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SEXUAL HEALTH

Prevalence of five curable sexually transmitted infections and associated risk factors among tertiary student men who have sex with men in Nairobi, Kenya: a respondent-driven sampling survey†

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ABSTRACT

Background. Young men who have sex with men (MSM) are a key population at high risk of sexually transmitted infections (STIs). We conducted a respondent-driven sampling (RDS) bio-behavioural survey to estimate the prevalence of five curable STIs: chlamydia, gonorrhoea, syphilis, trichomoniasis and *Mycoplasma genitalium* infection, and associated risk factors among tertiary student MSM (TSMSM) in Nairobi, Kenya. **Methods.** Between February and March 2021, we recruited 248 TSMSM aged ≥18 years who self-reported engaging in anal and/or oral sex with another man in the past year. Samples collected included urine, anorectal and oropharyngeal swabs for pooled *Chlamydia trachomatis*, *Mycoplasma genitalium*, *Neisseria gonorrhoeae* and *Trichomonas vaginalis* testing using multiplex nucleic acid amplification tests, and venous blood for serological *Treponema pallidum* screening and confirmation of current infection. Participants self-completed a behavioural survey on a REDCap digital platform. Data analysis was done using RDS-Analyst (v0.72) and Stata (v15). Differences in proportions were examined using the chi-squared (χ^2) test, and unweighted multivariate logistic regression was used to assess factors associated with STI prevalence. **Results.** RDS-adjusted prevalence rates of at least one of the five STIs, chlamydia, gonorrhoea, *Mycoplasma genitalium* infection, trichomoniasis and latent syphilis were 58.8%, 51.0%, 11.3%, 6.0%, 1.5% and 0.7%, respectively. Factors independently associated with STI prevalence were inconsistent condom use (adjusted odds ratio (AOR) = 1.89, 95% confidence interval (CI): 1.03–3.47, $P = 0.038$) and the last sex partner being a regular partner (AOR = 2.35, 95% CI: 1.12–4.92, $P = 0.023$). **Conclusion.** STI prevalence among TSMSM in Nairobi, Kenya, is disturbingly high, demonstrating urgent need for tailored testing, treatment and prevention interventions for this population.

Keywords: condom use, digital health, nucleic acid amplification tests (NAATs), risk reduction counselling, sex partner, sexual behaviour, sexual minorities, Sub-Saharan Africa, young key populations, young men who have sex with men (YMSM).

Introduction

Globally, compared to the general population, gay, bisexual and other men who have sex with men (collectively referred to as MSM) experience higher rates of sexually transmitted infections (STIs) such as chlamydia, gonorrhoea and syphilis.[1] Data from sub-Saharan African (SSA) countries have shown high rates of these and other STIs among MSM, including chlamydia in Tanzania – 7.5%[2] and Kenya – 26%[3]; gonorrhoea in Tanzania – 14.4%[2] and Kenya – 26%[3]; syphilis in Malawi – 12.3%[4] and Uganda – 9%[5]; *Mycoplasma genitalium* infection in Nigeria – 36.8%[6]; and trichomoniasis in South Africa – 9%.[7]

†A version of this manuscript was submitted and posted as a pre-print on the Research Square platform, and is available from the link below: https://www.researchsquare.com/article/rs-1828548/v1.

In terms of sexual behaviour, MSM may engage in both receptive and insertive anal and oral sex, making them susceptible to anorectal and oropharyngeal STIs besides the usual genital STIs. Unlike the genital STIs, extra-genital STIs are often asymptomatic and thus remain largely undiagnosed and untreated.[8] The World Health Organization (WHO) recommends offering MSM periodic testing for asymptomatic STIs using serological tests for syphilis and nucleic acid amplification tests (NAATs) for chlamydia and gonorrhoea.[9] Whereas serological tests are affordable and easy to use, NAATs require expensive technology and personnel with technical training, and are thus not routinely used in SSA countries. As a result, management of STIs in most SSA countries including Kenya is largely syndromic,[10] leading to missed cases and inadequate management (because many STIs are asymptomatic in early infection), elevated risk of acquisition and transmission of human immunodeficiency virus (HIV),[11] and future complications such as infertility.[12] Simulation studies have shown that this sub-optimal treatment of STIs plays a significant role in HIV infection among young MSM (YMSM) aged 18–24 years.[13] Besides, MSM infected with asymptomatic STIs may unknowingly infect sex partners, thus spreading the infections. Further, commensal oropharyngeal *Neisseria spp*. may transfer genetic material to untreated oropharyngeal *Neisseria gonorrhoeae*, leading to the development of resistance to extended spectrum cephalosporins.[14] Taken together, these factors make surveillance of STIs critical, especially among key populations at heightened risk of infection.

