/529) had infections at multiple anatomic sites.

Among those reporting rectal symptoms in the prior week, the prevalence of having a rectal infection with *C. trachomatis* or *N. gonorrhoeae* was 27.2% (22/81), followed by 25.0% (18/72) for urethral symptoms and urethral infections, and 18.3% (23/126) for pharyngeal symptoms and pharyngeal infections. Among those who did not report symptoms in the prior week, the prevalence of urethral *C.trachomatis* was 3.1% (14/457) and 0.9% (4/457) for *N. gonorrhoeae*. For both infections, the prevalence of both rectal and urethral infections were higher among those reporting symptoms in the prior week; there were no differences in the prevalence of pharyngeal infections by symptom status for either infection. The prevalence of *C. trachomatis* or *N. gonorrhoeae* infections by anatomic site, stratified by reported symptoms in the prior week are shown in Figure 1.

Factors associated with C*. trachomatis and N. gonorrhoeae infections*

In the multivariate logistic regression models, having either *C. trachomatis* or *N. gonorrhoeae* infection was associated with condomless anal intercourse (aOR: 1.98; 95% CI:

1.27-3.08) and sexualized drug use (aOR: 1.68; 95% CI: 0.73, 1.95). Rectal and urethral symptoms in the prior week were associated with infections in univariate analyses, but not in the multivariate model (aOR: 1.19; 95% CI: 1.07, 2.65). When examining each infection separately, meeting sex partners in mobile apps was an independent risk factor for *N. gonrorhoeae* infections (aOR: 2.33; 95% CI: 1.19, 4.54), but not *C. trachomatis* (aOR: 0.83; 95% CI: 0.48, 1.43). Both condomless anal sex (aOR: 2.09; 95% CI: 1.27-3.44) and sexualized drug use (aOR: 2.18; 95% CI: 1.30-3.64) were associated with *C. trachomatis*, but not *N. gonorrhoeae*. (Table 3).

Discussion

In this study including 529 primarily MSM in an HIV PrEP program in Hanoi, Vietnam, testing for *C. trachomatis* and *N. gonorrhoeae* at multiple anatomic sites identified a high prevalence (29%) of infections. Rectal infections were most common for *C. trachomatis* (14%), while pharyngeal infections were most common for *N. gonorrhoeae* (11%), demonstrating the utility of testing at multiple anatomic sites for the detection of infections outside of the genital tract. While the prevalence of urethral and rectal *C. trachomatis* and *N. gonorrhoeae* infections were higher among those who reported symptoms at those sites in the prior week, a substantial proportion of overall infections (44%) were detected among those without symptoms, underscoring the limitations of relying on syndromic management as an infection control strategy in this setting. These findings highlight the opportunity to enhance STI diagnosis and treatment within HIV PrEP programs in LMICs.

Our study provides important data on routine testing for *C. trachomatis* and *N. gonorrhoeae* within a large HIV PrEP program in a LMIC setting, where prevalence data are limited. A recent meta-analysis of STIs among people in HIV PrEP programs estimated a pooled prevalence of *C. trachomatis* or *N. gonorrhoeae* was 24%, suggesting a slightly higher burden among participants in our study population.[3] However, that study highlighted the scarcity of data from LMICs, which makes comparisons difficult, but the study did not find a significant difference in prevalence of chlamydia or gonorrhea by country income level. There is a paucity of published prevalence estimates of *C. trachomatis* and *N. gonorrhoeae* among MSM on HIV PrEP from other nearby countries in Asia, which could provide further context. One study done among adolescent MSM and transgender women in Thailand found a *C. trachomatis* prevalence of 15% and *N. gonorrhoeae* prevalence of 4.5%, estimates that are much lower than our study, although pharyngeal testing was not performed in that study which would likely account for some of that difference.[7] The prevalence of infections observed in our study align with existing evidence from other, largely high-income, settings indicating a high burden of STIs among MSM on HIV PrEP.[4,8]

Among participants in our study, we observed those reporting condomless anal sex were about twice as likely to have *C. trachomatis* or *N. gonorrhoeae* infection and those having sexualized drug use in the prior 6 months were 70% more likely to have *C. trachomatis* or *N. gonorrhoeae* infection. Identifying factors associated with infections could help to focus testing among those at highest risk for infections. For example, of the total 153 *C. trachomatis* or *N. gonorrhoeae* infections in our study, testing those reporting either condomless anal sex or sexualized drug use in the prior 6 months would have detected 75% of those infections.

