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The Emerging HIV Epidemic among Men Who have Sex with Men in Tamil Nadu, India: Geographic Diffusion and Bisexual Concurrency

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Abstract

In India, men who have sex with men (MSM) remain hidden because anal intercourse was criminalized and marriage socially required. We characterize HIV/STI prevalence among MSM in

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Tamil Nadu. Eligible participants were recruited using respondent-driven sampling in eight cities ($n = 721$). Median age was 28, 34% were married and 40% self-identified as homosexual. Median number of male partners in the prior year was 15; 45% reported any unprotected anal intercourse (UAI). HIV, *herpes simplex virus-2* (HSV-2), chronic hepatitis B virus (HBV) and syphilis prevalence were 9, 26, 2 and 8%, respectively; among married men, all were higher: 14, 32, 3 and 11% ($p < 0.01$ for HIV and HSV-2). Less education, HSV-2, more male partners, UAI and not having a main male partner were associated with HIV prevalence. The high STI and UAI prevalence may lead to a burgeoning HIV epidemic among MSM, reinforcing the need for focused preventive measures incorporating complex circumstances.

Keywords

Men who have sex with men; India; HIV; STIs; Sexual concurrency

Introduction

Since the first cases of AIDS were described in 1981 among homosexual men in the US [1] the epidemic has spread across populations and regions with heterosexual transmission accounting for the majority of global HIV infections [2]. Most prevention and treatment programs have targeted heterosexual transmission, especially in lower-and-middle income countries, resulting in neglect of other high-risk populations such as men who have sex with men (MSM) [2]. MSM in developing/transitional countries have a several-fold higher odds of HIV infection compared to the general population, with an 18-fold higher risk in Asia [3].

In India, the first evidence of HIV was described among sex workers in Tamil Nadu (TN) [4], then spreading to monogamous housewives via their husbands [5, 6]. Since heterosexual transmission is the primary driver of HIV in India, most prevention programs have targeted these individuals; recent evidence suggests that the HIV epidemic is declining among these populations [7, 8]. By contrast, MSM remain the only high-risk population in India where HIV prevalence is increasing [9].

There are an estimated 2.35 million sexually active MSM in India [10]; historically, MSM in India have been a hidden population because of Section 377 of the Indian Penal Code which criminalizes anal intercourse and Indian culture's requirement of opposite sex marriage [11, 12]. Consequently, few studies of HIV epidemiology among MSM in India exist. Most derive from urban sexually transmitted infection (STIs) clinics and few have characterized MSM in rural/semi-urban areas [13–17]. In a landmark decision on July 2, 2009, the Delhi High Court repealed Section 377 [18]. While this allows more freedoms for MSM, it is likely that stigma and discrimination will continue and may even increase as MSM become more visible in Indian society.

The current analysis presents the findings of a 2008 rapid assessment in TN aimed at (1) testing the feasibility of respondent-driven sampling (RDS) to recruit MSM populations across urban, semi-urban and rural settings; and (2) characterizing HIV/STI prevalence and associated factors among MSM in TN.

Methods

Study Setting

This study was conducted by the YR Gaitonde Centre for AIDS Research and Education (YRGCARE), a nongovernmental organization (NGO) in Chennai, across 18 different cities in the south Indian state of TN. Six of these sites were urban centers such as Chennai and Coimbatore, six were semi-urban such as Erode and Dindigul and six were rural (e.g., Nilgiris) (Fig. 1). All sites were classified as urban or semi-urban or rural according to the Indian government's classification system, which categorizes cities based on the local governing structure (e.g., Mayor, district collector, Panchayat). The sites were purposively sampled based on the pre-existence of NGOs/community based-organizations (CBOs) that worked with HIV prevention in these cities—not all of these NGOs/CBOs had previously worked with MSM populations but all were open to it. The adult male population in these cities ranged from ~100,000 to over two million. In each location, YRGCARE partnered with a local NGO/CBO and either utilized space within the local organization or rented space for study activities. This study was approved by the YRGCARE institutional review board.

Study Population

Eligible persons self-identified as male, were 18 years of age, and reported anal/oral intercourse with a man in the prior year. Prior to sampling, we conducted ethnographic work with NGOs to identify “peer leaders” who could be “seeds” for recruitment. These seeds were either nominated by the NGOs/MSM at the site as the most connected MSM or were self-nominated. Each seed was provided three referral coupons to give to other men whom they knew and thought would satisfy eligibility criteria. Each of these three participants referred by the seed was given three coupons each to refer three more participants. We allowed the networks initiated by each seed to run for three waves for a maximum of 39 recruits per seed. All but one site had one seed; Chennai had two due to its large population. A total of 19 seeds recruited 721 MSM from the 18 sites during October–November 2008. The median age of the seeds was 30 years; three were married and 14 self-identified as homosexual. Seventeen reported a history of commercial sex work and five were HIV-infected; only one seed was aware of his status prior to receiving an HIV test through this study.