Although more expensive than culturing of bacterial microorganisms, NAATs are currently the gold standard for detecting asymptomatic extra-genital bacterial STIs, given their high sensitivity and specificity.[15] Pooling samples from different anatomical sites from an individual and testing them together can be used to lower the cost of NAATs,[16] and has been shown to perform as well as single-anatomic site testing for *Chlamydia trachomatis* and *Neisseria gonorrhoeae* among MSM in various settings.[17–22]

At the onset of the developmental stage of emerging adulthood (18–25 years), in-school individuals transition from secondary to tertiary institutions.[23] In tertiary institutions, most students find themselves in an environment with limited direct supervision of their behaviour, and increased freedom and opportunities to engage in behavioural risks such as casual sex.[24] For tertiary student MSM (TSMSM), exposure to peers with similar sexual orientation and behaviour provides an environment with more socialising opportunities compared to their secondary school days.[25] There is evidence to suggest that TSMSM may seek casual sex partners online, have sex more often, and engage in condomless sex, group sex and sex work.[26] Moreover, TSMSM have been shown to have early sexual debuts, forced sex experiences, high sex partner turnover, concurrent sex partners, inconsistent condom use, and alcohol and drug use.[27] As well, structural factors, such as criminalisation of homosexuality in Kenya, and societal stigma and discrimination towards individuals with same-sex behaviour, may further limit healthcare engagement for TSMSM,[28] making it difficult to access services for prevention, screening and treatment of STIs. In sum, these behavioural and structural factors increase the risk of STIs among TSMSM, making them an important population to focus on for STIs research. In Kenya, little is known about the prevalence of STIs and associated risk factors among YMSM, including TSMSM. As part of the effort to bridge this knowledge gap, the current study examined the prevalence of five curable STIs (chlamydia, gonorrhoea, syphilis, trichomoniasis and *Mycoplasma genitalium* infection), and associated demographic, behavioural and contextual risk factors among TSMSM in Nairobi, Kenya.

Methods

The study methods are detailed in the published study protocol,[29] and summarised below.

Study design and setting

A cross-sectional bio-behavioural survey was conducted between February and March 2021, just after stringent coronavirus disease 2019 (COVID-19) prevention and control restrictions were eased in Kenya, and tertiary institutions resumed in-person teaching. Nairobi, Kenya's capital, was selected due to its large population of tertiary students, with approximately 150 campuses of various universities and colleges located in the city and within its metropolis.[30]

Participants, sampling, and recruitment

TSMSM were eligible to participate in the study if they were willing and able to provide written informed consent for study participation, were aged ≥18 years, provided proof of registration as a student in a university or college in Nairobi, were assigned male sex at birth, and reported consensual receptive or insertive anal and/or oral sexual intercourse with another man in the last 12 months. The sample size was primarily calculated to estimate the prevalence of HIV among TSMSM, based on WHO 2017 guidelines for bio-behavioural surveys among populations at higher risk of HIV infection.[31] Using the Cochran formula,[32] a design effect of three to account for clustering, estimated a HIV prevalence of 4.1% based on a previous study among TSMSM in South Africa,[33] a level of precision of 0.05 and 10% non-response; we used this to determine that a minimum sample size of 200 TSMSM would be required. The results of the primary objective of the study are reported elsewhere.[34] Respondent-driven sampling (RDS) was used following findings from formative qualitative research, which showed that this sampling method was appropriate and acceptable for recruiting TSMSM into HIV/STI research.[35] From the

TSMSM who took part in the formative research, six seeds were purposively selected based mainly on their self-reported personal network sizes and ability to recruit their peers. The seeds completed half a day training during which they were briefed on the purpose of the study, study procedures, eligibility criteria for prospective participants and types of incentives that would be offered. In addition, the seeds were offered a recruitment script, which if needed, would be used to inform their peers about the study. Upon completing the study procedures, each seed was issued three coupons to recruit their peers. A member of the study team used a prescribed form to screen prospective participants recruited by the seeds and subsequent participants. The screening involved checking the validity of the coupons (based on a unique code for each coupon linked to the seed starting off each recruitment chain), and fulfilment of the other set eligibility criteria. Upon completing the study procedures, each participant was briefed on how to recruit their peers into the study, issued three coupons and a recruitment script similar to the one issued to the seeds. Coupons were valid for a period of 2 weeks. Each seed and subsequent participant could recruit only a maximum of three peers into the study. Issuing of three coupons went on until the survey had recruited 120 participants (inclusive of seeds). Subsequently, two coupons were issued until the 150th participant, after which no more coupons were issued. The study remained open for recruitment for 2 weeks after the last coupons were issued, and closed with 248 TSMSM having participated. Each participant was reimbursed 1000 Kenyan shillings (equivalent to USD10 at that time) for their time and expenses related to transport to and from the study site, and 300 Kenyan shillings (equivalent to USD3) for every peer they recruited into the study. In addition, participants were offered condoms and water-based lubricants.

Data collection tools and procedures

The behavioural survey was conducted by self-administered interviews on tablets using a questionnaire set up on REDCap software (Vanderbilt University, TN, USA). The questionnaire was adapted from a validated questionnaire available from the integrated HIV bio-behavioural surveillance toolbox.[36] The questionnaire contained questions on sociodemographic characteristics, sexual behaviour and other contextual characteristics (symptoms of STIs, use of geosocial networking applications and condom affordability and accessibility), and was administered in English, the language of instruction in Kenyan tertiary institutions.

