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Human Immunodeficiency Virus (HIV) and Sexually Transmitted Infection (STI) incidence and associated risk factors among high-risk MSM and male-to-female transgender women in Lima, Peru

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Abstract

Background—Men who have sex with men (MSM) and male-to-female transgender women (TW) are at increased risk of HIV and sexually transmitted infections (STIs). We evaluated factors associated with incidence of HIV, HSV-2, and chlamydia and gonorrhea (anal and pharyngeal).

Methods—We used data from the *Comunidades Positivas* trial with MSM/TW who have sex with men in Lima, Peru. Participants were asked about sexual risk behaviors and underwent HIV/STI testing at baseline and 9- and 18-month follow-ups. We used discrete time proportional hazards regression to calculate hazard ratios (HRs) for variables associated with incidence of each STI.

Results—Among 718 MSM/TW, HIV incidence was 3.6 cases per 100 person-years. HIV incidence was associated with having an incident STI (aHR 3.73). Unprotected receptive anal intercourse was associated with incident anal chlamydia (aHR 2.20). An increased number of sexual partners increased incident HSV-2 (aHR 3.15 for 6–14 partners and 3.97 for 15–46 partners compared to 0–2 partners). Risk of anal gonorrhea decreased with each sexually active year (aHR 0.94) and increased for unprotected compensated sex (aHR 2.36). Risk of pharyngeal gonorrhea also decreased with each year since sexual debut (aHR 0.95). Risk of anal chlamydia decreased with each sexually active year (aHR 0.96), risk increased with reports of unprotected sex work (aHR 1.61), and unprotected receptive anal sex (aHR 2.63). All aHRs have p-values < 0.05.

Conclusion—MSM/TW experience high incidence of HIV. Up-to-date prevalence and incidence information and identifying factors associated with infection can help develop a more effective combination prevention response.

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Conflicts of Interest: None

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Keywords

HIV; HSV-2; gonorrhea; chlamydia; MSM; transgender; Peru

Introduction

Up-to-date Sexually Transmitted Infection (STI) epidemiologic surveillance is necessary to develop and evaluate interventions. Men who have sex with men (MSM) and male-to-female transgender women (TW) reporting sexual contact with men and TW partners, have a significantly higher STI prevalence than any other populations in Peru. Their increased STI prevalence is well documented,[1–5] but there are few incidence estimates[6] and further analysis is needed to understand risk factors for infection. Estimates place Human Immunodeficiency Virus (HIV) seroprevalence at 13.9% for MSM overall[1] and prevalence upwards of 30% among TW.[7] The prevalence of many STIs is highest among MSM, such as herpes simplex virus type-2 (HSV-2) infection at 69.0%, recent syphilis at 10.5%, and urethral gonorrhea and/or chlamydia at 1.5%.[8] Among Peruvian men from the general population, prevalences are 0.4% for HIV, 13.5% for HSV-2, 0.5% for syphilis, 4.2% for urethral chlamydia, and 0.1% for urethral gonorrhea.[9] Investigations worldwide present similar findings of high HIV/STI seroprevalence among MSM and TW populations as compared to the general population.[10,11] These elevated prevalence figures rationalize the focus of surveillance and prevention strategies specifically for MSM and TW.

In Peru, Lima and Callao remain the epicenter of a concentrated HIV epidemic with 77% of all new cases.[12] It is estimated that 55% of all HIV incidence occurs among MSM[13] who comprise approximately 6% of Peru's population.[5,9] Various factors influence the high STI prevalence in MSM and TW worldwide. These include biological factors (i.e. high transmissibility of HIV through condomless anal intercourse), behavioral (e.g. multiple sex partners, drug and alcohol use with sexual activity, frequent involvement in commercial sex work due to lack of other options), and structural (discrimination, violence, and limited access to healthcare, education, housing, or employment)[14–18] Despite access to condoms, advances in antiretroviral therapy coverage, counseling promoting risk reduction, and access to STI screening, prevalence remains high among these most at risk groups.

Although STI prevalence has been well documented for Peru's MSM, only two previous studies have assessed HIV and STI incidence, through case-control analysis and mathematical modeling to predict incidence.[19,20] In our analysis we use the Comunidades Positivas study with data gathered from MSM and TW participants over 18 months.[21] We assess incidence of HIV, HSV-2, anal and pharyngeal chlamydia and gonorrhea infections and associated risk factors in the MSM and TW population of Lima and Callao.