Reporting rectal or urethral symptoms in the prior week was not associated with infections in the multivariate analysis, highlighting the difficulty of using symptoms to identify infections, given a high proportion of these types of infections are asymptomatic.[9] Despite this, the prevalence of rectal and urethral *C. trachomatis* and *N. gonorrhoeae* was significantly higher among those who reported symptoms in the prior week, suggesting symptoms are still correlated with a higher frequency of infections at those sites. Our findings suggest that testing for urethral infections among asymptomatic individuals is of limited value, as the prevalence in this group was very low, 0.9% for *N. gonorrhoeae* and 3.1% for *C. trachomatis*. Meeting sex partners on mobile apps is increasingly common globally and this behavior was associated with twice the odds of *N. gonorrhoeae*, but not *C. trachomatis*, infections in our study, a finding that was also observed in our previous work in a similar study population.[6] Possible explanations for this observation might be there is a higher prevalence of *N. gonorrhoeae* among certain sexual networks of online mobile app users or there is more oral sex within that network, since the majority of these infections were pharyngeal. These findings indicate that focused testing for *N. gonorrhoeae* among those meeting sex partners on apps could be a strategy to improve gonorrhea control.

Our study further highlights the high prevalence of *C. trachomatis* and *N. gonorrhoeae* infections among people in HIV PrEP programs and the need to improve evidence-based guidelines for testing, particularly in LMICs. Given the high prevalence and incidence of STIs in HIV PrEP programs, many guidelines recommend quarterly screening for *C. trachomatis* and *N. gonorrhoeae* among MSM on HIV PrEP.[10,11] Yet while some modeling studies support quarterly screening to reduce the population prevalence, the clinical and public health evidence

249 supporting the frequency of testing is lacking and the populations coverage needed to achieve a
250 population-benefit of decreased prevalence is much higher than observed in practice.[12–16]
251 The recent Gonoscreen Study, a randomized-controlled trial evaluating quarterly screening for
252 *C. trachomatis* and *N. gonorrhoeae* compared to no screening among MSM in Belgium found
253 quarterly screening was associated with fewer *C. trachomatis* infections and complications, but
254 observed no difference among *N. gonorrhoeae* infections.[17] Beyond the frequency of
255 screening, there is also a larger debate about the utility of screening for asymptomatic STIs in
256 populations of MSM, particularly those on HIV PrEP.[18,19] While *C. trachomatis* and *N.*
257 *gonorrhoeae* infections increase the risk for HIV transmission and provide a strong rationale for
258 using these as an entry point for HIV PrEP,[20] the increased risk for HIV acquisition caused by
259 bacterial STIs is largely mitigated among those on HIV PrEP.[21,22] Moreover, antimicrobial
260 resistance is one potential consequence of increased screening and treatment and is a
261 significant concern, particularly for *N. gonorrhoeae* and *Mycoplasma genitalium*; increased
262 antibiotic consumption was observed among those randomized to quarterly screening in the
263 Gonoscreen study.[17] Antimicrobial resistance in *N. gonorhoeae* is particularly concerning in
264 Vietnam, where the prevalence of ceftriaxone resistance, the first-line agent for treatment, is
265 more than 20% in some settings.[23]
266 Our study findings must be interpreted in light of the following limitations. First, the
267 study population might have been subject to slection bias. Efforts were made to expand
268 inclusivity by simplifying the study eligibility crtieria to reflect that of the HIV PrEP program.
269 Still, it was not possible to recruit all PrEP program clients and 70% of those who were recruited
270 agreed to be screened; thus, it is possible those who chose not to participate were different

than those who participated. Second, our study outcome was the prevalence of *C. trachomatis* and *N. gonorrhoeae* infections at each visit, so while participants were allowed to participate more than once, few did, and we were unable to estimate the incidence of *C. trachomatis* or *N. gonorrhoeae* infections. Third, our study population of primarily MSM were largely well-educated, employed, and living in Hanoi, the second most populated city in Vietnam, and might not be generalizable to other populations or settings. Our study took place within the largest HIV PrEP program in Hanoi, which is a strength of our study.

