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Integration of GeneXpert CT/NG and OSOM Trichomonas testing into STI management in an adolescent clinic in Harare, Zimbabwe: a cross-sectional study

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ABSTRACT

Objective To assess whether integrating aetiological sexually transmitted infection (STI) testing into routine adolescent care improves diagnostic and clinical performance compared with syndromic management alone in Harare, Zimbabwe.

Design Cross-sectional study.

Setting Mbare Adolescent clinic.

Participants 402 sexually active adolescents aged 16–19 years were consecutively enrolled (September 2023–June 2024).

Methods Standardised assessment included history, examination and routine HIV/syphilis screening. Vaginal/endocervical swabs (females) and urine (males) were tested for *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (NG) and *Trichomonas vaginalis* (TV) using GeneXpert CT/NG and OSOM Trichomonas rapid testing. Syndromic treatment followed national guidelines. We assessed laboratory results among participants receiving syndromic treatment and infections detected through aetiological screening among those not receiving syndromic treatment, stratified by pathogen and sex.

Results Among participants (median age 18 years; 49.8% female), 153/402 (38%) had an STI-related syndrome. Syndromic management led to treatment targeting CT in 182/402 (45%), NG in 176/402 (44%) and TV in 83/402 (21%) participants. Aetiological testing detected CT in 80/402 participants (20%)—65/200 (33%) females and 15/202 (7%) males—and NG in 73/402 (18%)—44/200 (22%) females and 29/202 (14%) males; TV was detected in 35/200 (18%) females and 1/202 (1%) males.
Among participants receiving syndromic treatment, 44/106 (42%) females and 12/42 (29%) males tested negative for all pathogens assessed. Pathogen-specific negative results among treated females were observed for CT in 73/104 (70%), NG in 70/101 (69%) and TV in 56/77 (73%); among treated males, the corresponding proportions were 31/42 (74%) for CT and 14/42 (33%) for NG.
Among participants not receiving syndromic treatment, CT was detected in 28/79 (35%), NG in 8/79 (10%) and TV in 3/84 (4%) females, and CT in 4/134 (3%) and NG in 1/137 (1%) males.

Conclusions STIs were frequently detected among adolescents attending primary care, including among those without symptoms. Among symptomatic participants receiving syndromic treatment, aetiological testing identified discordance between treatment and laboratory findings while screening identified infections among participants not receiving syndromic treatment. Integrating aetiological testing into adolescent services could complement syndromic management by supporting more targeted treatment and detection of asymptomatic infections.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study was conducted within routine adolescent clinical services, enabling evaluation of diagnostic approaches under real-world implementation conditions.
⇒ Consecutive enrolment of sexually active adolescents aged 16–19 years reduced the potential for selective recruitment among eligible clinic attendees.
⇒ All participants underwent aetiological testing, enabling direct comparison of syndromic management with laboratory-confirmed *Chlamydia trachomatis*, *Neisseria gonorrhoeae* and *Trichomonas vaginalis* infections.
⇒ Recruitment from a single adolescent clinic and incomplete documentation of refusals limit generalisability and assessment of potential participation bias.
⇒ Testing was limited to urogenital specimens and selected pathogens, and retrospective processing of some specimens may have reduced NG culture recovery.

INTRODUCTION

Sexually transmitted infections (STIs) represent a significant public health issue worldwide, with adolescents being a particularly vulnerable group due to a range of

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physiological, behavioural risk and structural barriers to accessing care. Globally, adolescents are disproportionately affected by STIs and often face barriers to accessing appropriate screening and treatment.[1] Untreated STIs can lead to serious health complications including and not limited to, reproductive health issues, increased risk of Human Immunodeficiency Virus (HIV) acquisition, and other long-term health consequences, particularly in low- and middle-income countries (LMICs) where access to healthcare remains limited.[2 3]

Sub-Saharan Africa has the highest global health burden of STIs, with adolescents and women of reproductive age at the highest risk.[4] Data from 2020 showed prevalence of the different infections ranging 1.5%–7.6%, always higher among women and higher among people living with HIV (PLHIV). Geographic variation was also important, with eastern and southern Africa presenting the highest burden. Limited sexual health education, stigma, cultural taboos and restricted access to healthcare services, including adolescent-friendly models of care, further restrict adolescents from seeking STI testing and treatment.[1]

Zimbabwe reflects these broader regional trends. A door-to-door population-based prevalence survey conducted between 2020 and 2022 across 16 communities found that one in five young people tested positive for at least one of three curable STIs: *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (NG) and *Trichomonas vaginalis* (TV).[5] National data similarly show that HIV incidence is significantly higher among adolescent girls and young women, particularly those aged 15–24.[6]

Despite the high burden, STI diagnosis in Zimbabwe, as in many LMICs, relies predominantly on syndromic management, largely because affordable, rapid and decentralisable diagnostic tests remain limited, particularly in primary care settings. National guidelines are aligned with WHO recommendations based on symptom-based treatment without laboratory testing.[7–9] However, syndromic management fails to detect many infections, as over 70% of curable STIs are asymptomatic. Indeed, an estimated 75% of CT infections, 40% of NG infections and 72% of TV infections are asymptomatic.[10 11] Consequently, many infections remain untreated, while others are unnecessarily exposed to broad-spectrum antibiotics.

The rising concern of antibiotic resistance, particularly in NG further complicates STI management. Limited understanding of local antimicrobial susceptibility patterns and circulating genotypic profiles constrains evidence-based treatment decisions and appropriate adaptation of national guidelines.[12]

To explore options for improving STI diagnosis, this implementation study was conducted among adolescents attending a youth-friendly clinic in Mbare, a high-density and socioeconomically vulnerable suburb of Harare, Zimbabwe. The primary objective was to evaluate the diagnostic and clinical value of integrating aetiological testing, using the GeneXpert CT/NG assay and the OSOM Trichomonas rapid test into routine care, compared with syndromic management alone. Secondary objectives included evaluating the diagnostic accuracy of the OSOM Trichomonas test using the GeneXpert TV assay as the reference standard and characterising the antibiotic resistance profiles of NG isolates identified during the study.

METHODS

Study setting and design

This cross-sectional study was conducted at the adolescent clinic of Mbare polyclinic, in Harare, Zimbabwe. Mbare is one of the most densely populated suburbs of the city, with an estimated 74 000 residents.[13] Since 2015, the adolescent clinic has been supported by Médecins Sans Frontières (MSF) in collaboration with the Ministry of Health and Child Care (MoHCC).

The adolescent clinic provides free, adolescent-friendly and peer-led services to young people aged 10–19 years. Comprehensive services include sexual and reproductive health, general outpatient consultations, tuberculosis screening, STI management, on-site laboratory testing, counselling and psychosocial support. The clinic also adapts services to improve accessibility for adolescents with disabilities and those with substance use disorders. In addition to facility-based care, trained adolescent peer educators conduct community outreach activities focused on sensitisation and health promotion.