Methods

Design Overview

The *Comunidades Positivas* randomized control trial used a 2 × 2 factorial design testing a social/structural intervention (Positive Communities) and a biomedical intervention

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(participant-delivered partner STI treatment). In this trial, 24 *barrios* (low-income neighborhoods) in the region of Lima were randomized and assigned to one of four intervention conditions. Independent of intervention assignment, MSM and TW were recruited from each *barrio* and assessed for the outcomes of interest at baseline, 9 months, and 18 months. This assessment included a behavioral interview, serology for HIV-1, HSV-2, and nucleic acid amplification testing (NAAT) for chlamydia and gonorrhea in both pharyngeal and anal swabs.

The *Comunidades Positivas* intervention was not effective and therefore we have not explored the associations of the intervention arm with HIV/STI incidence,[21] further results are forthcoming. All participants from both trial arms are included in the analyses presented here.

Inclusion Criteria

Participants included those biological males between the ages of 18 and 45 at baseline who reported at least one sexual encounter with a man in the past 12 months, reported a sexual preference for other men, lived or worked near the intervention area, showed willingness to participate in the study, and planned to stay in the community for the 18-month study period.

Participant Recruitment

Lower-income *barrios* with visible MSM and TW communities were selected and through a snowball technique potential participants were identified and invited to enroll in the study. Selection of- and participant recruitment in the first 16 *barrios* took place in the metropolitan area of Lima between March and May, 2008. In the remaining 8 *barrios* (4 within Metropolitan Lima and 4 in surrounding Lima provinces), these processes took place between September and December 2009.

Data Collection

Data for the baseline, 9-month, and 18-month assessments were gathered in rented storefronts or apartments with interviews and collected specimens. All participants completed a behavioral survey and went through pre-test counseling for HIV/STI with a trained counselor as required by Peruvian law. Following counseling a trained phlebotomist drew a 10 ml blood sample and collected a pharyngeal swab. Self-obtained rectal swab samples were also collected. STI and HIV results were provided within two weeks of initial visit along with post-test counseling. Treatment was offered to participants with STI signs and symptoms or laboratory diagnosed bacterial STIs. Given the intervention's inclusion of participant-delivered partner STI treatment, this was provided to half of the participants, while the other half were referred for partner treatment to local health clinics, the standard of care. Newly diagnosed HIV cases were referred to the Peruvian HIV antiretroviral treatment program.

Laboratory Methods

HIV antibody status was determined using Genetic Systems HIV-1/HIV-2 EIA (BIO-RAD Laboratories, Redmond, WA). Positive results were confirmed with GenScreen HIV-1 Western Blot (BIO-RAD Laboratories, Redmond, WA). HSV-2 antibody status was

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determined by type-specific enzyme immunoassay HerpeSelect 2 ELISA IgG (Focus Diagnostics, Cypress, CA). Chlamydia and gonorrhea were determined in pharyngeal and rectal secretions using Aptima Combo 2 Assay for chlamydia trachomatis (CT) and/or Neisseria gonorrhea (NG) (GenProbe, San Diego, CA). For quality control (QC) purposes, 10% of samples were sent to the San Francisco Department of Public Health Laboratory (San Francisco, CA) for HIV, HSV-2, and CT/NG QC testing.

Anal and pharyngeal rather than urethral samples of gonorrhea and chlamydia were measured in this study because participant prevalence of urethral infection at baseline was too low to justify continued measurement.

Protection of Human Subjects

The study was approved by the Institutional Review Boards of the University of California, Los Angeles, and the Universidad Peruana Cayetano Heredia. Data were collected from eligible participants who gave their written informed consent to participate in the study. Study implementation was overseen by an independent Data and Safety Monitoring Board.

Measures Used

Sexual risk behavior including the number of sex partners and insertive and receptive anal sex were based on aggregate counts of these behaviors with the participants' last three sex partners in the previous 6 months. Participants were determined to have unmet basic needs if they reported any month in the past year where they did not have money to cover their basic needs. Sexual partnerships were coded as stable if the participant self-reported a sex partner as being a live-in partner or boyfriend rather than a causal or commercial partner. Number of sex partners in the last year was split into quintiles.

The incident STI variable was coded as positive if during the course of the 18 month study period the participant had an incident infection of HSV-2, anal gonorrhea, or anal chlamydia. HIV infection was not included in this variable.