Biological specimen collection and testing

After completing the behavioural survey, participants were offered testing for HIV[34] and other STIs. Each participant provided approximately 3–4 mL of venous blood for serological syphilis testing using a rapid plasma reagin (RPR) test for screening and a *Treponema pallidum* haemagglutination assay (TPHA) test for confirmation of current syphilis infection. Additionally, each participant provided approximately 20–30 mL of first void urine, one pharyngeal, and one anorectal swab for testing of *Chlamydia trachomatis*, *Mycoplasma genitalium*, *Neisseria gonorrhoeae* and *Trichomonas vaginalis*. Participants self-collected the urine sample in a sterile jar after receiving instructions from the clinician. All pharyngeal swabs were collected by a clinician. A majority (approximately three-quarters) of the anorectal swabs were collected by a clinician, whereas one-quarter were self-collected by participants after receiving instructions from the clinician. Pharyngeal swabs were collected by swabbing the tonsils and the posterior pharynx using flocked swabs. Anorectal swabs were collected by inserting a flocked swab 3 cm into the anus and gently rotating for 5–10 s. Each swab was placed in a separate tube containing universal transport medium. All samples were transported to the laboratory within 24 h. Urine, pharyngeal and anorectal samples from each individual were pooled within 24 h. As per literature,[21,37] the tubes containing the pharyngeal and anorectal swabs were robustly shaken for 15 s, the swabs pressed firmly on the sides of the tube to get rid of fluid, and then discarded. Subsequently, 1 mL of fluid from each of these tubes was mixed with 1 mL of urine in a sterile tube to make a volume of 3 mL. Samples were stored at 2–8°C as per the NAAT manufacturer's instructions and tested within 72 h from collection. Deoxyribonucleic acid (DNA) extraction was done using the QIAamp® kit (Qiagen®, Germany) and DNA detection was done using a multiplex real-time polymerase chain reaction (PCR) test kit for *Chlamydia trachomatis*, *Mycoplasma genitalium*, *Neisseria gonorrhoeae* and *Trichomonas vaginalis* (Sacace Biotechnologies®, Italy) on a Rotor-Gene Q (Qiagen®, Germany) thermocycler.

Ethics approval

This study was approved by the University of the Witwatersrand Human Research Ethics Committee-Medical (Ref. No. M200215) and University of Nairobi-Kenyatta National Hospital Ethics and Research Committee (Ref. No. P990/12/2019). All participants provided written informed consent.

Data analysis

Data analysis excluded six seeds who were purposely selected to begin the RDS recruitment. Weighted STI prevalence with 95% confidence intervals (CI) were calculated using RDS Analyst (RDS-A) software (ver. 0.72).[38] Weighting was done using Gile's successive sampler estimator, which takes to account the self-reported participant network size, recruitment patterns, and estimated size of the study population.[39] We asked the following question to estimate a participant's network size: 'How many TSMSM who study and live in

Nairobi, who know you by name, and you know them by name, have you spoken to in the last 4 weeks/1 month?'. Due to the COVID-19 restrictions in place just before the survey, we added the following clarification: 'By speaking, we mean either talking face-to-face or communicating on the phone whether through calling, texting or voice notes'. As per the Joint United Nations Programme on HIV/AIDS recommendations,[40] an estimated population size of 8406 for TSMSM (1.45% of male tertiary students in the Nairobi metropolis) was used, with 95% CI and 1000 bootstraps.

Stata (ver. 15; StataCorp LLC, College Station, TX, USA) was used for further analysis of the unweighted data. Some continuous variables such as age and self-reported number of sex partners were converted into binary categories and analysed as such. Categorical variables were summarised using proportions, and differences in proportions examined using the chi-squared (χ^2) test. Multivariate logistic regression models were used to measure associations between various factors and STI prevalence. Testing positive for at least one of the five STIs was used as the primary outcome variable. All exposure variables with a $P < 0.1$ in bivariate analysis and without missing values were included in the multivariate model. Unweighted regression models were used because they have been shown to perform better than weighted regression models for RDS data.[41] Both adjusted odds ratio (AOR) and 95% confidence interval (CI) were calculated for each exposure variable in the final model. All statistical tests were two-sided. Variables with a *P*-value <0.05 were considered statistically significant.

Results

Characteristics of TSMSM

Six seeds recruited 242 participants in eight waves, resulting in a total of 248 TSMSM. The details of the recruitment networks are depicted in Fig. 1. The characteristics of participants in total and by STI status (proportion that tested positive for at least one of the five STIs) are shown in Table 1. Median age was 21 years (interquartile range, IQR, 20–22), with 96.3% of participants aged ≤24 years. More than half (58.3%) attended university, close to three-quarters (71.9%) were in public institutions, and four-fifths (79.3%) resided in hostels inside or outside their institutions, away from their families. A majority (89.3%) owned a smart phone at the time of the study, almost half (46.5%) had ever used a mobile phone geosocial networking application (app) for MSM to meet a sex partner, and one-third (33.6%) had met their last sex partner online. Sexual behaviours that may increase the risk of STIs at the genital, anorectal and oropharyngeal anatomic sites were also common among participants in the 12 months preceding the survey. Almost three-quarters (70.2%) had engaged in both receptive and insertive anal–penile intercourse, more than three-quarters (78.1%) had engaged in both receptive and insertive oral–penile intercourse and more than half (58.7%) had had engaged in both receptive and insertive oral–anal intercourse.