Study population

The study population included adolescents aged 16–19 years who attended the study site for any reason between September 2023 and June 2024 and met the inclusion criteria of having been sexually active in the past 12 months. Adolescents attended the facility for a broad range of services, including general outpatient care, HIV testing and treatment, STI screening and management, contraception services, antenatal care, health education and mental health and psychosocial support. Information about the study was also disseminated through routine community outreach activities led by peer educators, including health education sessions and promotion of available sexual and reproductive health services. Recruitment was therefore not restricted to adolescents seeking STI-related care. Eligible female participants who were menstruating at enrolment were asked to return after menstruation for specimen collection. Participants ≥18 years provided written informed consent and participants <18 years written informed parental consent and child assent. Participants were enrolled consecutively until the target sample size of 402 was reached. No financial or material incentives were offered for participation in the study.

Study procedures

Community sensitisation was conducted by trained peer educators to encourage adolescents to attend the clinic. Participants who provided informed consent underwent a standardised clinical assessment, completed a structured

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questionnaire on sociodemographic characteristics and sexual behaviour, and received a physical examination.

Sexual behaviour was assessed using the Five Ps sexual risk assessment tool, which collects information on five domains: Partners, Practices, Protection from STIs, Past history of STIs and Prevention of pregnancy. This standardised questionnaire facilitates consistent and comprehensive assessment of sexual risk behaviours among adolescents and adults in clinical settings.[14]

HIV testing was offered as part of routine service delivery to all participants who were not previously known to be living with HIV, in accordance with the national HIV testing algorithms.[15] Screening was conducted using Determine HIV1/2 (Abbott Diagnostics, Abbott Park, Illinois, USA) and SD Bioline HIV1/2 (Abbott Diagnostics Korea, Yonginsi, South Korea) rapid diagnostic tests. Participants who preferred self-testing were offered supervised oral self-HIV test using the Oraquick HIV self-test (OraSure Technologies, Bethlehem, Pennsylvania, USA).

The SD Bioline Syphilis rapid test (Abbott Diagnostics Korea, Yonginsi, South Korea) was used for screening. Participants with a reactive result underwent clinical assessment, treatment history review and blood samples were collected for Rapid Plasma Reagin testing to help distinguish active or recent infection from previously treated infection

Participants testing positive for HIV or syphilis were treated according to the MoHCC Guidelines[15] which are in line with international recommendations (WHO).[16]

Syndromic assessment and management

All participants underwent a standardised clinical assessment performed by trained study nurses, irrespective of symptom status. STI-related symptoms and clinical signs were documented through self-report and clinical examination, including genital itchiness, dysuria, genital discharge, lower abdominal pain (LAP), genital ulcers or vesicles and other genital symptoms. Female participants also underwent speculum examination, with vaginal discharge classified as curd-like, thin and adherent, yellowish/purulent or absent.

Vaginal discharge syndrome was defined as clinically observed vaginal discharge. Women with curd-like discharge and/or vulval erythema were managed as vulvovaginal candidiasis. Women with thin/adherent or purulent discharge, cervicitis or a positive sexual risk assessment received syndromic treatment for CT, NG and/or TV.

Male urethral discharge syndrome was defined as clinically observed urethral discharge and was treated for CT and NG.

LAP syndrome was defined by participant-reported LAP supported by clinical assessment. Women with warning signs suggestive of alternative or urgent diagnoses (eg, delayed menses, recent pregnancy loss, abnormal bleeding, fever, abdominal mass, guarding or rebound tenderness) were referred for urgent evaluation. Women with LAP and abdominal tenderness, vaginal discharge, adnexal swelling or tenderness or cervical excitation tenderness were managed syndromically for pelvic inflammatory disease (PID). Pregnancy testing and additional investigations were performed when clinically indicated.

Genital ulcers and genital vesicles were assessed and managed according to national guidelines.

At the end of the initial consultation, nurses assigned syndromic diagnosis and prescribed treatment according to the Zimbabwe National STI Management Guidelines,[7] adapted from WHO syndromic management recommendations.[8] Decisions incorporated medical history, sexual risk assessment, clinical findings and results of rapid tests (HIV, syphilis and OSOM TV).

Recommended treatment included azithromycin 1 g orally single dose or doxycycline 100 mg orally two times per day for 7 days (CT); cefixime 400 mg orally single dose or ceftriaxone 250 mg intramuscularly single dose (NG); and metronidazole 400 mg orally two times per day for 7 days or tinidazole 2 g orally single dose (TV). Women managed syndromically for PID received ceftriaxone 250 mg intramuscularly single dose plus doxycycline and metronidazole for 14 days. Participants presenting with STI-related symptoms received partner notification cards to encourage testing and treatment.

Study-specific STI testing

Laboratory testing was integrated into routine clinical services and did not replace syndromic management at the initial consultation.

Flocked-tip Amies agar charcoal vaginal or endocervical swabs were collected from female participants, and urine samples from male participants. Additional urethral swabs were collected from males with visible urethral discharge and underwent the same microbiological analyses as urine samples. Samples were transported to designated laboratories for testing.

Testing included:

GeneXpert CT/NG and TV assays

Laboratory testing was performed at the laboratory in the Mbare clinic and at Beatrice Road Infectious Disease Hospital (BRIDH) using the GeneXpert CT/NG and GeneXpert TV assays (Cepheid, Sunnyvale, California, USA), in accordance with the manufacturer's instructions. The assays use automated real-time PCR technology for detection of pathogen DNA. The assay analytical run time is approximately 90 min and was recorded for both clinical management and study purposes. GeneXpert TV testing was performed retrospectively to assess OSOM diagnostic accuracy.

OSOM Trichomonas rapid test

TV testing was performed using the OSOM Trichomonas rapid test (Sekisui Diagnostics, USA). Testing was performed by trained nurses or laboratory personnel, in clinic consultation rooms, in accordance with the manufacturer's instructions. For male participants, urine specimens were used following the study protocol, although

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urine is not a specimen type recommended by the manufacturer for this assay. Test results were documented on study-specific forms.

Culture and antimicrobial susceptibility testing

Swab samples NG positive by GeneXpert were transported to the National Reference Laboratory. Cold-chain (2°C–8°C) transport with monitored temperature was arranged two times per day (11:00 and 14:30) to minimise delays in processing. On reception, samples were registered, and sample inoculation was done immediately on in-house prepared gonococcal (GC) agar plates with added haemoglobin and 1% IsoVitaleX enrichment. Agar plates were incubated for up to 48 hours in 5% CO2 humid atmosphere at 36°C±1°C. Bacterial colonies with a presumptive identification of NG (ie, Gram-negative, oxidase-positive diplococci) were further processed for final species identification with the API-NH system (bioMérieux, Marcy-l'Étoile, France). Antimicrobial susceptibility testing was performed using E-tests (bioMérieux, Marcy-l'Étoile, France) for ceftriaxone, cefixime, azithromycin, ciprofloxacin and kanamycin. Screening for penicillin resistance was done with cefinase paper discs (Becton and Dickinson Company, Sparks, USA). Results were interpreted according to Clinical and Laboratory Standards Institute(CLSI), 2023 guidelines,[17] except for kanamycin, for which WHO interpretative criteria were applied.[18] MIC values were reported in doubling-dilution units according to the WHO EGASP General Protocol (2021),[19] and quality control was ensured using *N. gonorrhoeae* ATCC 49226.