The CAGE scale was based on four questions asking about Cutting-down alcohol consumption, Annoyance with criticism of one's drinking, feelings of Guilt about their drinking, and needing to have a drink as a morning Eye-opener. The questions were dichotomized into ever and never, and participants who answered ever to two or more questions were coded as CAGE-positive. In this population this scale has a Cronbach's alpha of 0.75.[22]

Statistical Analysis

Variables associated with seroconversion to positivity for HIV or HSV-2 and infection with gonorrhea or chlamydia, were modeled utilizing Discrete Time Proportional Hazards regression for bivariate and multivariate analyses. For calculation of HIV and HSV-2 incidence rates and analyses of factors associated with these infections, baseline seropositives were excluded separately for each infection. We did not exclude patients with baseline positivity for gonorrhea and chlamydia because they received treatment for these infections and once treated, they returned to the pool of susceptibles. However, we took the

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potential lack of independence between multiple positives for gonorrhea and chlamydia into account by adjusting the standard errors by participant using the cluster command. Given the overlap between the social and sexual networks of MSM and transwomen in the neighborhoods understudy, our analyses have looked at transgender identity as an exposure, but analysis was not conducted separately for MSM and transgender women. In the multivariate models, we included all variables that had a bivariate p-value less than or equal to 0.10 or those variables considered important a priori regardless of bivariate p-value, such as number of years since sexual debut. All analyses were conducted using Stata 12.1 (College Station, TX).

Results

Population Characteristics

A total of 510 MSM and 208 TW participants were enrolled at baseline, at the 9-month follow-up 619 participated (86.2%), and the 18-month follow-up 574 MSM and TW (79.9%) participated. Our study participants were primarily low income, between the ages of 25 to 35 (43.8%) with an average age of 29.5 years; the majority originated from the metropolitan region of Lima (53.6%), were primarily homosexual or gay identified (64.4%), and had a secondary education (62.6%). The majority of participants reported more difficultly using condoms as a result of alcohol or drug use (60.2%). Those who engaged in compensated sex (54.8%) were more likely to report using condoms with clients rather than not using condoms (55.2% versus 44.8%). The majority of study participants did not engage in insertive anal sex (74.6%); conversely, most (91.1%) engaged in receptive anal sex. Those who engaged in receptive anal sex were more likely not to use condoms (56.1% versus 35.1%) (see Table 1).

Participants who were HIV seropositive at baseline had had, on average, more years of sexual activity than those who were seronegative, 17.5 vs. 14.9 years ($P < 0.01$). HIV infection was not associated with region of origin, sexual identity, and education levels at baseline. Seronegative persons were more likely to engage in condomless receptive anal sex, 59.3%, than those seropositive, 42.1% ($P < 0.01$).

Table 2 displays HIV and STI prevalence at baseline as well as the incidence of these infections over the 18 month follow-up. Baseline HIV seroprevalence was 17.9%, 70% of whom did not know their infection status. HIV incidence during the study was 3.6 per 100 person-years. Incidence rates were calculated for each 9-month follow-up period, baseline to 9 months and 9 to 18 months. Rates remained similar across the two periods for most STIs, HIV showed a slight decrease from 5.0 cases per 100 person-years in the first 9 months of follow-up to 2.3 cases per 100 person years in the second 9 months of follow-up.

Bivariate and Multivariate Analysis

Notable positive bivariate associations were found between HIV incidence and a lower number of years of sexual activity (HR 0.95, $P = 0.04$) and greater incidence of a composite STI outcome including HSV-2, anal gonorrhea, and/or anal chlamydia infection (HR 4.93, $P < 0.01$). In the multivariate model, HIV incidence was associated with incident HSV-2, anal

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gonorrhea, or anal chlamydia (aHR 3.73, P < 0.01). Multivariate analysis found that HSV-2 incidence was positively associated with having 6 to 14 and 15 to 46 sex partners in the last year (aHR 3.21, P = 0.04; aHR 3.97, P = 0.02) (see Table 3).

In multivariate analysis, incidence of anal gonorrhea was associated with a lower number of years of sexual activity (aHR 0.94, P < 0.01), and with TW identity (aHR 1.68, P = 0.04), engaging in condomless compensated sex (aHR 2.36, P = 0.01), having 15 to 46 sex partners (aHR 3.31, P = 0.01) and engaging in receptive anal intercourse with condoms (aHR 2.76, P = 0.05). Pharyngeal gonorrhea was negatively associated with number of years of sexual activity (aHR 0.95, P < 0.01) (see Table 4).

Anal chlamydia was also associated with a lower number of years of sexual activity (aHR 0.96, P < 0.01), with engaging in condomless compensated sex (aHR 1.61, P = 0.05), and in anal sex with and without condoms (aHR 2.25, P= 0.04; aHR 2.63, P = 0.02) (see Table 5).