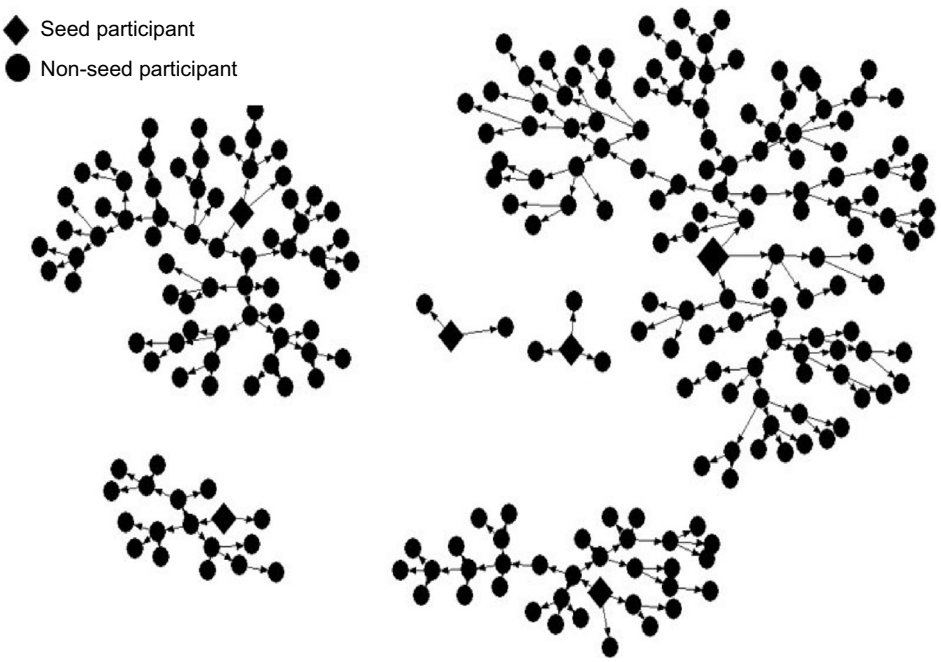

Fig. 1. Recruitment chains of tertiary student men who have sex with men in Nairobi, Kenya ($N = 248$).

Table 1. Characteristics of TSMSM in total and by STI status in Nairobi, Kenya ($N = 242$).

Variable	Category	Total number (%)	Number STI positive (%)	χ^2	*P*-value
Sociodemographic characteristics					
Age (years)	18–20	89 (36.8)	57 (64.0)	0.01	0.917
	21–30	153 (63.2)	99 (64.7)		
Gender identity	Cisgender male	219 (90.5)	139 (63.5)	0.99	0.320
	Transgender female	23 (9.5)	17 (74.0)		
Sexual orientation identity	Gay	153 (63.2)	102 (66.7)	2.16	0.339
	Bisexual	80 (33.1)	47 (58.8)		
	Heterosexual	9 (3.7)	7 (77.8)		
Institution attended	University	141 (58.3)	92 (65.2)	0.09	0.763
	College	101 (41.7)	64 (63.4)		
Ownership of institution attended	Public	174 (71.9)	111 (63.8)	0.12	0.728
	Private	68 (28.1)	45 (66.2)		
Type of course studied	Science, technology, engineering and mathematics	156 (64.5)	94 (60.3)	3.40	0.066
	Arts, business and humanities	86 (35.5)	62 (72.1)		
Year of study at university/college[A]	1st and 2nd year	153 (66.0)	102 (66.7)	0.80	0.372
	3rd and 4th year	79 (34)	48 (60.8)		
Residence	College/rented hostel	192 (79.3)	120 (62.5)	1.56	0.211
	With family	50 (20.7)	36 (72.0)		
Ever attended boarding school	Yes	203 (16.1)	131 (64.5)	<0.01	0.959
	No	39 (83.9)	25 (64.1)		
Main source of financial support	Parents/guardians	137 (56.6)	87 (63.5)	0.64	0.724
	Employment	65 (26.9)	41 (63.0)		
	Bursary/scholarship	40 (16.5)	28 (70.0)		
Had smartphone at time of the study	Yes	216 (89.3)	137 (63.4)	0.94	0.331
	No	26 (10.7)	19 (73.1)		
General sexual behaviour characteristics					
Ever had vaginal sex with a woman	Yes	130 (53.7)	77 (59.2)	3.36	0.067
	No	112 (46.3)	79 (70.5)		
Age at first anal sex with a man	<18 years	79 (32.9)	50 (63.3)	0.04	0.843
	≥18 years	161 (67.1)	104 (64.6)		
Sexual role at first anal sex with a man	Insertive	103 (42.8)	62 (60.2)	1.82	0.402
	Receptive	83 (34.4)	54 (65.1)		
	Versatile	55 (22.8)	39 (70.9)		
Nature of first anal sex with a man	Consensual	201 (83.4)	131 (65.2)	0.39	0.533
	Coerced/forced	40 (16.6)	24 (60.0)		
Preferred age of sex partner	Same/younger age	187 (77.6)	116 (62.0)	2.26	0.323
	Any age	36 (15.0)	27 (75.0)		
	Older	18 (7.4)	12 (66.7)		
Preferred sexual role	Insertive	117 (48.6)	68 (58.1)	4.08	0.130
	Versatile	75 (31.1)	54 (72.0)		
	Receptive	49 (20.3)	33 (67.4)		

(*Continued on next page*)

Table 1. (*Continued*).