Our findings provide further evidence of the high prevalence of *C. trachomatis* and *N. gonorrhoeae* infections among people on HIV PrEP, including the high proportions of rectal, pharyngeal, and asymptomatic infections. Despite the high prevalence of infections, the high cost of molecular STI testing is a major barrier to implementing routine testing in HIV PrEP programs in LMICs.[4] Testing for urethral *C. trachomatis* and *N. gonorrhoeae* infections among those without urethral symptoms is likely to be of limited value, based on our findings. Further research is needed to establish evidence-based recommendations on the role and frequency of testing for asymptomatic infections, including the cost-effectiveness of different approaches. Biomedical interventions like doxycycline prophylaxis and vaccinations are promising tools for STI prevention and further research is needed on the effectiveness and implementation in LMIC settings, where key factors such as antimicrobial resistance and differences in user preferences will influence their impact.

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Table 1. Baseline demographic, behavioral, and clinical characteristics of 529 participants enrolled from an HIV PrEP program clinic in Hanoi, Vietnam.

	Overall (N = 529)	Positive for *C. trachomatis* (N=108)		Positive for *N. gonorrhoeae* (N=76)		Positive for *C. trachomatis* or *N. gonorrhoeae* (N=153)	
	n (%)	n (%)	p-value	n (%)	p-value	n (%)	p-value
Median Age (IQR)	25.1 (21.7-29.5)	25.3 (21.1 – 29.7)	0.869†	24.8 (22.1 – 27.2)	0.281†	25.1 (21.5 – 28.3)	0.336†
Age group			0.644		0.243		0.834
16- < 25 years old	261 (49.3)	51 (47.2)		38 (50.0)		75 (49.0)	
25- < 35 years old	221 (41.8)	45 (41.7)		35 (46.1)		66 (43.1)	
35 - 63 years old	47 (8.9)	12 (11.1)		3 (4.0)		12 (7.8)	
Gender self-identification			0.126‡		0.316‡		0.232‡
Man	432 (81.7)	85 (78.7)		58 (76.3)		121 (79.1)	
Transgender woman	9 (1.7)	0		1 (1.3)		1 (0.7)	
Other/Unsure*	88 (16.6)	23 (21.3)		17 (22.4)		31 (20.3)	
Education			0.687		0.942		0.797
High school or below	52 (9.8)	13 (12.0)		8 (10.5)		17 (11.1)	
In post-secondary training	154 (29.1)	31 (28.7)		21 (27.6)		45 (29.4)	
Completed post-secondary training or higher	323 (61.1)	64 (59.3)		47 (61.8)		91 (59.5)	
Monthly income in million VND (median, IQR)	9.0 (5 – 15)	8.5 (5-14)	0.813†	8 (4.5 – 14.5)	0.566†	8 (5 – 14.5)	0.493†
Employed	419 (79.2)	84 (77.8)	0.682	63 (82.9)	0.392	123 (80.4)	0.668
Gender of sex partners prior 6 months							
Men only	507 (95.8)	105 (97.2)	0.420	75 (98.7)	0.180	150 (98.0)	0.106
Women only	46 (8.7)	11 (10.2)	0.538	3 (4.0)	0.112	11 (7.2)	0.433
Men and women	1 (0.2)	0	1.000‡	0	1.000‡	0	1.000‡
No sex partners	9 (1.7)	1 (0.9)	0.694‡	0	0.371‡	1 (0.7)	0.458‡
Number of sex partners in prior 1 month#	1 (1 – 2)	2 (1 – 3)	<0.001†	2 (1 – 2)	0.150†	2 (1 – 3)	<0.001†
Anal sex with male partners in prior 1 month#	396 (88.4)	95 (94.1)	0.043	64 (92.8)	0.219	131 (92.9)	0.043
Anal sex position with male partner#			0.633		0.109		0.385
Insertive anal sex always	137 (34.6)	29 (30.5)		22 (34.4)		44 (33.6)	
Receptive anal sex always	149 (37.6)	38 (40.0)		18 (29.1)		45 (34.4)	
Both insertive and receptive	110 (27.8)	28 (29.5)		24 (37.5)		42 (32.1)	
Condomless anal sex in prior 1 month#	203 (51.3)	63 (66.3)	0.001	39 (60.9)	0.091	83 (63.4)	0.001
Vaginal sex with female partners in prior month#	38 (7.2)	8 (7.4)	0.064	2 (2.6)	0.814	8 (5.2)	0.064
Deep kissing in prior week#	260 (86.1)	61 (84.7)	0.700	41 (89.1)	0.518	85 (86.7)	0.823
Any group sex, prior 6 months	65 (12.3)	13 (12.0)	0.929	14 (18.4)	0.078	22 (14.4)	0.350
Any sexualized drug use, prior 6 months	240 (45.4)	68 (63.0)	<0.001	40 (52.6)	0.169	88 (57.5)	<0.001