Discussion

To date the *Comunidades Positivas* study offers the longest follow-up, 18 months, for HIV/STI incidence in Lima's MSM and TW population. Our findings of the high baseline prevalence and incidence rates of the STIs measured are supported by previous high prevalence findings in other studies[4,5,23,24]. This provides further validation of Lima's lower-income MSM and TW as populations at the heart of a concentrated and active HIV epidemic and at high-risk for other STIs. Compared to previously reported incidence from 1998–2000[19] (3.5 per 100 person-years for HIV, and 10.4 per 100 person-years for HSV-2) and HIV incidence from 2007–2009 (3.9 per 100 person-years)[6], our HIV rate was similar at 3.6 per 100 person-years, but our HSV-2 incidence was higher at 17.2 per 100 person-years. The similarity in HIV incidence with the previous cohorts shows the sustained risk of HIV infection among MSM/TW in Peru despite the availability of treatment, in line with data from this same cohort on low serostatus awareness among HIV positive MSM/TW, leading to late diagnosis and initiation of treatment[25]. Gonorrhea and chlamydia incidence rates were similar to the prevalence at baseline, as expected for treatable infections.

Incident HSV-2, anal gonorrhea, or anal chlamydia infection were risk factors for incident HIV infection. It is likely that factors which placed study participants at risk for STI were common between HIV, HSV-2, and anal gonorrhea and chlamydia. We excluded pharyngeal gonorrhea and chlamydia from the analysis because these sexual practices have a different route of infection and are likely associated with different risk factors as well. Although it has proven difficult to capture all potential behavioral – and, even less so, structural, risk factors for incident HIV/STI, by focusing on the proximal outcome of incident infection we demonstrate an association between infections by different STIs. This has important implications for HIV interventions because co-infection synergism or HIV infection capacitation by an existing STI may increase the likelihood of HIV infection. Pre- or co-existing STI can lead to lesions in the skin, allowing the HIV virus to more easily penetrate the skin barrier, or can cause inflammation facilitating HIV contact with immune cells.[26–28]

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Interestingly, when comparing population statistics at baseline, the HIV-seronegative MSM population was more likely to engage in unprotected receptive anal sex than the HIV positive population. We may hypothesize that some HIV positive men who were aware of their status were taking greater precautions to prevent HIV transmission to their sex partners. However, not all participants had performed an HIV test within the last year of baseline; as such they would not have the information necessary to make decisions based on their serostatus. It is then likely that other dynamics, not directly expressed in individual behaviors, are contributing to this paradoxical phenomenon. For example, as related to sexual networks of the individual; some respondents may be in more at-risk sex networks and may therefore be more likely to contract HIV even with safer sex practices.[29] Those who engage in riskier sex, such as sex workers or those having sex with sex workers, would be more likely to use condoms because of the perceived risk of this activity. Likewise they may even report condom use more frequently due to social desirability bias.

A higher number of years of sexual activity was the only protective factor for anal gonorrhea and chlamydia. We attribute this to the transient nature of bacterial infections, which can be cured with antibiotics. Experience with prior infections or general knowledge can allow individuals to recognize the infections or take precautions to prevent infection. Significant risk factors for anal gonorrhea included TW identity, condomless compensated sex, having a greater number of sex partners, and engaging in receptive anal sex with condoms. STI prevalence is typically elevated within the TW population compared to the already high levels among homosexual and bisexual men. As a result of the aforementioned personal, socioeconomic, and structural conditions it is reasonable that TW identity associates as a risk factor for anal gonorrhea. Any form of sexual activity with or without protection can increase the likelihood of STI acquisition, and the risk likely rises when engaging in compensated sex with clients.[30] If a client engages in compensated unprotected sex with a sex worker, it is likely that they have engaged in similar behaviors with other gay or transgender individuals, including sex workers.

Protected and unprotected anal sex were risk factors for anal chlamydia. As it would be expected, engaging in anal sex with or without protection increases the likelihood of contracting an anal STI. As with anal gonorrhea, not using condoms during compensated sex would increase the likelihood of exposure to chlamydia.

There were several limitations to this study. The 9 month gaps between follow-ups of study participants present challenges in terms of capturing curable STIs which may have been contracted but were subsequently treated within this period. Additionally, measurement of risk behaviors focused on a recall window of 6 months, which does not cover the entire 9-month time between visits; this could miss risk behavior associated with STI incidence during the follow-up period. However, the shorter recall window was included to achieve more accurate recollection among the study participants. The 80% retention of study participants over the course of 18 months of the study may have produced follow-up dropout bias; however the only statistically significant difference between those who remained until the second follow-up and those who did not was related to the number of years since sexual debut. Dropouts were an average of 13.6 years from their sexual debut, compared to 15.8 years among those who remained in the study ($P < 0.01$). Although this study includes an

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ethnographically identified population and not a random sample, study ethnographers identified and recruited all eligible MSM/TW from the included barrios. The conclusions of this study should be interpreted as representing MSM/TW residents of low-income barrios in the province of Lima. An additional limitation is the multiple comparisons conducted; we have tried to focus our conclusions only on strong associations and not on those with nominal significance.