Variable	Category	Total number (%)	Number STI positive (%)	χ^2	*P*-value
Sexual behaviour characteristics with men during last 12 months					
Number of men participant had anal sex with	One (1)	69 (28.7)	40 (58.0)	1.70	0.193
	More than one (1)	172 (71.3)	115 (66.9)		
Participated in group sex	No	202 (83.8)	129 (63.9)	0.11	0.783
	Yes	39 (16.2)	26 (66.7)		
Had insertive anal intercourse	Yes	222 (92.1)	140 (63.1)	1.92	0.165
	No	19 (7.9)	15 (79.0)		
Had receptive anal intercourse	Yes	187 (77.6)	125 (66.8)	2.33	0.127
	No	54 (22.4)	30 (55.6)		
Had both insertive and receptive anal intercourse	Yes	170 (70.2)	44 (61.1)	0.50	0.478
	No	72 (29.8)	112 (65.9)		
Had insertive oral intercourse	Yes	220 (91.3)	142 (64.6)	0.06	0.809
	No	21 (8.7)	13 (61.9)		
Had receptive oral intercourse	Yes	197 (81.7)	131 (66.5)	2.24	0.135
	No	44 (18.3)	24 (54.6)		
Had both insertive and receptive oral intercourse	Yes	189 (78.1)	125 (66.1)	1.06	0.304
	No	53 (21.9)	31 (58.5)		
Had insertive oral–anal intercourse	Yes	158 (65.6)	102 (64.6)	0.01	0.914
	No	83 (34.4)	53 (63.9)		
Had receptive oral–anal intercourse	Yes	175 (72.6)	116 (66.3)	1.08	0.298
	No	66 (27.4)	39 (59.1)		
Had both insertive and receptive oral–anal intercourse	Yes	142 (58.7)	92 (64.8)	0.02	0.900
	No	100 (41.3)	64 (64.0)		
Always used a condom	Yes	74 (30.7)	39 (52.7)	6.30	0.012*
	No	167 (69.3)	116 (69.5)		
Gave money/goods/services to a sex partner	Yes	116 (51.9)	75 (64.7)	0.01	0.916
	No	125 (48.1)	80 (64.0)		
Received money/goods/services from a sex partner	Yes	141 (58.5)	93 (66.0)	0.40	0.527
	No	100 (41.5)	62 (62.0)		
Both gave and received money/goods/services to and from a male sex partner, respectively	Yes	109 (44.8)	73 (67.0)	0.55	0.460
	No	133 (55.2)	83 (62.4)		
Sexual behaviour characteristics with last sex partner					
Age of partner (years)	15–24	204 (84.7)	126 (61.8)	3.77	0.052
	≥25	37 (15.3)	29 (78.4)		
Where partner was met	Offline	160 (66.4)	96 (60.0)	3.86	0.049*
	Online	81 (33.6)	59 (72.8)		
Used condom	Yes	159 (65.7)	100 (62.9)	0.50	0.480
	No	83 (34.3)	56 (67.5)		
Gave money/goods/services to partner	Yes	25 (10.4)	16 (64.0)	<0.01	0.936
	No	216 (89.6)	140 (64.8)		
Received money/goods/services from partner	Yes	51 (21.2)	31 (60.8)	0.44	0.507
	No	190 (78.8)	125 (65.8)		

(*Continued on next page*)

Table 1. (*Continued*).

Variable	Category	Total number (%)	Number STI positive (%)	χ^2	*P*-value
Had taken alcohol/other drug before sex	Yes	99 (40.9)	63 (63.6)	0.05	0.823
	No	143 (59.1)	93 (65.0)		
Type of partner	Regular	200 (83.0)	136 (68.0)	6.95	0.008*
	One time	41 (17.0)	19 (46.3)		
Contextual characteristics					
HIV serostatus					
HIV serostatus at time of study	HIV negative	222 (91.7)	139 (62.6)	4.01	0.045*
	HIV positive	20 (8.3)	17 (85.0)		
STI symptoms experienced during last 12 months					
Urethritis	Yes	39 (16.2)	25 (64.1)	<0.01	0.959
	No	203 (83.8)	131 (64.5)		
Anal discharge	Yes	20 (8.3)	15 (75.0)	1.06	0.304
	No	222 (91.7)	141 (63.5)		
Ulcer on or near penis or anus	Yes	29 (12.0)	19 (65.5)	0.02	0.885
	No	212 (88.0)	136 (64.2)		
Pre-exposure prophylaxis use					
Ever taken	Yes	27 (11.2)	20 (74.1)	1.23	0.268
	No	215 (88.8)	136 (63.3)		
Currently taking	Yes	14 (5.8)	11 (78.6)	1.30	0.256
	No	228 (94.2)	145 (63.6)		
Use of geosocial networking applications (apps) for MSM					
Ever used apps to find a sex partner	Yes	112 (46.5)	84 (75.0)	9.70	0.002*
	No	129 (53.5)	72 (55.8)		
Condoms					
Perceived affordability	Affordable	141 (58.3)	97 (68.8)	2.77	0.096
	Not affordable	101 (41.7)	59 (58.4)		
Perceived ease of getting condoms in campus	Easy	104 (43.0)	71 (68.3)	1.15	0.283
	Not easy	138 (57.0)	85 (61.6)		

*Significant difference in proportions.
[A]10 missing values.
STIs, sexually transmitted infections; TSMSM, tertiary student men who have sex with men.