Due to delays in reagent availability, testing occurred in two phases: (1) retrospective testing of samples stored at −80°C and (2) prospective testing once supplies became available.

Follow-up of participants

Laboratory results from GeneXpert CT/NG, GeneXpert TV and NG antimicrobial resistance profiles were sent to Mbare Adolescent clinic both electronically and as hard-copy formats. Clinic nurses reviewed all results and contacted participants by telephone to communicate their test outcomes, with up to three phone call attempts made per participant, depending on the timing and completeness of available results.

Participants with laboratory-confirmed STI results were invited for an in-person follow-up consultation if initial syndromic management was incomplete or discordant with laboratory findings; participants who had already received adequate empiric treatment were informed of the results and the adequacy of treatment.

A final follow-up was conducted 14 days post-treatment to assess symptom resolution and confirm treatment completion. Participants unreachable by phone were followed up through home visits conducted by peer educators to ensure continuity of care.

Data collection and management

Data were collected using standardised case report forms, including demographic information, sexual behaviour risk, examination findings, syndromic diagnoses, treatment provided and partner notification intentions. Symptoms and signs were systematically recorded, with additional details captured in free text where applicable. Nurses selected the syndromic diagnosis based on reported symptoms and clinical examination findings, in accordance with syndromic management guidelines.

Treatment was categorised by pathogen targeted (CT, NG and TV) according to medications administered during the initial visit.

Data entry was performed into a study-specific database using Research Electronic Data Capture (REDCap) by a trained data encoder.[20] No directly personal identifying information was captured (name, phone number, etc) in the database.

Study outcomes and data analysis

The study's primary outcomes were as follows: (1) Overtreatment, defined as treatment provided based on syndromic management in participants who had aetiological testing negative and (2) Undertreatment, defined as participants with aetiologically confirmed infection who did not receive treatment under the syndromic approach or received wrong treatment according to microbiological testing.

Outcomes were estimated using the diagnostic yield of the GeneXpert CT/NG and OSOM Trichomonas rapid testing, stratified by sex assigned at birth (female and male) and by clinical syndromic category.

For the purpose of this study, participants' clinical presentations were categorised into two mutually exclusive groups:

a. STI-related discharge syndromes: defined as vaginal discharge, urethral discharge and/or females LAP managed syndromically for CT, NG and/or TV according to national guidelines, excluding alternative diagnoses managed under a separate clinical pathway (eg, vulvovaginal candidiasis).
b. No STI-related discharge syndrome: For prevalence analyses, this group was further divided into asymptomatic participants and those presenting with a non-discharge STI-related syndrome or non-STI syndrome.

Baseline demographic and clinical characteristics—including STI history, current symptoms and syndromes, treatment received, and results from both rapid and molecular diagnostic tests—were summarised and stratified by sex assigned at birth. Given the role of HIV infection as a risk factor for STI acquisition, selected analyses also present outcomes specifically for PLHIV.

Coinfection patterns were described to capture the burden of multiple concurrent STIs considering combinations of infections detected through aetiological testing and were stratified by sex and HIV status where relevant.

Diagnostic accuracy of the OSOM Trichomonas test was assessed using the GeneXpert TV assay as the reference

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standard. Sensitivity, specificity, positive predictive value and negative predictive value were calculated and are reported with corresponding 95% CIs.

Antimicrobial susceptibility of NG isolates obtained from positive cultures was summarised using frequencies and proportions for each antibiotic tested.

Partner notification and follow-up outcomes were assessed by documenting participants' willingness to notify partners, partner presentations for care, successful participant contact for aetiological test results and return for follow-up treatment among those requiring therapy.

Continuous variables were described using means and SD for normally distributed data, and medians with IQRs for non-normally distributed data. Categorical variables were summarised using frequencies and proportions. Missing data were minimal and were coded as 'unknown' for descriptive analyses.

All analyses were conducted using Stata V.15.1 (StataCorp).

Sample size

Sample size calculation was based on estimated regional STIs prevalence.[21] Assuming a precision of 3% for CT in both males and females, 2% for NG in both sexes, 2% for TV in males and 5% in females, a null hypothesis prevalence of 2.5%, a type I error probability (α) of 0.05 and a statistical power (1–β) of 0.90, the required sample size was estimated at 200 males and 200 females.

Patient and public involvement

There was no patient or public involvement in study design or conduct.

RESULTS

Participants' characteristics

Between 11 September 2023 and 4 June 2024, 963 adolescents were screened at Mbare Adolescent clinic. Of these, 402 participants were enrolled and underwent testing with GeneXpert CT/NG and OSOM Trichomonas test and were included in the analyses (figure 1).

Among the 402 adolescents, (median age 18 years; IQR 17–19), 200 were female (49.8%) and 202 (50.2%) were male, based on sex assigned at birth. Gender identity matched sex assigned at birth for nearly all participants, with only two identifying as 'other'. Sociodemographic characteristics are summarised in table 1.

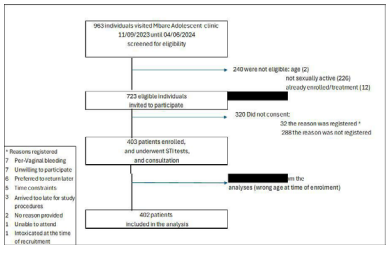

Figure 1 Study flow chart. Flow chart of participant screening, enrolment and inclusion in the analysis. STI, sexually transmitted infection.

Risk assessment using the Five Ps tool indicated predominantly heterosexual activity, with 30% reporting ≥2 partners in the past 2 months and 61% in the past year. One-third of female participants were pregnant (table 1).

Approximately 14% of participants (55/402) reported ever having had an STI, most commonly characterised by vaginal or urethral discharge, and half of these individuals had received treatment. A total of 27 participants (7%) were PLHIV, including 18 with a previously known diagnosis; among these, 17 reported current antiretroviral therapy, 9 having a viral load measurement and 8 of those an undetectable viral load. Additionally, nine participants (2.2%) had a reactive treponemal rapid test and no prior history of treatment.

Male condoms were the most used contraceptive method (184 participants, 46%); however, 39 females (20%) and 20 males (10%) reported not using any form of contraception. Regarding STI prevention, 98 females (49%) and 16 males (8%) reported taking no preventive measures. Condom use for STI prevention was inconsistent: 95 participants (79 females and 16 males) reported never using condoms while an additional group of 238 participants (101 females and 137 males) reported occasional use. Altogether, 125 participants (37.3%) provided reasons for non-consistent or inconsistent use, including lack of awareness of condom effectiveness during oral sex, personal preference, trust in their partner and partner refusal (online supplemental table 1).