Conclusions

The high prevalence and incidence rates of HIV/STIs measured in the *Comunidades Positivas* study highlight the high risk among low income MSM and TW in Lima, their role as an important target population at the heart of a concentrated HIV epidemic, and the need for effective, community-relevant combination interventions. As STI co-infection is a notable risk factor for HIV infection, justifying HIV screening, prevention, and treatment interventions which focus on other STIs such as HSV-2, gonorrhea, and chlamydia. Hence, interventions will need to focus on prevention and treatment of HIV and these STIs in MSM and TW.

The lack of association of behavioral factors with incident HIV infection signals that our surveillance tools and measures may have been unable to capture dynamics that, for example, may affect the probability of having sex with infected partners. Beyond instructing participants to test frequently and always use condoms, HIV interventions need to further broaden the intervention perspective from the individual to the community and focus on screening and treating at-risk sex networks. More accurate surveillance tools need to be utilized; for example, not only focus on the last three partners, but rather capture the risk factors for those who have a substantially larger sex network.

Our study outlines the factors associated with incident infection; these should be taken into account when designing and implementing future interventions. Through continued focus on combination prevention and treatment of HIV infection, informed by up-to-date population surveillance and significant risk factors for infection, we can improve HIV/STI prevention interventions in Peru’s MSM and TW populations.

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Table 1

Characteristics of baseline seropositive and seronegative MSM and TW in Lima, Peru, 2009–2011

Variables and Population Statistics	Total (713) N (%)	HIV+ at baseline (127, 17.8%) N (%)	HIV- at baseline (581, 81.5%) N (%)	p-value
Age (quintiles)				
18–20	82 (11.5)	5 (3.8)	76 (11.6)	**<0.01**
21–24	146 (20.5)	27 (20.5)	198 (30.1)	
25–35	312 (43.8)	59 (44.7)	252 (38.4)	
36–45	173 (24.3)	41 (31.1)	131 (19.9)	
Sexuality and Gender Identity[1]				
Homosexual	459 (64.4)	83 (6.6)	372 (64.7)	0.84
Bisexual	40 (5.6)	8 (6.3)	31 (5.4)	
Transgender	207 (29.0)	35 (27.8)	172 (29.9)	
Educational level				
Less than secondary	66 (9.3)	13 (10.2)	52 (9.0)	0.79
Complete secondary	446 (62.6)	73 (57.5)	370 (63.7)	
Post-secondary	201 (28.2)	41 (32.3)	159 (27.4)	
Employment Status				
Employed	390 (54.7)	64 (61.0)	325 (62.5)	0.77
Unemployed	238 (33.4)	41 (39.0)	195 (37.5)	
Use of alcohol and drugs made condom use during sex more difficult in last 3 months				
Never	429 (60.2)	81 (63.8)	346 (59.9)	0.41
Sometimes/Always	281 (39.4)	46 (36.2)	232 (40.1)	
Use of condoms with compensated sex				
No compensated sex	321 (45.0)	50 (39.4)	267 (46.0)	0.13
Always	216 (30.3)	37 (29.1)	179 (30.9)	
Sometimes/Never	175 (24.5)	40 (31.5)	134 (23.1)	
Lack money in last 12 months				
Never	74 (10.4)	8 (6.3)	65 (11.2)	0.20
Rarely	216 (30.3)	35 (27.6)	179 (30.8)	
Sometimes	301 (42.2)	57 (44.9)	244 (42.0)	

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Variables and Population Statistics	Total (713) N (%)	HIV+ at baseline (127, 17.8%) N (%)	HIV- at baseline (581, 81.5%) N (%)	p-value
Very often	122 (17.1)	27 (21.3)	93 (16.0)	
# of sex partners in 1 year (quintiles)				
0–2	143 (20.1)	28 (22.0)	114 (19.7)	0.84
3–5	146 (20.5)	25 (19.7)	119 (20.5)	
6–14	160 (22.4)	29 (22.8)	123 (21.2)	
15–46	131 (18.4)	25 (19.7)	109 (18.8)	
47+	133 (18.7)	20 (15.7)	115 (19.8)	
Insertive anal sex in last 6 months[2]				
Never	532 (74.6)	92 (72.4)	434 (75.3)	0.07
Always protected	65 (9.1)	18 (14.2)	46 (8.0)	
At least once unprotected	116 (16.3)	17 (13.4)	96 (16.7)	
Receptive anal sex in last 6 months[2]				
Never	62 (8.9)	14 (11.1)	46 (8.2)	**<0.01**
Always protected	245 (35.1)	59 (46.8)	183 (32.5)	
At least once unprotected	392 (56.1)	53 (42.1)	334 (59.3)	
Persons with a CAGE score < 2[3]	242 (33.9)	42 (37.5)	197 (34.9)	0.59
Persons with a CAGE score 2+	444 (62.3)	70 (62.5)	368 (65.1)	
Years since sexual debut active (Mean ± StDev)	15.3 ± 8.1	17.5 ± 7.2	14.9 ± 8.2	**<0.01**