STIs prevalence, differences in proportions and associated factors

The unadjusted and RDS-adjusted prevalence of various STIs among study participants is shown in Table 2. In RDS-adjusted estimates, more than half (58.8%, 95% CI: 50.4–67.3%) of study participants tested positive for at least one of the five STIs, with chlamydia (51.0%, 95% CI: 42.3–59.8%) followed by gonorrhoea (11.3%, 95% CI: 6.1–16.5%), then *Mycoplasma genitalium* infection (6.0%, 95% CI: 2.6–9.4%) being the three most prevalent STIs. Co-infection with more than one STI was also observed with chlamydia/gonorrheoa (5.7%, 95% CI: 2.7–8.7%) being the most common type of co-infection, followed by chlamydia/*Mycoplasma genitalium* infection (4.5%, 95% CI: 2.3–6.7%), then gonorrhoea/*Mycoplasma genitalium* infection and chlamydia/gonorrhoea/*Mycoplasma genitalium* (both at 1.7%, 95% CI: 0.1–3.3%).

Table 1 also shows the results of bivariate analysis. These results revealed that STI prevalence (testing positive for at least one of the five STIs) was statistically significantly higher among participants who used condoms inconsistently when having sex with a man during the 12 months preceding the survey ($\chi^2 = 6.30$, $P = 0.012$), who met their last sex partner online ($\chi^2 = 3.86$, $P = 0.049$), whose last sex partner was a regular partner ($\chi^2 = 6.95$, $P = 0.008$), who tested positive for HIV at the time of the study ($\chi^2 = 4.01$, $P = 0.045$), and who had ever used a geosocial networking app for MSM to find a sex partner ($\chi^2 = 9.70$, $P = 0.002$).

Table 2. Prevalence of STIs among TSMSM in Nairobi, Kenya ($N = 242$).

STIs	Unadjusted prevalence *n* (%)	RDS-adjusted prevalence % (95% CI)
At least one STI	156 (64.5)	58.8 (50.4–67.3)
Chlamydia	142 (58.7)	51.0 (42.3–59.8)
Gonorrhoea	36 (14.9)	11.3 (6.1–16.5)
Mycoplasma genitalium infection	25 (10.3)	6.0 (2.6–9.4)
Latent syphilis (RPR+ve and TPHA−ve)	5 (2.0)	0.7 (−0.1–1.5)
Trichomoniasis	3 (1.2)	1.5 (−0.3–3.3)
HIV	20 (8.3)	3.6 (1.3–6.0)
Co-infections		
At least one STI and HIV	17 (7.0)	2.9 (0.8–4.9)
Chlamydia and gonorrhoea	26 (10.7)	5.7 (2.7–8.7)
Chlamydia and *Mycoplasma genitalium* infection	22 (9.1)	4.5 (2.3–6.7)
Mycoplasma genitalium infection and gonorrhoea	8 (3.3)	1.7 (0.1–3.3)
Chlamydia, *Mycoplasma genitalium* infection and gonorrhoea	8 (3.3)	1.7 (0.1–3.3)
Chlamydia, *Mycoplasma genitalium* infection, gonorrhoea and trichomoniasis	0 (0.0)	0
Chlamydia, *Mycoplasma genitalium* infection, gonorrhoea, trichomoniasis and latent syphilis	0 (0.0)	0

STI, sexually transmitted infection; TSMSM, tertiary student men who have sex with men; RPR, rapid plasma reagin test for screening for syphilis antibodies; TPHA, *Treponema pallidum* haemagglutination assay for confirmation of current syphilis infection.

The results of multivariate logistic regression analysis are shown in Table 3. As shown by the AOR, independent factors associated with testing positive for at least one of the five STIs were: inconsistent condom use when having sex with a man within the 12 months preceding the survey (AOR 1.89, 95% CI: 1.03–3.47, $P = 0.038$) and the last sex partner being a regular partner (AOR = 2.35, 95% CI: 1.12–4.92, $P = 0.023$).

Discussion

Our study aimed to estimate the prevalence of five curable STIs and associated risk factors among TSMSM in Nairobi, Kenya. We found that more than half (58.8%) of study participants had at least one of the five STIs, with the descending order of prevalence being chlamydia, gonorrhoea, *Mycoplasma genitalium* infection, trichomoniasis and syphilis. In terms of co-infection, chlamydia/gonorrhoea was the most common followed by chlamydia/*Mycoplasma genitalium* infection, and gonorrhoea/*Mycoplasma genitalium* infection at the same rate as chlamydia/gonorrhoea/*Mycoplasma genitalium* infection. Co-infection with at least one of the five STIs and HIV was at the rate of 2.9% (95% CI: 0.8–4.9%).

The prevalence of chlamydia was almost double that observed among MSM in Coastal Kenya – 26%,[3] and more than double that observed among YMSM in Vietnam – 22%.[42] We found a prevalence of gonorrhoea (11%) less than half that observed among MSM in Coastal Kenya – 26%[3] and similar to that seen among YMSM in Vietnam – 12%.[42] Overall, the higher prevalence of chlamydia compared to gonorrhea in our study is consistent with evidence from systematic reviews that has shown that despite chlamydia and gonorrhoea being the most prevalent STIs among MSM, chlamydia is more prevalent than gonorrhoea,[43] possibly due to chlamydia's longer duration of infection and higher transmissibility as compared to gonorrhoea.[44] For *Mycoplasma genitalium* infection and trichomoniasis, the observed prevalence was a sixth of that seen among MSM in Nigeria – 37%[6] and in South Africa – 9%,[7] respectively. The observed prevalence of latent syphilis was seven-fold less than that found among TSMSM in China – 4.7%, where evidence suggests that the syphilis epidemic among TSMSM has been growing, and is fuelled by a high prevalence of risky sexual behaviours.[26]

The overall prevalence of STIs among TSMSM in our study was higher than that in the general population in Kenya, as shown by a study that found the prevalence of chlamydia, *Mycoplasma genitalium* infection, gonorrhoea, trichomoniasis and at least one of the four aforementioned STIs was 16.8%, 28.6%, 7.1%, 7.1% and 49.5%, respectively.[45] Therefore, while not neglecting the general population, there is need to focus more attention on the prevention and control of STIs among key populations such as MSM, including TSMSM. This approach may further foster benefits for the prevention and control of STIs in the general population, given that MSM who also have sex with women (36.8% in our study) form a bridge population that may transmit STIs to women, and these women in turn transmit to men in the general population, thus amplifying the STI epidemics.