	Overall (N = 529)	Positive for *C. trachomatis* (N=108)		Positive for *N. gonorrhoeae* (N=76)		Positive for *C. trachomatis* or *N. gonorrhoeae* (N=153)	
	n (%)	n (%)	p-value	n (%)	p-value	n (%)	p-value
Met sex partners via mobile apps	297 (56.1)	66 (61.1)	0.244	55 (72.4)	0.002	97 (63.4)	0.032
Pharyngeal symptoms in prior week	126 (23.8)	21 (19.4)	0.232	20 (26.3)	0.581	33 (21.6)	0.438
Rectal symptoms in prior week	87 (16.5)	25 (23.2)	0.035	15 (19.7)	0.403	29 (19.0)	0.321
Genitourinary symptoms in prior week	72 (13.6)	17 (15.7)	0.469	15 (19.7)	0.092	26 (17.0)	0.148
Any genitourinary symptoms at the day of enrollment	14 (2.7)	7 (6.5)	0.012‡	8 (10.5)	<0.001‡	12 (7.8)	<0.001‡
Any symptoms in prior week	217 (41.0)	49 (45.4)	0.303	41 (54.0)	0.013	70 (45.8)	0.158
Self-reported STI diagnosis in the prior 3 months	29 (5.5)	6 (5.6)	0.970	6 (7.9)	0.318	9 (5.9)	0.796
Used antiseptic mouthwash in the previous month	286 (54.1)	65 (60.2)	0.152	38 (50.0)	0.442	84 (54.9)	0.805

*Participants who were gender nonconforming or gender incongruent, or unsure of their gender identity.
†Wilcoxon rank-sum (Mann-Whitney) test was performed
‡Fisher's exact test was performed
§Variables that contains missing values because "Don't know" or "Don't remember" choice were treated as missing.
#Sample size was lower than 529 due to skip pattern (e.g., sample size for "Condomless anal sex" was among people who reported engaging in anal sex)

309 **Table 2.** Prevalence of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infections by anatomic site

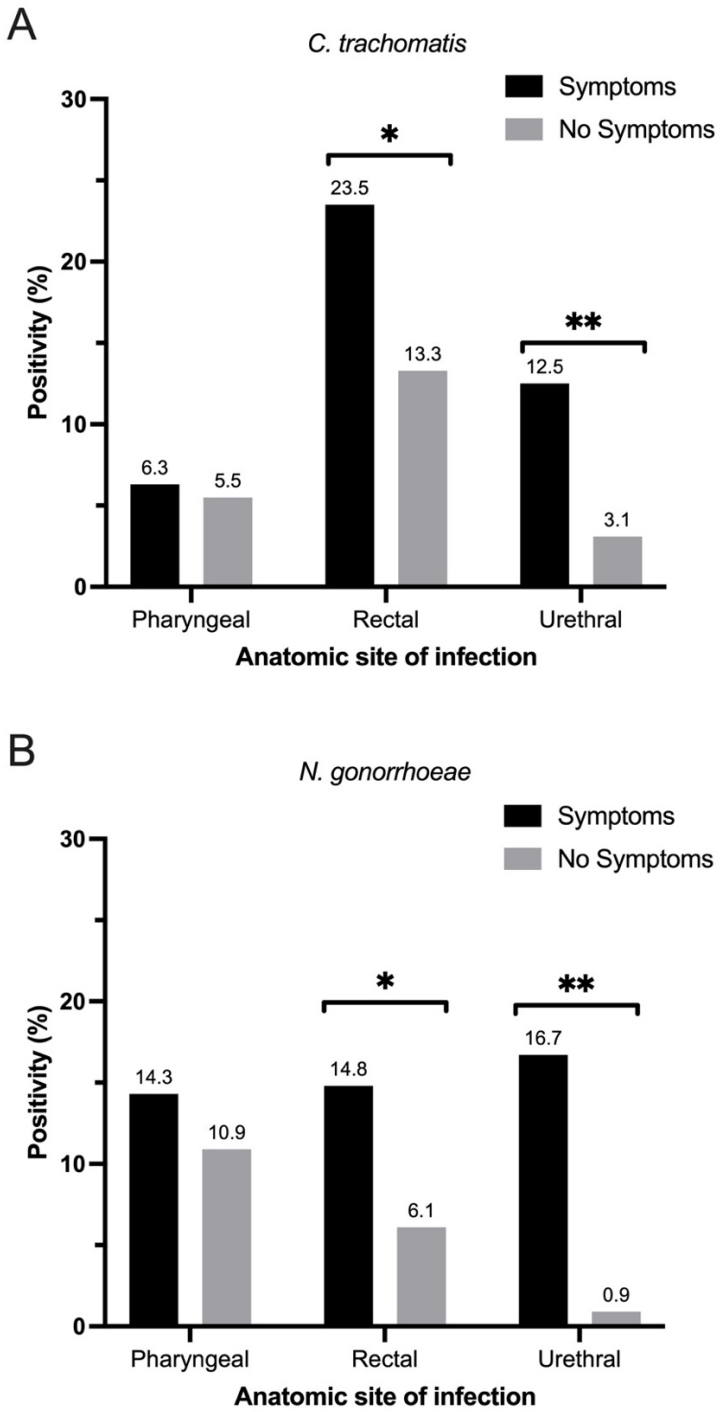
310 among 529 participants enrolled from an HIV PrEP program clinic in Hanoi, Vietnam.