[1] The concepts of gender identity and sexuality are often conflated in Lima's LGBT community (i.e. transwomen when asked their gender identity may respond that they are gay)

[2] Some of the HIV positives at baseline are known positives and report less unprotected anal sex

[3] CAGE is the acronym for a 4 question screen for alcoholism, a 2+ CAGE score is indicative of a drinking problem

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Table 2

Prevalence and Incidence (per 100 person-years) of HIV, HSV-2, anal and pharyngeal gonorrhea, and anal and pharyngeal chlamydia among MSM and TW, Lima, Peru 2009–2012

	MSM/TGW		MSM		TGW	
STIs	**Baseline prevalence (95% CI)**	**Incidence per 100 person-years (95% CI)**	**Baseline prevalence (95% CI)**	**Incidence per 100 person-years (95% CI)**	**Baseline prevalence (95% CI)**	**Incidence per 100 person-years (95% CI)**
HIV	17.9% (15.2–21.0%)	3.6 (3.5–3.7)	18.4% (15.1–22.1%)	4.0 (3.9–4.1)	16.9% (12.1–22.7%)	2.3 (2.1–2.5)
HSV-2	69.7% (66.1–73.1%)	17.2 (16.8–17.7)	65.0% (60.6–69.3%)	17.9 (17.3–18.4)	80.7% (74.6–85.8%)	12.2 (10.1–14.2)
Anal gonorrhea	9.6% (7.5–12.0%)	10.1 (10.0–10.2)	8.6% (6.2–11.6%)	8.0 (7.8–8.1)	12.3% (8.1–17.6%)	15.3 (14.9–15.7)
Pharyngeal gonorrhea	6.5% (4.8–8.5%)	7.8 (7.8–7.9)	5.4% (3.6–8.0%)	7.6 (7.5–7.8)	9.7% (6.0–14.6%)	8.6(8.3–8.9)
Anal chlamydia	19.0% (16.1–22.1%)	16.3 (16.2–16.4)	19.3% (15.7–23.2%)	16.1 (15.9–16.3)	20.2% (14.9–26.4%)	16.9 (16.5–17.4)
Pharyngeal chlamydia	4.8% (3.3–6.6%)	3.4 (3.3–3.4)	4.1% (2.5–6.4%)	3.4 (3.3–3.5)	6.8% (3.7–11.1%)	3.4 (3.2–3.6)

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Table 3

Bivariate and multivariate associations with HIV and HSV-2 infection

Variables	HIV						HSV-2					
	Crude HR	95% CI	P	Adjusted HR	95% CI	P	Crude HR	95% CI	P	Adjusted HR	95% CI	P
Years since sexual debut	**0.95**	**0.91–1.00**	**0.04**	0.96	0.92–1.01	0.13	**1.05**	**1.00–1.10**	**0.05**	1.06	1.00–1.12	0.06
Sexual/Gender identity												
Gay/Bisexual	Ref			Ref			Ref			Ref		
Travesti	0.59	0.22–1.57	0.29	0.47	0.16–1.35	0.16	0.70	0.29–1.69	0.43	0.74	0.28–1.98	0.55
Use of condoms during paid sex												
No paid sex	Ref						Ref					
Always	0.95	0.41–2.20	0.90				0.74	0.34–1.59	0.44			
Sometimes/Never	0.65	0.19–2.29	0.51				1.52	0.73–3.16	0.26			
Alcohol/drugs make condom use more difficult, last 3 months												
Never	Ref						Ref					
Sometimes/Always	1.15	0.52–2.53	0.73				1.62	0.89–2.95	0.11			
Lack money, last 12 months												
Never	Ref						Ref			Ref		
Rarely	1.69	0.38–7.57	0.50				0.41	0.16–1.05	0.06	0.39	0.15–1.01	0.05
Sometimes	1.32	0.29–5.91	0.72				0.64	0.27–1.52	0.31	0.56	0.24–1.34	0.19
Very often	1.89	0.32–11.10	0.48				0.85	0.27–2.64	0.78	0.73	0.21–2.59	0.63
CAGE positive	1.10	0.46–2.64	0.83				1.46	0.81–2.65	0.21			
No. of sex partners, last 12 months (quintiles)												
0–2	Ref			Ref			Ref			Ref		
3–5	2.45	0.48–12.48	0.28	2.08	0.41–10.72	0.38	1.62	0.47–5.61	0.45	1.70	0.47–6.06	0.42
6–14	3.98	0.85–18.59	0.08	3.26	0.67–15.84	0.14	**3.15**	**1.01–9.82**	**0.05**	**3.21**	**1.03–9.97**	**0.04**
15–46	3.14	0.64–15.30	0.16	1.99	0.37–10.61	0.42	**3.65**	**1.15–11.65**	**0.03**	**3.97**	**1.27–12.38**	**0.02**
47+	1.95	0.36–10.71	0.44	1.69	0.30–9.68	0.55	1.48	0.36–6.06	0.59	1.67	0.39–7.14	0.49
Insertive anal sex, last 6 months												
Never	Ref						Ref					
Always protected	0.88	0.21–3.75	0.87				0.69	0.25–1.87	0.47			