A total of 201 participants (50%) reported symptoms, among PLHIV 13 of 22 females (59%) and 4 of 5 males (80%) reported symptoms (figure 2). Genital discharge was the most frequently reported symptom (131/201, 65.2%), followed by itchiness (88/201, 43.8%), dysuria or urinary changes (85/201, 42.3%), and LAP (38.3%); genital ulcers and warts were uncommon. Among symptomatic females (n=128), genital discharge predominated (78.3%), followed by itchiness (50.8%) and LAP (48.4%), whereas among symptomatic males (n=73), dysuria or urinary changes were most common (54.8%).

Agreement between aetiological testing and syndromic management

Syndromic management and treatment received

Of the 201 participants reporting symptoms, 183 (91.0%) were classified as having an STI syndrome following clinical assessment, whereas 18 (9.0%) were diagnosed with non-STI conditions (eg, urinary tract infections). Among those with an STI syndrome, 153 met the study definition of an STI-related discharge syndrome, comprising 110 females (100 with vaginal discharge and 8 with LAP) and 43 males. The remaining 30 participants presented with other STI syndromes, including genital ulcers or vesicular lesions or vulvovaginal candidiasis). Among PLHIV (n=27), 18 (66.6%) were diagnosed with an STI discharge syndrome (table 2).

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Table 1 Baseline participant characteristics by sex (N=402): demographic, sexual behaviour and health status for sexually transmitted infection risk

	Female (200)		Male (202)		Total	
	No.	%	No.	%	No.	%
Highest educational level						
Primary or incomplete secondary	118	59.0	100	49.5	218	54.2
Complete secondary or higher	82	41.0	102	50.5	184	45.8
Marital status						
Married/union	37	18.5	3	1.5	40	10.0
Single/divorced/separated	163	81.5	199	98.5	362	90.0
Main occupation (394)						
Unemployed	110	56.4	63	31.7	173	43.9
Student	24	12.3	46	23.1	70	17.8
Employed*	61	30.8	28	14.1	47	11.9
Sexual history						
Different sex partner (397)	182	92.0	198	99.5	380	95.7
≥2 partners in last 2 months	31	15.5	87	43.1	118	29.4
≥2 partners in last 12 months	87	43.0	156	77.2	243	60.9
Pregnant (self-reported by females)	66	33.0				
STI and HIV prevention method used						
None	98	49.0	16	7.9	114	28.4
Male condoms	96	48.0	185	91.6	281	69.9
HIV PrEP	4	2.0	2	1.0	6	1.5
Sexual behaviour (STI risk in last 12 months)						
Vaginal sex	200	100.0	200	99.0	400	99.5
Anal sex	4	2.0	6	3.0	10	2.5
Oral sex	20	10.0	18	8.9	38	9.5
No condom use during any type of sexual activity	18	100.0	12	100.0	30	100.0
STI history						
Previous STI (ever had)	34	17.0	21	10.4	55	13.7
Previous STI treatment (55)	17	50.0	6	28.6	23	41.8
HIV status						
HIV negative	178	89.0	197	97.5	375	93.3
PLHIV previously diagnosed †	14	7.0	4	2.0	18	5.0
PLHIV newly diagnosed	8	4.0	1	0.5	9	2.2
Current syphilis rapid test results						
Negative	191	95.5	201	99.0	392	97.5
Positive, no previous treatment	8	4.0	1	0.5	9	2.2
Positive, after previous treatment	1	0.5	0	0.0	1	0.3

Values are n (%) unless otherwise indicated. Percentages are based on N=402 overall (200 females and 202 males), except where a different denominator is indicated in brackets because of missing data or restriction to a subgroup.
*including vendor, general worker, self-employed, service worker, sportsmen and sex worker (8).
†All previously diagnosed PLHIV self-reported being on antiretroviral treatment.
PLHIV, people living with HIV; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infection.

Treatment regimens targeting CT were prescribed to 182 participants (45.3% of the total cohort), including 115 females (57.5% of all females) and 67 males (33.2% of all males). Regimens targeting NG were given to 176 participants (43.8%), comprising 112 females (56.0%) and 64 males (31.7%). Treatment targeting TV was administered to 83 participants (20.7%), almost exclusively among females (83; 41.5%), with no males receiving

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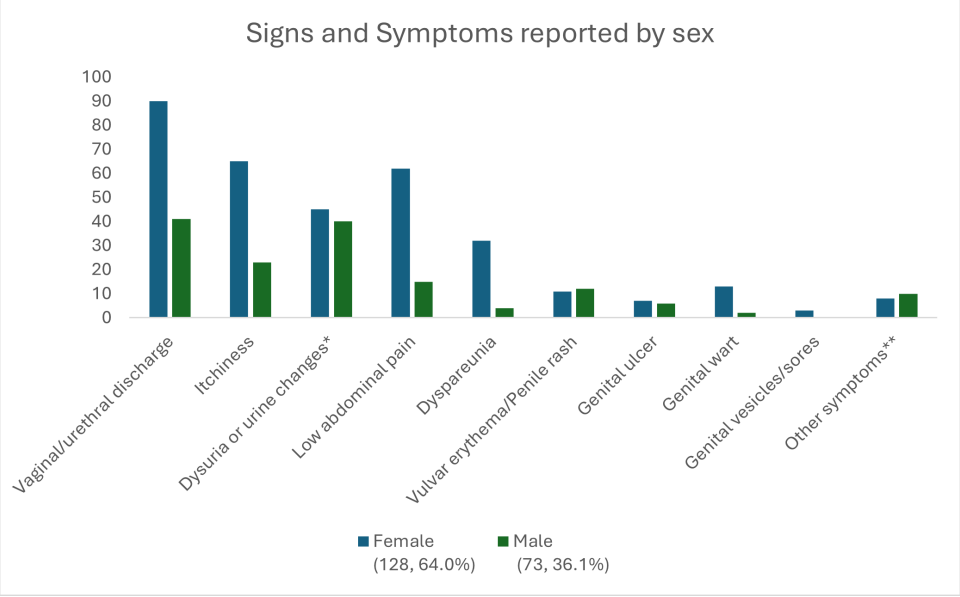

Figure 2 Distribution of reported symptoms and genital signs by sex. Numbers of reported symptoms and genital signs among the 201 symptomatic participants, by sex. Female, n=128; male, n=73. *Urine changes included changes in urine colour, odour or frequency. **Other symptoms included side pain, backache, bruising, painful swollen testicle, penile swelling, perianal pain and a swollen penile vein.

TV-targeted therapy. More details are provided in online supplemental table 2.

Discrepancies were observed between documented syndromic classifications and treatment received. Four women with a documented syndrome did not receive syndromic treatment, whereas 13 asymptomatic women received treatment for at least one targeted infection. In a small number of participants, treatment covered CT or NG only despite guideline recommendations for combined CT/NG treatment. No documented clinical rationale was available for these discrepancies.