311

Anatomic Site	**C. trachomatis (n/N*, %)**	**N. gonorrhoeae (n/N*, %)**	***C. trachomatis* or *N. gonorrhoeae* (n/N*, %)**	***C. trachomatis* and *N. gonorrhoeae* (n/N*, %)**
Total Infections (Any Site)	108 (20.4)	76 (14.4)	153 (28.9)	31 (5.9)
Single Site Infections				
Pharyngeal only	19/528 (3.6)	32/528 (6.1)	41/528 (7.7)	3/528 (0.6)
Rectal only	57/493 (11.6)	10/494 (2.0)	52/493 (10.6)	4/493 (0.8)
Urethral only	14/529 (2.7)	2/529 (0.4)	11/529 (2.1)	0/529 (0)
Multisite Infections				
Pharyngeal and rectal	9/493 (1.8)	18/494 (3.6)	26/494 (5.3)	13/493 (2.6)
Pharyngeal and urethral	1/528 (0.2)	5/528 (1.0)	7/528 (1.3)	3/528 (0.6)
Urethral and rectal	7/493 (1.4)	2/494 (0.4)	7/493 (1.4)	1/493 (0.2)
Pharyngeal, rectal, and urethral	1/493 (0.2)	7/494 (1.4)	9/494 (1.8)	7/493 (1.4)

312

313 **Figure 1.** Prevalence of *C. trachomatis* (Panel A) and *N. gonorrhoeae* (Panel B) infections at pharyngeal,
314 rectal, and urethral sites, stratified by reported symptoms at that site in the prior week.
315



316
317
318 ***p-value ≤0.05; **p-value ≤0.01**

319 **Table 3.** Multivariable logistic regression with factors associated with *C. trachomatis* only, *N.*

320 *gonorrhoeae* only, and *C. trachomatis* or *N. gonorrhoeae* infections.