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Variables		HIV						HSV-2					
		Crude HR	95% CI	P	Adjusted HR	95% CI	P	Crude HR	95% CI	P	Adjusted HR	95% CI	P
	At least once unprotected	0.67	0.16–2.85	0.59				0.94	0.39–2.27	0.89			
Receptive anal sex, last 6 months													
	Never	Ref						Ref					
	Always protected	1.37	0.39–4.85	0.63				1.14	0.50–2.55	0.76			
	At least once unprotected	0.62	0.15–2.55	0.51				0.70	0.28–1.72	0.43			
Has a stable partner													
	No	Ref						Ref					
	Yes	0.59	0.27–1.28	0.18				1.34	0.72–2.50	0.35			
Incident HSV-2/Anal GC/Anal CT													
	No	Ref			Ref								
	Yes	**4.93**	**2.27–19.73**	**<0.01**	**3.73**	**1.59–8.74**	**<0.01**						

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Table 4

Bivariate and multivariate associations with anal and pharyngeal gonorrhea infection

Variables	Anal Gonorrhea						Pharyngeal Gonorrhea					
	Crude HR	95% CI	P	Adjusted HR	95% CI	P	Crude HR	95% CI	P	Adjusted HR	95% CI	P
Years since sexual debut	**0.95**	**0.92–0.97**	**<0.01**	**0.94**	**0.91–0.97**	**<0.01**	**0.95**	**0.93–0.98**	**<0.01**	**0.95**	**0.92–0.97**	**<0.01**
Sexual/Gender Identity												
Gay/Bisexual	Ref			Ref			Ref			Ref		
Travesti	**1.98**	**1.27–3.08**	**<0.01**	**1.68**	**1.04–2.73**	**0.04**	1.19	0.74–1.93	0.47	1.23	0.76–2.00	0.39
Use of condoms with paid sex												
No paid sex	Ref			Ref			Ref					
Always	**1.89**	**1.16–3.01**	**0.01**	1.43	0.78–2.65	0.25	1.27	0.76–2.12	0.37			
Sometimes/Never	**2.64**	**1.54–4.52**	**<0.01**	**2.36**	**1.26–4.42**	**0.01**	1.07	0.54–2.11	0.84			
Alcohol/drugs make condom use more difficult in last 3 months												
Never	Ref						Ref					
Sometimes/Always	1.36	0.88–2.08	0.16				1.19	0.73–1.92	0.48			
Lack money in last 12 months												
Never	Ref						Ref					
Rarely	1.22	0.56–2.68	0.62				2.07	0.74–5.80	0.17			
Sometimes	1.23	0.57–2.65	0.60				1.89	0.67–5.29	0.23			
Very often	1.45	0.58–3.67	0.43				1.76	0.50–6.23	0.38			
CAGE	1.07	0.67–1.69	0.79				0.83	0.50–1.37	0.46			
# of sex partners in 1 year (quintiles)												
0–2	Ref						Ref					
3–5	**3.80**	**1.46–9.90**	**<0.01**	2.34	0.98–5.60	0.06	0.87	0.41–1.85	0.72			
6–14	**3.52**	**1.27–9.75**	**0.02**	1.89	0.74–4.84	0.18	0.52	0.21–1.29	0.16			
15–46	**6.95**	**2.67–18.10**	**<0.01**	**3.31**	**1.34–8.18**	**0.01**	1.36	0.66–2.78	0.40			
47+	**4.17**	**1.55–11.22**	**<0.01**	1.74	0.67–4.54	0.26	1.26	0.60–2.66	0.54			
Insertive anal sex in last 6 months												
Never	Ref						Ref					
Always protected	1.05	0.48–2.29	0.89				0.62	0.25–1.53	0.29			