The clinical classification, specimen collection, initial treatment, study laboratory testing and follow-up pathway is summarised in figure 3.

Microbiological diagnosis results

Samples were collected from all participants. Among females (n=200), 146 (73.0%) provided vaginal swabs and 50 (25.0%) provided endocervical swabs, and sample type was not reported for 4 (2.0%). All male participants submitted urine samples, and 31 (15.3%) additionally provided urethral swabs.

Using the GeneXpert CT/NG assay, CT was detected in 80 participants (19.9% of the total cohort), comprising 65 females (32.5%) and 15 males (7.4%). Among the 27 PLHIV, 10 (37.0%) tested positive for CT (table 2).

NG was identified in 73 participants (18.2%), including 44 females (22.1%) and 29 males (14.4%). NG was detected in 10 PLHIV (37.0%).

TV assessed using the OSOM rapid test was detected in 35 females (17.5%), of whom seven (25.9%) were PLHIV. Among males, one OSOM-positive result was recorded, but not confirmed by GeneXpert; however, two male participants tested positive for TV by GeneXpert.

CT/NG coinfection was observed in 21 females (10.5%) and 10 males (5%). Concurrent infection with CT or NG among OSOM-positive participants was documented in 21 of 36 OSOM-positive cases (58.3%). Overall, 20 females (10.0%) and one male (0.5%) had an OSOM-positive result with concurrent CT or NG positivity. Among these, 16 females were also TV-positive by GeneXpert.

Overtreatment and undertreatment

Overtreatment and undertreatment were evaluated by comparing syndromic management against aetiological testing results.

Among 110 symptomatic females, 106 (96%) received treatment, typically covering CT, NG and often TV as part of triple therapy. Of those treated females (n=106), 44 (42%) tested negative for all infections. By pathogen, 30% (31/104) were CT-positive, 31% (31/101) were NG-positive and 27% (21/77) were TV-positive. Among asymptomatic untreated females, 35% (28/79) tested positive for CT, 10% (8/79) for NG and 4% (3/84) for TV (table 3).

Among 43 symptomatic males, 42 (98%) received treatment. Of them, 29% tested negative for all infections; 26% (11/42) were CT-positive and 67% (28/42) NG-positive. Among asymptomatic untreated males, 3% (4/134) and 1% (1/137) had positive tests for CT and NG, respectively (table 3).

Pathogen-specific overtreatment ranged from 56% to 84% among treated participants, while undertreatment

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Table 2 Prevalence of *Chlamydia trachomatis, Neisseria gonorrhoeae* and *Trichomonas vaginalis* among participants stratified by sex, syndrome assessment and HIV status

				***Chlamydia trachomatis* infection**						***Neisseria gonorrhoeae* infection**						***Trichomonas vaginalis***					
				Female		**Male**		**Total**		**Female**		**Male**		**Total**		**Female**		**Male**		**Total**	
	N	**Females**	**Males**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
All participants	402	200	202	65	32.5	15	7.4	**80**	**19.9**	44	22.1	29	14.4	**73**	**18.2**	35	17.5	1	0.5	**36**	**9.0**
Syndrome assessment																					
Asymptomatic	201	72	129	24	33.3	4	3.1	**28**	**13.9**	6	8.3	1	0.8	**7**	**3.4**	6	8.3	0	0.0	**6**	**3.0**
Non-discharge STI-related syndrome	48	18	30	8	42.1	0	0.0	**8**	**16.7**	4	21.1	0	0.0	**4**	**8.2**	3	10.3	0	0.0	**3**	**6.3**
STI-related discharge syndrome	153	110	43	33	30.0	11	25.6	**44**	**28.8**	34	30.9	28	65.1	**62**	**40.5**	26	23.6	1	2.3	**27**	**17.6**
HIV status																					
HIV negative	375	178	197	55	30.9	15	7.6	**70**	**18.7**	37	20.8	26	13.2	**63**	**16.8**	28	15.7	1	0.5	**29**	**7.7**
PLHIV (previously diagnosed)	18	14	4	6	42.9	0	0.0	**6**	**33.3**	3	21.4	2	50.0	**5**	**27.8**	2	14.3	0	0.0	**2**	**11.1**
PLHIV (newly diagnosed)	9	8	1	4	50.0	0	0.0	**4**	**44.4**	4	50.0	1	100	**5**	**55.6**	5	62.5	0	0.0	**5**	**55.6**

N denotes the total number of participants in each subgroup; **n** denotes the number of participants with a positive test result. Percentages were calculated using the total number of participants in each stratum as the denominator. HIV status was classified as HIV-negative, PLHIV previously diagnosed before study enrolment, or PLHIV newly diagnosed during the study. Asymptomatic refers to participants reporting no STI-related symptoms at presentation. STI-related discharge syndrome was defined as vaginal discharge, urethral discharge and/or lower abdominal pain LAP in females managed syndromically for *Chlamydia trachomatis*, *Neisseria gonorrhoeae* and/or *Trichomonas vaginalis* according to national guidelines, excluding alternative diagnoses managed under separate clinical pathways (e.g. vulvovaginal candidiasis). Non-discharge STI-related syndrome refers to STI-related presentations not meeting the definition of an STI-related discharge syndrome. STI diagnoses were based on laboratory test results. *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infections were detected using the Xpert CT/NG assay (Cepheid, Sunnyvale, CA, USA), and *Trichomonas vaginalis* infection was detected using the OSOM Trichomonas Rapid Test (Sekisui Diagnostics, Lexington, MA, USA). Percentages may not total 100% because infections were not mutually exclusive. The bold indicates the total column (female and male together).
PLHIV, people living with HIV; STI, sexually transmitted infection.

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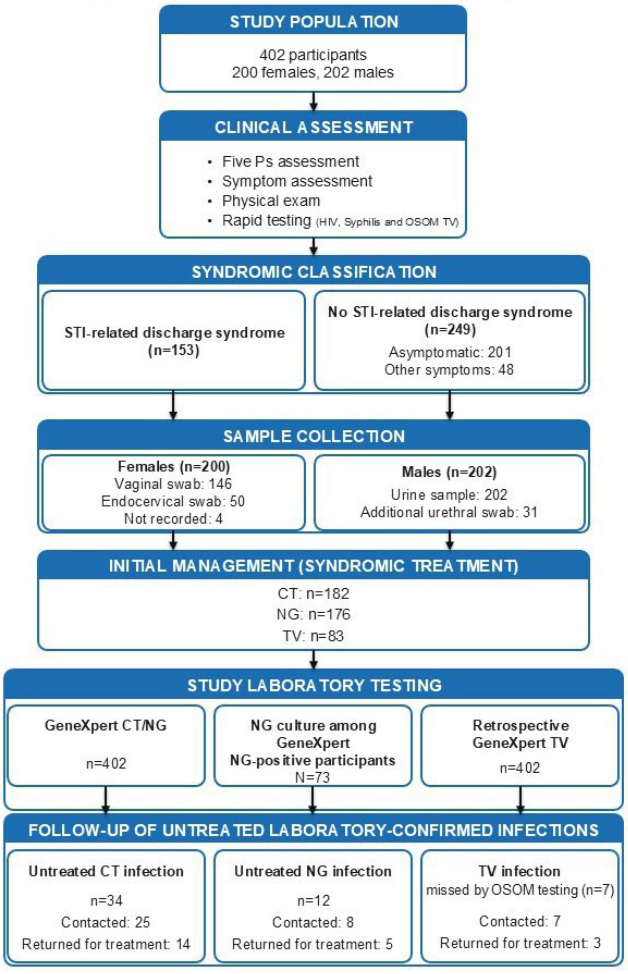