321

	C. trachomatis		***N. gonorrhoeae***		***C. trachomatis* or *N. gonorrhoeae***	
Characteristics	aOR (95% CI)	p-value	aOR (95% CI)	p-value	aOR (95% CI)	p-value
Age group						
16 to < 25 years old	1.00		1.00		1.00	
25 to < 35 years old	0.75 (0.44, 1.26)	0.278	1.03 (0.58, 1.85)	0.908	0.81 (0.51, 1.29)	0.382
≥ 35 years old	1.27 (0.58, 2.79)	0.553	0.39 (0.11, 1.38)	0.144	0.76 (0.36, 1.64)	0.490
Two or more sex partners in prior 1 month	1.68 (0.98, 2.88)	0.061	1.16 (0.63, 2.15)	0.630	1.53 (0.95, 2.47)	0.080
Condomless anal sex in prior 1 month	**2.09 (1.27, 3.44)**	**0.004**	1.52 (0.86, 2.68)	0.152	**1.98 (1.27, 3.08)**	**0.003**
Sexualized drug use in prior 6 months	**2.18 (1.30, 3.64)**	**0.003**	1.07 (0.60, 1.91)	0.819	**1.68 (1.07, 2.65)**	**0.025**
Met sex partners via mobile apps	0.83 (0.48, 1.43)	0.505	**2.33 (1.19, 4.54)**	**0.013**	1.21 (0.74, 1.96)	0.449
Any anal or urethral symptoms in prior week	1.44 (0.84, 2.45)	0.182	1.30 (0.72, 2.36)	0.385	1.19 (0.73, 1.95)	0.487
Used an antiseptic mouthwash in the prior 1 month	1.14 (0.70, 1.86)	0.592	0.72 (0.41, 1.25)	0.240	0.85 (0.55, 1.32)	0.462
Model information						
Sample size included	396		396		396	
Hosmer-Lemeshow p-value	0.724		0.434		0.3621	
McFadden's R2	0.069		0.053		0.053	
Log likelihood	-203.127		-165.818		-238.097	

322

References

1. Kojima N, Davey DJ, Klausner JD. Pre-exposure prophylaxis for HIV infection and new sexually transmitted infections among men who have sex with men. AIDS **2016**; 30:2251–2252.

2. Traeger MW, Schroeder SE, Wright EJ, et al. Effects of Pre-exposure Prophylaxis for the Prevention of Human Immunodeficiency Virus Infection on Sexual Risk Behavior in Men Who Have Sex With Men: A Systematic Review and Meta-analysis. Clin Infect Dis **2018**; 67:676–686.

3. Ong JJ, Baggaley RC, Wi TE, et al. Global Epidemiologic Characteristics of Sexually Transmitted Infections Among Individuals Using Preexposure Prophylaxis for the Prevention of HIV Infection: A Systematic Review and Meta-analysis. JAMA Netw Open **2019**; 2:e1917134.

4. Ong JJ, Fu H, Baggaley RC, et al. Missed opportunities for sexually transmitted infections testing for HIV pre-exposure prophylaxis users: a systematic review. J Int AIDS Soc **2021**; 24:e25673.

5. Wi TE, Ndowa FJ, Ferreyra C, et al. Diagnosing sexually transmitted infections in resource-constrained settings: challenges and ways forward. J Int AIDS Soc **2019**; 22 Suppl 6:e25343.

6. Adamson PC, Bhatia R, Tran KDC, et al. Prevalence, Anatomic Distribution, and Correlates of Chlamydia trachomatis and Neisseria gonorrhoeae Infections Among a Cohort of Men Who Have Sex With Men in Hanoi, Vietnam. Sex Transm Dis **2022**; 49:504–510.

7. Songtaweesin WN, Pornpaisalsakul K, Kawichai S, et al. Sexually transmitted infections incidence in young Thai men who have sex with men and transgender women using HIV pre-exposure prophylaxis. Int J STD AIDS **2022**; 33:447–455.

8. World Health Organization. WHO implementation tool for pre-exposure prophylaxis (PrEP) of HIV infection. Module 13. Integrating STI services. Geneva, Switzerland.: 2022. Available at: https://www.who.int/publications/i/item/9789240057425. Accessed 11 June 2024.

9. Kent CK, Chaw JK, Wong W, et al. Prevalence of Rectal, Urethral, and Pharyngeal Chlamydia and Gonorrhea Detected in 2 Clinical Settings among Men Who Have Sex with Men: San Francisco, California, 2003. Clinical Infectious Diseases **2005**; 41:67–74. Available at: https://doi.org/10.1086/430704.

10. Centers for Disease Control and Prevention. Preexposure prophylaxis for the prevention of HIV infection in the United States—2021 Update: a clinical practice guideline. 2021. Available at: https://www.cdc.gov/hiv/pdf/risk/prep/cdc-hiv-prep-guidelines-2021.pdf. Accessed 12 June 2024.

11. British HIV Association, British Association of Sexual Health and HIV. BHIVA/BASHH guidelines on the use of HIV pre-exposure prophylaxis (PrEP), 2018. 2018. Available at: https://www.bhiva.org/PrEP-guidelines. Accessed 12 June 2024.