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Variables		Anal Gonorrhea						Pharyngeal Gonorrhea					
		Crude HR	95% CI	P	Adjusted HR	95% CI	P	Crude HR	95% CI	P	Adjusted HR	95% CI	P
	At least once unprotected	0.67	0.29–1.55	0.35				0.91	0.42–1.97	0.82			
Receptive anal sex in last 6 months													
	Never	Ref			Ref			Ref					
	Always protected	1.90	0.90–4.02	0.09	**2.76**	**1.02–7.51**	**0.05**	1.83	0.78–4.31	0.16			
	At least once unprotected	1.65	0.73–3.74	0.23	2.07	0.72–5.89	0.18	1.48	0.63–3.49	0.37			
Do you have a stable partner?													
	No	Ref						Ref					
	Yes	1.20	0.77–1.88	0.42				1.03	0.65–1.63	0.90			

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Table 5

Bivariate and multivariate associations with anal and pharyngeal chlamydia infection

Variables	Anal Chlamydia						Pharyngeal Chlamydia					
	HR	95% CI	P	aHR	95% CI	P	HR	95% CI	P	aHR	95% CI	P
Years since sexual debut	**0.96**	**0.94–0.98**	**<0.01**	**0.96**	**0.93–0.98**	**<0.01**	0.96	0.91–1.00	0.06	0.96	0.91–1.00	0.07
Sexual/Gender Identity												
Gay/Bisexual	Ref			Ref			Ref			Ref		
Travesti	1.08	0.76–1.54	0.65	1.08	0.75–1.57	0.67	1.03	0.48–2.18	0.94	1.05	0.49–2.25	0.89
Use of condoms with paid sex												
No paid sex	Ref			Ref			Ref					
Always	1.29	0.91–1.85	0.16	1.15	0.76–1.75	0.50	0.58	0.25–1.35	0.21			
Sometimes/Never	1.50	0.97–2.33	0.07	**1.61**	**1.01–2.57**	**0.05**	0.87	0.32–2.37	0.79			
Alcohol/drugs make condom use more difficult in last 3 months												
Never	Ref						Ref					
Sometimes/Always	1.21	0.85–1.71	0.29				1.14	0.53–2.43	0.73			
Lack money in last 12 months												
Never	Ref						Ref					
Rarely	1.07	0.59–1.94	0.82				0.59	0.15–2.32	0.45			
Sometimes	0.87	0.48–1.59	0.67				0.84	0.23–3.12	0.80			
Very often	0.85	0.37–1.92	0.69				1.47	0.33–6.45	0.61			
CAGE	1.37	0.91–2.07	0.13				1.79	0.75–4.29	0.19			
# of sex partners in 1 year (quintiles)												
0–2	Ref						Ref					
3–5	1.25	0.71–2.21	0.44	1.25	0.73–2.14	0.42	2.32	0.71–7.59	0.17			
6–14	1.29	0.73–2.32	0.38	1.12	0.63–1.99	0.71	1.33	0.36–4.96	0.67			
15–46	**1.86**	**1.07–3.24**	**0.03**	1.22	0.69–2.18	0.49	1.20	0.30–4.81	0.80			
47+	1.43	0.82–2.49	0.20	1.03	0.57–1.85	0.93	2.24	0.67–7.45	0.19			
Insertive anal sex in last 6 months												
Never	Ref			Ref			Ref					
Always protected	0.52	0.25–1.10	0.09	0.56	0.27–1.16	0.12	0.26	0.04–1.89	0.18			
At least once unprotected	1.20	0.74–1.95	0.47	1.31	0.76–2.24	0.33	0.55	0.13–2.32	0.41			

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Variables	Anal Chlamydia						Pharyngeal Chlamydia					
	HR	95% CI	P	aHR	95% CI	P	HR	95% CI	P	aHR	95% CI	P
Receptive anal sex in last 6 months												
Never	Ref			Ref			Ref					
Always protected	1.63	0.90–2.94	0.11	**2.25**	**1.04–4.86**	**0.04**	1.25	0.35–4.40	0.73			
At least once unprotected	**2.24**	**1.19–4.19**	**0.01**	**2.63**	**1.20–5.79**	**0.02**	1.71	0.53–5.53	0.37			
Do you have a stable partner?												
No	Ref						Ref					
Yes	0.96	0.71–1.29	0.77				0.93	0.46–1.87	0.84			

aHR = Adjusted HR, adjusted for all variables listed in the model.