Figure 3 Study procedures, laboratory testing and participant follow-up. Flow diagram showing clinical assessment and syndromic classification, specimen collection, initial syndromic treatment, study laboratory testing with GeneXpert CT/NG, NG culture and GeneXpert TV, and follow-up of participants with untreated laboratory-confirmed infections. CT, *Chlamydia trachomatis*; NG, *Neisseria gonorrhoeae*; STI, sexually transmitted infection; TV, *Trichomonas vaginalis*; OSOM TV, OSOM Trichomonas Rapid Test.

ranged from 1% to 35% among untreated participants, with estimates by sex and pathogen shown in table 4.

Diagnostic accuracy of OSOM trichomonas test

Among the 200 females tested, OSOM correctly identified 29 true positives and 154 true negatives, with 6 false positives and 11 false negatives, yielding a sensitivity of 73% and a specificity 96% (table 5). Among males, OSOM produced a single positive result which was not confirmed by GeneXpert.

Antibiotic resistance in NG

Of the 73 (18.2%) participants with a GeneXpert NG-positive result, 29 (39.7%) were culture-confirmed (table 6). Antimicrobial susceptibility testing was performed on all 29 isolates according to CLSI/WHO criteria, except for ciprofloxacin, for which 26 isolates were tested. All isolates were susceptible to ceftriaxone (MIC: 0.002–0.016 µg/mL), cefixime (MIC: 0.016–0.064 µg/mL) and kanamycin (MIC: 0.016–12µg/mL), while 2/29 (6.9%) were resistant to azithromycin (MIC=256 µg/mL). Among the 26 isolates tested for ciprofloxacin, 17 (65.4%) were resistant and 7 (26.9%) showed intermediate susceptibility. Overall, 24/26 (92.3%) isolates were classified as either resistant or intermediate to ciprofloxacin according to CLSI interpretive criteria.

Feasibility and operational performance of laboratory testing

GeneXpert CT/NG testing was performed for all 402 participants, with 271 (67.4%) tests conducted at the Mbare laboratory and 131 (32.6%) at BRIDH. Results were available at the clinic on the same day for 209 participants (52.0%). Of the remaining 193, 164 (85.0%) received results the following day.

OSOM TV testing was performed for all participants at the adolescent clinic, with a mean reading time of 11 min (SD±8).

Implementation of NG culture and antimicrobial susceptibility testing at the NMRL was affected by intermittent shortages of reagents and consumables. Samples collected from 11 September to 31 October 2023 were processed retrospectively, with subsequent samples processed prospectively. During prospective testing, antimicrobial susceptibility results were available within 1 week of specimen collection.

GeneXpert TV testing was performed retrospectively at the Mbare and BRIDH from February to July 2024 to assess OSOM TV diagnostic accuracy.

Partner notification and follow-up

Regarding partner notification, no participant reported having been notified by a partner to attend the clinic. Follow-up and second-visit treatment outcomes varied by infection cause. Among the 34 participants with untreated CT infections, 25 were successfully contacted, 22 were invited to return for treatment and 14 ultimately received therapy. Among the 12 participants with NG untreated, 8 were contacted, 6 were invited to return and 5 returned and were treated. Of the 36 participants who tested positive for TV by OSOM, 26 received treatment at the initial visit; during follow-up, 10 were contacted, and one subsequently tested negative on GeneXpert. Among the 13 additional GeneXpert-positive not detected by OSOM, 6 were treated initially and 3 returned for follow-up treatment.

DISCUSSION

Summary of results and literature overview

This study found a substantial burden of curable STIs among adolescents attending a primary care clinic in Harare. CT, NG and TV were highly prevalent (20%, 18% and 9%, respectively), and a large proportion of

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Table 3 Pathogen-specific treatment, aetiological test results, overtreatment and undertreatment, by sex and STI-related discharge syndrome status

Syndrome status	Pathogen	Treatment status	Participants, n (%)	Pathogen positive, n (%)	Overtreatment	Undertreatment
Females						
STI-related discharge syndromes (n=110)	CT	Treated	104 (95)	31 (30)	73	NA
		Untreated	6 (5)	2 (33)	NA	2
	NG	Treated	101 (92)	31 (31)	70	NA
		Untreated	9 (8)	3 (33)	NA	3
	TV	Treated	77 (70)	21 (27)	56	NA
		Untreated	33 (30)	6 (18)	NA	6
No STI-related discharge syndrome (n=90)	CT	Treated	11 (12)	4 (36)	7	NA
		Untreated	79 (88)	28 (35)	NA	28
	NG	Treated	11 (12)	2 (18)	9	NA
		Untreated	79 (88)	8 (10)	NA	8
	TV	Treated	6 (7)	5 (83)	1	NA
		Untreated	84 (93)	3 (4)	NA	3
Males						
STI-related discharge syndrome (n=43)	CT	Treated	42 (98)	11 (26)	31	NA
		Untreated	1 (2)	0 (0)	NA	0
	NG	Treated	42 (98)	28 (67)	14	NA
		Untreated	1 (2)	0 (0)	NA	0
No STI-related discharge syndrome (n=159)	CT	Treated	25 (16)	0 (0)	25	NA
		Untreated	134 (84)	4 (3)	NA	4
	NG	Treated	22 (14)	0 (0)	22	NA
		Untreated	137 (86)	1 (1)	NA	1

Participants were categorised into two mutually exclusive groups: (a) STI-related discharge syndrome, defined as vaginal discharge, urethral discharge and/or female lower abdominal pain managed syndromically for CT, NG and/or TV, excluding conditions such as vulvovaginal candidiasis and (b) no STI-related discharge syndrome, including asymptomatic participants and those presenting with other non-discharge STI-related syndromes. For each pathogen, overtreatment was defined as receipt of pathogen-targeted treatment at the initial consultation in a participant with a negative reference test result. Undertreatment was defined as a positive reference test result without receipt of treatment targeting that pathogen at the initial consultation (GeneXpert CT/NG and/or OSOM TV, as applicable). 'Treated and tested positive' refers to participants who received treatment and had a positive aetiological test result for the corresponding infection; 'not treated and tested negative' refers to participants who did not receive treatment and had a negative aetiological test result. Percentages were calculated using the total number of participants in each treatment and diagnostic category for the corresponding STI and sex.
CT, *Chlamydia trachomatis*; NA, not available; NG, *Neisseria gonorrhoeae*; STI, sexually transmitted infection; TV, *Trichomonas vaginalis*.

infections, particularly among females, occurred in asymptomatic individuals. This discordance between infection and symptoms underscores why syndromic management alone is insufficient for effective clinical care in this setting.