Table 3. Multivariate logistic regression of factors associated with prevalent STIs among TSMSM in Nairobi, Kenya ($N = 240$).

Variable	Category	Unadjusted odds ratios (95% CI)	*P*-value	Adjusted odds ratio (95% CI)	*P*-value
Type of course	Science, technology, engineering and mathematics	Ref	0.067	Ref	0.125
	Arts, business and humanities	1.70 (0.96–3.01)		1.60 (0.87–3.03)	
Ever had vaginal sex with a woman	Yes	Ref	0.068	Ref	0.448
	No	1.64 (0.96–2.81)		1.26 (0.70–2.26)	
Consistently used a condom when having sex with a man within last 12 months	Yes	Ref	0.013	Ref	0.038*
	No	2.04 (1.16–3.58)		1.89 (1.03–3.47)	
Age of last sex partner (years)	15–24	Ref	0.057	Ref	0.313
	≥25	2.24 (0.97–5.16)		1.60 (0.65–3.92)	
Where last sex partner was met	Offline	Ref	0.051	Ref	0.434
	Online	1.78 (0.99–3.20)		1.31 (0.67–2.58)	
Type of last sex partner	One time	Ref	0.010	Ref	0.023*
	Regular	2.46 (1.24–4.86)		2.35 (1.12–4.93)	
HIV serostatus at time of study	HIV negative	Ref	0.057	Ref	0.434
	HIV positive	3.38 (0.96–11.89)		1.71 (0.44–6.58)	
Ever used a geosocial networking app for MSM to seek sex partner	No	Ref	0.002	Ref	0.184
	Yes	2.38 (1.37–4.12)		1.55 (0.81–2.94)	
Perception of affordability of condoms	Not affordable	Ref	0.097	Ref	0.146
	Affordable	1.56 (0.92–2.67)		1.54 (0.86–2.76)	

*Factors independently associated with STI prevalence ($P < 0.05$).
N, number of observations without missing values; STI, sexually transmitted infection; TSMSM, tertiary student men who have sex with men.

In the present study, inconsistent condom use and having a regular sex partner were independently associated with STI prevalence. The inconsistent condom use observed in our study could have been due to problems with affordability and accessibility of condoms, with 41.7% and 57.0% of study participants finding condoms 'not affordable' and 'not easy' to access in campus, respectively. Inconsistent condom use has also been seen among TSMSM in China and YMSM in Sweden and New Zealand, and is attributed to having a regular sex partner and believing that condoms reduce sexual pleasure.[46–48] Another study of YMSM in Hong Kong revealed that despite knowledge of the risk of condomless anal sex (CAS), socio-cultural norms and expectations relating to sexual positioning (insertive partner/top or receptive partner/bottom) contribute to inconsistent condom use, with CAS and condomless internal ejaculation considered a demonstration of intimacy and commitment.[49] Interestingly, in our study, the last sex partner being a regular partner was a risk factor for STIs, and this could be linked to reduced condom use with regular partners, as revealed in the foregoing studies.[46–48]

This study has several implications for future research and development of interventions in the response to STIs among YMSM, including TSMSM. Since condoms remain the leading STI prevention tool, public health practitioners should ensure affordability, availability and accessibility of condoms for YMSM, including for those in tertiary learning institutions. Additionally, practitioners should aim to provide more compelling condom awareness, education and training so as to promote condom use among YMSM. Most importantly, to ensure condom use and effectiveness, interventions need to speak to perceptions of pleasure, relationships and sexual positioning issues that have been shown to have a negative impact on consistent condom use, despite YMSM being aware of the risk of CAS. In the case of Kenya, further research is needed to ascertain whether the studded/dotted condoms routinely distributed by the government and popularised under the tag 'prevention with pleasure',[50] appeal to and meet the needs of YMSM, including TSMSM. Behaviours (such as CAS) that put MSM at risk of infection with STIs also put them at risk of HIV infection. Indeed, a 2019 modelling study among MSM in the USA showed that 10.4% of incident HIV infections were attributable to prevalent chlamydia and gonorrhoea infections.[51] Given the observed high prevalence of STIs in our sample, it is important to reinforce the need for interventions such as pre-exposure prophylaxis (PrEP) to prevent new HIV infections among TSMSM. From our study sample, only a paltry 11.2% and 5.8% had ever taken and were currently taking PrEP, respectively. Further research is required to understand the low use of PrEP in this population, despite

PrEP being freely available in Kenya. However, we note that although the use of PrEP decreases the risk of HIV infection, there is evidence to suggest that it may also lead to a high incidence of STIs among MSM, as a result of additional risk compensation – reduced sexual inhibition leading to increased risky sexual behaviour such as condomless sex.[52] Accordingly, because PrEP does not prevent other STIs, we thus recommend its use as part of a comprehensive sexual health package, which should also include STI screening and treatment, condom use promotion and risk-reduction counselling.