12. Jenness SM, Weiss KM, Goodreau SM, et al. Incidence of Gonorrhea and Chlamydia Following Human Immunodeficiency Virus Preexposure Prophylaxis Among Men Who Have Sex With Men: A Modeling Study. Clinical Infectious Diseases **2017**; 65:712–718. Available at: https://doi.org/10.1093/cid/cix439.

13. Reitsema M, Hoek AJ van, van der Loeff MS, et al. Preexposure prophylaxis for men who have sex with men in the Netherlands: impact on HIV and Neisseria gonorrhoeae transmission and cost-effectiveness. AIDS **2020**; 34:621. Available at: https://journals.lww.com/aidsonline/fulltext/2020/03150/preexposure_prophylaxis_for_men_who_have_sex_with.14.aspx.

14. Hocking JS, Temple-Smith M, Guy R, et al. Population effectiveness of opportunistic chlamydia testing in primary care in Australia: a cluster-randomised controlled trial. The Lancet **2018**; 392:1413–1422. Available at: https://www.sciencedirect.com/science/article/pii/S0140673618318166.

15. Tsoumanis A, Hens N, Kenyon CR. Is Screening for Chlamydia and Gonorrhea in Men Who Have Sex With Men Associated With Reduction of the Prevalence of these Infections? A Systematic Review of Observational Studies. Sexually Transmitted Diseases **2018**; 45:615. Available at: https://journals.lww.com/stdjournal/fulltext/2018/09000/is_screening_for_chlamydia_and_gonorrhea_in_men.7.aspx.

16. Tao G, Patel CG, He L, Workowski K. STI/HIV testing, STIs, and HIV PrEP use among men who have sex with men (MSM) and men who have sex with men and women (MSMW) in United States, 2019-2022. Clin Infect Dis **2024**; :ciae314.

17. Vanbaelen T, Tsoumanis A, Florence E, et al. Effect of screening for *Neisseria gonorrhoeae* and *Chlamydia trachomatis* on incidence of these infections in men who have sex with men and transgender women taking HIV pre-exposure prophylaxis (the Gonoscreen study): results from a randomised, multicentre, controlled trial. The Lancet HIV **2024**; 11:e233–e244. Available at: https://www.sciencedirect.com/science/article/pii/S2352301823002990.

18. Williams E, Williamson DA, Hocking JS. Frequent screening for asymptomatic chlamydia and gonorrhoea infections in men who have sex with men: time to re-evaluate? The Lancet Infectious Diseases **2023**; 23:e558–e566. Available at: https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(23)00356-0/abstract.

19. Ridpath AD, Chesson H, Marcus JL, et al. Screening Peter to Save Paul: The Population-Level Effects of Screening Men Who Have Sex With Men for Gonorrhea and Chlamydia. Sexually Transmitted Diseases **2018**; 45:623. Available at: https://journals.lww.com/stdjournal/citation/2018/09000/screening_peter_to_save_paul__the_population_level.8.aspx.

20. Kasaie P, Schumacher CM, Jennings JM, et al. Gonorrhoea and chlamydia diagnosis as an entry point for HIV pre-exposure prophylaxis: a modelling study. BMJ Open **2019**; 9:e023453. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6429744/.

21. Volk JE, Marcus JL, Phengrasamy T, et al. No New HIV Infections With Increasing Use of HIV Preexposure Prophylaxis in a Clinical Practice Setting. Clin Infect Dis **2015**; 61:1601–1603.

22. Hoornenborg E, Coyer L, Achterbergh RCA, et al. Sexual behaviour and incidence of HIV and sexually transmitted infections among men who have sex with men using daily and event-driven pre-exposure prophylaxis in AMPrEP: 2 year results from a demonstration study. The Lancet HIV **2019**; 6:e447–e455. Available at: https://www.sciencedirect.com/science/article/pii/S2352301819301365.

23. Adamson PC, Hieu VN, Nhung PH, Whiley DM, Chau TM. Ceftriaxone resistance in Neisseria gonorrhoeae associated with the penA-60.001 allele in Hanoi, Viet Nam. The Lancet Infectious Diseases **2024**; 0. Available at: https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(24)00230-5/fulltext.