Prevalence was higher than pooled regional estimates. A meta-analysis across 28 sub-Saharan Africa countries reported CT prevalences of 16.1% in females and 9.7% in males, NG prevalences of 3.9% and 3.0%, and TV prevalences of 6.3% and 0.9%, respectively.[4] The higher burden in our study likely reflects the characteristics of adolescents seeking care in this clinic, including multiple overlapping risk factors. These include low uptake of preventive measures, multiple sexual partnerships and high levels of adolescent pregnancy—factors consistently associated with increased STI risk in regional studies among young people in Zimbabwe and South Africa.[22–24]

The pattern of infection observed also reflects well-established epidemiology in adolescent populations. Detection among consistently higher among females, and TV was detected almost exclusively among females, consistent with its known epidemiology.[21]

Among symptomatic participants, positivity reached 30% for CT and 40% for NG, exceeding estimates from several other symptomatic cohorts globally.[25 26] Conversely, a study in Eritrea detected no CT or NG among women with vaginal discharge, highlighting the limited specificity of discharge alone as a proxy for bacterial STIs.[27]

STI prevalence was particularly high among PLHIV (37% for both CT and NG). These findings differ from the more moderate pooled prevalence among women living with HIV in the previously cited meta-analysis (15.6% for TV, 4.0% for CT and 3.5% for NG).[4] However, they are consistent with surveillance data from LMICs

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Table 4 Overtreatment and undertreatment of *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (NG) and *Trichomonas vaginalis* (TV) under syndromic management, by sex assigned at birth

		Treated at the initial consultation			Untreated at the initial consultation		
Sex	Pathogen	Test positive n (%)	Test negative n (%) Overtreatment	Total n	Test positive n (%) Undertreatment	Test negative n (%)	Total n
Females	CT	35 (30)	**80 (70)**	115	**30 (35)**	55 (65)	85
n=200	NG	33 (29)	**79 (71)**	112	**11 (13)**	77 (87)	88
	TV	26 (31)	**57 (69)**	83	**9 (8)**	108 (92)	117
Males	CT	11 (16)	**56 (84)**	67	**4 (3)**	131 (97)	135
n=202	NG	28 (44)	**36 (56)**	64	**1 (1)**	137 (99)	138

Overtreatment was defined as treatment for a given STI based on syndromic assessment in participants who subsequently tested negative by aetiological diagnosis (GeneXpert CT/NG and/or OSOM TV, as applicable). Undertreatment was defined as a positive aetiological test result for a given STI without receipt of treatment for that STI at the initial consultation. 'Treated and tested positive' refers to participants who received treatment and had a positive aetiological test result for the corresponding infection; 'not treated and tested negative' refers to participants who did not receive treatment and had a negative aetiological test result. Percentages were calculated using the total number of participants in each treatment and diagnostic category for the corresponding STI and sex.
STI, sexually transmitted infection.

showing that HIV–STI co-infection remains common and that PLHIV are disproportionately affected by STIs. This underscores the importance of integrating STI and HIV services.[22]

Behavioural and structural factors likely contribute to the high burden of infection observed. Inconsistent condom use and multiple partnerships have been repeatedly identified as key drivers of STI transmission among adolescents.[22–24] Population-based studies from Zimbabwe and South Africa further demonstrate clear associations between STI prevalence and early initiation of sexual activity, age-disparate relationships, unmet contraceptive need and unintended pregnancy.[22–24] Our finding of limited STI knowledge mirrors regional evidence that poor awareness of STI symptoms and available services remains a major barrier to prevention and timely care.[28] Evidence from Eswatini similarly suggests that behavioural risk factors interact with broader structural vulnerabilities, contributing to sustained STI transmission in high-prevalence settings.[29]

Performance and limitations of syndromic management

In this study, syndromic management led to substantial overtreatment, particularly among females, with approximately 70% of those treated for CT, NG or TV ultimately testing negative. Overtreatment was also frequent among males, especially for CT. These findings are consistent with extensive evidence demonstrating the limited diagnostic performance of syndromic algorithms, which are characterised by suboptimal sensitivity and specificity.[24]

Although syndromic management can perform reasonably in men presenting with urethral discharge syndrome, with reported sensitivities ranging from 65% to 80%, its performance is markedly weaker in women.[29] Vaginal discharge-based algorithms may have sensitivities as low as 20% reflecting the fact that discharge is frequently physiological or due to non-STI conditions.[27] The Eritrean study cited earlier had similar findings: only 25.7% of symptomatic individuals tested positive for a specific STI, underscoring substantial overtreatment.[27]

More than one-third of asymptomatic women had CT but did not receive treatment at initial consultation. Because most CT and NG cervical infections are asymptomatic,[30] syndromic strategies fail to detect many infections in young women, delaying treatment and allowing continued transmission. Undiagnosed infections may

Table 5 Diagnostic accuracy of the OSOM Trichomonas rapid test compared with GeneXpert TV as the reference standard for the detection of TV infection among female adolescents

		GeneXpert TV					
		Detected	Not detected	Total			
OSOM TV test	Detected	29	6	35	Sensitivity	73%	(66% to 79%)
		(73%)	(4%)		Specificity	96%	(94% to 99%)
	Not detected	11	154	165	Positive predictive value (PPV)	83%	(78% to 88%)
		(28%)	(96%)		Negative predictive value (NPV)	93%	(90% to 97%)
	Total	40	160	200			

Sensitivity, specificity, PPV and NPV are reported with 95% CIs.
TV, *Trichomonas vaginalis*.

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Table 6 Detection and antimicrobial susceptibility of *Neisseria gonorrhoeae* (NG) among adolescents attending the Mbare clinic, Zimbabwe

NG infection: culture results							
	N	Female		Male		Total	
		n	%	n	%	n	%
GeneXpert NG detected	402	44	22.1	29	14.4	**73**	**18.2**
NG detected by culture	73	11	25.0	18	62.1	**29**	**39.7**
Phase 1 (retrospective)	35	2		5		7	20.0
Phase 2 (prospective)	38	9		13		22	57.9
NG infection: antibiogram results							
Resistance	**N**	**R**	**%**	**I**	**%**	**S**	**%**
Ceftriaxone	29	0	0.0	0	0.0	29	100.0
Cefixime	29	0	0.0	0	0.0	29	100.0
Azithromycin	29	2	6.9	0	0.0	27	93.1
Ciprofloxacin	26	17	65.4	7	26.9	2	7.7
Kanamycin	29	0	0.0	0	0	29	100.0