Our findings revealed that 89.3% of our study participants owned a smart phone at the time of the survey. This finding is consistent with previous work that demonstrated that 95% of Kenyan tertiary students own a smart phone, and are regular and savvy users of the internet.[53] In addition, almost half (46.5%) of our study participants had used a geosocial networking mobile phone application for MSM (such as Grindr) to find a sex partner, and one-third (33.6%) had met their last sex partner online. As such, online platforms could potentially be used for reaching TSMSM with interventions that promote and provide STI testing, treatment and prevention services. A systematic review conducted in 2017 showed that online interventions have the potential to address STIs among YMSM,[54] and such interventions have also been recommended by others following a study that found that most MSM in Kenya and South Africa regularly socialise online.[55] Online interventions are particularly recommended due to their private and discrete nature, which may enable TSMSM to bypass some of the barriers they encounter while seeking services in physical health facilities, especially the experiences of stigma and discrimination by healthcare providers.[28,56] Indeed, a consortium of universities within the Nairobi metropolis has developed, and deployed for use is a mobile phone app called RADA (slang for 'be alert').[57] Among other things, the app provides information on sexual and reproductive health matters to tertiary students, but its design and content is largely heteronormative. Considerations should therefore be made for the development of an app that suits and meets the needs of TSMSM. This could be achieved through collaboration with, and support from various stakeholders, including: researchers, policymakers, practitioners, funders, and TSMSM as the eventual app users.

To our knowledge, our study is the first one to investigate the prevalence and associated risk factors of five curable STIs among TSMSM in Kenya, and possibly in SSA countries, using the RDS method. Besides the traditional STIs (chlamydia, gonorrhoea and syphilis), we also investigated two emerging STIs (*Mycoplasma genitalium* infection and trichomoniasis) that are also prevalent among MSM. Pooling of samples from the three anatomical sites offered us a cost-effective way to detect extra-genital agents of STIs that would otherwise be undetected due to their usually asymptomatic nature.[8] Nevertheless, even with the pooling of samples, detection of agents of STIs using NAATs is still costly and not routinely available in resource-limited settings such as Kenya. In the absence of NAATs, treatment of STIs in SSA countries is likely to continue being syndromic. For MSM, quarterly screening that includes physical examination for genital, anorectal and oropharyngeal STIs, and assessment of risky sexual behaviours, can complement the syndromic management of STIs. To further support early diagnosis and hence appropriate treatment of STIs, we suggest that policymakers and providers consider the use of accurate, affordable and timely point-of-care tests for STIs among MSM.[58]

Our findings should be viewed in light of some limitations. RDS is a peer-referral, probability-based sampling method that is susceptible to underestimation or overestimation of study outcomes. To offset this limitation, when calculating our sample size, we applied a design effect of three to account for the clustering that occurs due to homophily and minimise the traditional bias associated with snowball sampling, and used RDS-adjusted analysis to estimate the prevalence of various STIs. To minimise the effect of seed selection bias, we excluded from analysis the six seeds who were purposely selected to start off recruitment. Because we asked about past life events and experiences, there was a possibility of recall bias. To mitigate this, most of our questions focused on events and experiences that occurred within 12 months before the study, with only a few questions focusing on periods longer than 12 months. In addition, we asked questions about sexual behaviour, which may be affected by social desirability bias. To minimise this, participants self-administered the behavioural survey questionnaire on a tablet computer, as this has been shown to be more effective in offsetting this kind of bias, compared to face-to-face interviews.[59] Approximately three-quarters of anorectal samples were collected by the clinician and the other quarter by participants after they received instructions from the clinician. This could potentially lead to variability in the test results of the various STIs. However, evidence suggests that when participants are given and are able to follow clear instructions on self-collection of anorectal samples, clinician-collected and self-collected samples yield concordant results.[60] The cross-sectional nature of the study limits inferences about the direction of causality though the factors we identified to be associated with STIs prevalence, and are plausibly causal based on findings from previous studies.[46–48] Finally, although we used a comprehensive set of variables in the logistic regression analysis, we cannot rule out the possibility of residual confounding from other variables that were not assessed, such as experiences of stigma, discrimination and violence. Despite these limitations, this survey offers valuable lessons on the burden of five curable STIs and associated risk factors among TSMSM, and hopefully will be useful in informing further research, and development of interventions for the prevention and

control of STIs in this key but understudied population, both in Kenya and other similar settings.

Conclusion

We found a high prevalence of STIs among TSMSM that was associated with inconsistent condom use and regular sex partners. Accordingly, tailored interventions for testing, treatment and prevention of STIs are urgently called for in this population. Particularly, accurate, affordable and timely point-of-care tests for agents of STIs are required to optimise treatment and control. Given the high prevalence of STIs observed and their plausible association with incident HIV infection, there is need to implement modern HIV prevention interventions such as PrEP in this population. Further, interventions that increase condom use efficacy and offer risk-reduction counselling are requisite, with online platforms being a potential avenue for the delivery of such interventions.

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Data availability. The data that support this study cannot be publicly shared due to ethical or privacy reasons, but may be shared upon reasonable request to the corresponding author, if appropriate.

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