GeneXpert NG detected refers to participants with a positive NG result by the GeneXpert CT/NG assay. NG detected by culture refers to NG isolates successfully recovered by culture from participants with a positive GeneXpert NG result. Culture yield is presented overall and stratified by laboratory processing phase: phase 1 (retrospective analysis of stored samples) and phase 2 (prospective analysis of samples). Antimicrobial susceptibility testing was performed on culture positive NG isolates. R, I and S were interpreted according to Clinical and Laboratory Standards Institute guidelines (M100), with WHO criteria applied for kanamycin. Percentages are calculated using the total number of isolates tested for each antibiotic. The bold indicates the overall total.
CG, *Chlamydia trachomatis*; I, intermediate; R, resistant; S, susceptible.

lead to serious complications, including PID, infertility, ectopic pregnancy and increased HIV transmission.[29]

Overtreatment also has important implications for antimicrobial stewardship, through both unnecessary antibiotic exposure and the potential use of ineffective or suboptimal treatment in the presence of resistance. This is particularly concerning for NG, a pathogen with a well-documented capacity to develop resistance to multiple antibiotic classes.[31]

In this study, all NG strains were susceptible to ceftriaxone and cefixime, supporting current first-line treatment in Zimbabwe; however, interpretation is limited by the small number of isolates tested. Ciprofloxacin susceptibility was very low, representing a marked decline from earlier surveillance, where reported resistance ranged from 10% to 31%.[32 33] Similar patterns have been observed in neighbouring South Africa and may reflect the continued use of ciprofloxacin in non-recommended indications despite its removal from national guidelines.[34] Continued antimicrobial resistance surveillance therefore remains essential to inform treatment recommendations.

The effectiveness of syndromic management is also influenced by local STI epidemiology and implementation. Our estimates of CT, NG and TV burden and current NG susceptibility patterns may inform future review of syndrome-specific treatment packages and periodic reassessment of syndromic algorithms.

Operational challenges further reduced effectiveness: prescribing did not always align with syndromic management or laboratory results, and follow-up care often defaulted to syndromic regimens. While the Osom test allowed for same-day treatment, some women received unnecessary treatment based on syndromic management despite negative results. These issues illustrate the need for workflow redesign, staff training and supervision when integrating diagnostics.

The OSOM Trichomonas rapid test showed high specificity (96%) but only moderate sensitivity compared with GeneXpert, resulting in missed infections. These findings are consistent with prior studies showing good specificity but variable sensitivity.[10 35] Its utility in men was extremely limited as expected: OSOM is designed for vaginal swabs and performs poorly on male urine. In our study, only two male infections were detected by GeneXpert, further restricting meaningful performance comparisons but concerns regarding its poor applicability for male screening have been reported previously.[35]

Programmatic implications

For adolescents presenting with STI-related symptoms, our findings support expanded use of aetiological testing for CT and NG where results can be returned rapidly enough to inform clinical management.[8] In our setting, GeneXpert testing was available onsite or nearby, with turnaround times of hours, suggesting that improved workflows could enable same-day diagnosis and treatment. This is particularly important for adolescents, who

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often face barriers for follow-up visits and confidentiality concerns.[23 28]

The substantial burden of asymptomatic CT and NG infection observed, highlights the limitations of relying exclusively on symptom-based case finding. Although current WHO guidance does not support universal screening of asymptomatic adolescents, our findings suggest further evaluation of targeted screening approaches in higher-risk groups, including female adolescents and adolescents living with HIV. Any expansion of asymptomatic testing would need to consider diagnostic costs, laboratory capacity, acceptability, treatment and partner services, and the ability to deliver timely results. Further implementation and cost-effectiveness studies are needed to define the role of asymptomatic screening within adolescent STI services in high-burden settings.

The frequent occurrence of co-infections suggests that multipathogen testing may be preferable to single-pathogen approaches, particularly among PLHIVs.[36]

In settings where same-day aetiological diagnosis is not feasible, syndromic management will likely remain the primary approach for symptomatic patients, although targeted aetiological testing may still be valuable where systems exist for timely result communication and treatment initiation. The limited success of patient recall observed in this study highlights the importance of optimising diagnostic workflows and result delivery. Until affordable, high-sensitivity point-of-care tests become widely available, programmes should prioritise targeted aetiological testing while maintaining syndromic management for most patients.[22 37 38]

Strengths and limitations

This study provides a detailed assessment of STI burden, diagnostic performance and treatment practices within a real-world adolescent clinic setting. The integration of molecular testing into routine services offers practical insights into the feasibility of diagnostic-based STI management in a high-prevalence, resource-limited context.

However, participants were recruited from a single adolescent-friendly clinic in Harare and may limit the generalisability of the findings. Recruitment was additionally supported by peer educators which have influenced the characteristics of adolescents attending and enrolling in the study and contributed to selection bias. Participation bias cannot be excluded, as refusals were incompletely documented. If those declining participation were less sexually active, less symptomatic or perceived themselves at lower risk of STIs, prevalence may have been overestimated. Alternatively, if symptomatic adolescents disproportionately declined participation (eg, due to discomfort or time constraints), prevalence may have been underestimated.

Laboratory limitations included the use of predominantly vaginal rather than endocervical swabs, potentially reducing NG culture yield. In addition, retrospective testing of isolates may have reduced bacterial viability, contributing to low NG culture recovery and potentially underestimating resistance patterns. Only urogenital specimens were collected for CT and NG testing; consequently, anorectal and oropharyngeal infections may have been missed, potentially underestimating the overall burden of these infections.

Finally, the study focused on CT, NG and TV and did not include laboratory testing for other causes of urethritis, cervicitis, vaginal discharge or PID, including bacterial vaginosis, vulvovaginal candidiasis and *Mycoplasma genitalium*. As a result, the aetiology of STI-related syndromes may not have been fully characterised. Partner notification and follow-up were limited, and reinfection was not assessed, preventing evaluation of longer-term transmission dynamics.

CONCLUSIONS

This study highlights the high burden of STIs among adolescents attending primary care, substantial limitations of syndromic management, and the critical value of aetiological testing to improve treatment accuracy. Expanding access to rapid molecular diagnostics alongside better integration, follow-up and adolescent-centred care, is essential to reduce overtreatment and undertreatment and to optimise STI control in adolescent populations.

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Patient consent for publication Not applicable.

Ethics approval The study was approved by the Medical Research Council of Zimbabwe (MRCZ No A/2820) and the MSF Ethics Review Board (ID20108) and

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the study was conducted in accordance with the Declaration of Helsinki [39] and the Ethical Guidelines for Health-Related Research Involving Humans by CIOMS.[40]

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Data availability statement Data are available on reasonable request. Individual pseudonymised participant data that underlie the results reported in this article (text, tables, figures and appendices, with data dictionary) will be made available to others upon submission of a proposal. Requests will be reviewed and sharing of the data will follow the conditions required by all applicable laws and the possible prior signature of any necessary agreement, in accordance with the legal framework set forth by Médecins Sans Frontières (MSF) data sharing policy, which ensures that all security, legal and ethical concerns are addressed.

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