Study Procedures and Data Collection

At each site, participants provided written informed consent. A risk assessment questionnaire was administered by an interviewer in Tamil. After pre-test counseling, a blood sample was collected. Finally, each participant was given coupons to recruit three additional participants. All samples were processed at the YRGCARE infectious disease laboratory and all participants returned for results and post-test counseling. Participants were compensated INR 300 (USD 6). In this study, participants were not compensated for referring their peers.

HIV serostatus was determined using double ELISA (Murex HIV-1.2.O, Abbott Murex, UK and Vironostika® HIV Uniform II Ag/Ab, Biomérieux, The Netherlands). Exposure to

Herpes simplex virus, type 2 (HSV-2) was diagnosed by the presence of antibodies (IgG) to HSV-2 using ELISA methodology (Euroimmun AG, Lubek, Germany). Participants were classified as negative if their HSV-2 status was indeterminate. Syphilis was detected by an initial screening with RPR (Span Diagnostics Ltd., Surat, India) and confirmed with TPPA (Fujirebio Inc., Tokyo, Japan). Chronic HBV infection was determined by the presence of hepatitis B surface antigen (HBsAg) (HepanostikaHBsAg Uniform II, Biomérieux, The Netherlands) and hepatitis C serostatus was characterized by antibodies to HCV (anti-HCV) using the Murex Anti-HCV kit (Abbott Murex, Republic of South Africa).

The risk assessment questionnaire captured information on general demographics, sexual identity, history of sexual behavior in the prior year with men and women, experience with injection drug use, general health care access and HIV and STI testing experience. In terms of sexual identity, men were asked if they were heterosexual, homosexual or bisexual. In terms of sexual behavior, men were asked about their experiences with oral, anal and vaginal sex with main and other male and female partners. Participants were asked both whether they had ever exchanged sex for money or goods and whether they had exchanged money or goods for sex. For sexual acts between men, we did not distinguish between insertive and receptive sexual acts.

Statistical Analysis

As the purpose of this study was to test the feasibility of RDS, a chain referral strategy used to recruit hidden populations [19], and not to accrue an RDS sample, all networks were intentionally stopped at the third recruitment wave. Data are thus treated as a convenience sample, as a minimum of six recruitment waves is required to satisfy RDS criteria [20]. Chi-squared/Mann-Whitney tests were used to compare demographic and risk behaviors between HIV-infected and uninfected MSM as well as those with and without an ulcerative STI. Multivariate Poisson regression with generalized estimating equations and robust variance estimation was used to identify factors associated with prevalent HIV infection, HSV-2 and syphilis while accounting for clustering by site [21]. Confidence intervals reported reflect the robust standard errors in their estimation. All variables deemed important a priori were included in the final multivariate model regardless of statistical significance. The analysis of correlates of HIV excluded eight men who were aware they were HIV positive at baseline. Statistical analyses were conducted using Intercooled STATA Version 10.1 (College Station, TX, USA).

Results

Feasibility of RDS

The median number of referrals per seed/recruit was three. All participants knew the person who referred them; 52% were referred by a friend, 30% by a casual sexual partner and 16% by a main sexual partner. Ninety-five percent of the 760 referral cards handed out were returned to the study site by referred participants; no referred participants were ineligible or refused participation.

Demographics, Risk Behaviors and Health-Seeking Behaviors

The median age was 28 years (interquartile range [IQR]: 23–36; HIV-infected participants were older (32 vs. 28 years; $p < 0.001$). The majority (60%) self-identified as bisexual. About 56% were single and 34% were married to a woman. The proportion married was higher among HIV-infected than HIV-uninfected MSM ($p < 0.01$). HIV-infected participants were also less educated (Table 1).

The median number of male partners in the prior year was 15; HIV-infected MSM reported more male partners (25 vs. 15; $p < 0.001$). The proportions who reported unprotected anal intercourse (UAI) and exchanging money for sex with another male in the prior year were 45 and 84%, respectively.

Almost half (45%) had visited a health care worker (HCW) in the prior year; HIV-infected participants were more likely to have visited a HCW (60 vs. 40%; $p < 0.01$). Overall, 391 (54%) had previously been tested for HIV. Of those who tested HIV positive in the study, 40 (62%) had been previously tested for HIV and only eight (12%) reported being previously diagnosed as HIV-infected.

Prevalence of HIV and STIs

The prevalence of HIV, syphilis, chronic HBV and HSV-2 were 9.0, 8.0, 2.4 and 25.8%, respectively. Only one participant had antibodies to HCV. HIV-infected participants had significantly higher prevalence of antibodies to HSV-2 (58.5 vs. 22.6%), syphilis (26.2 vs. 6.3%) and chronic HBV (7.7 vs. 1.8%; $p < 0.001$ for all).

HIV infections were not restricted to the large metropolitan cities in TN (Fig. 1); several semi-urban settings and small towns (population ~1 million) such as Perambalur and Sivagangai also had HIV-infected MSM. There was no statistically significant difference in HIV prevalence across urban, semi-urban and rural sites ($p = 0.47$).

Correlates of HIV and STIs

In univariate analysis, older age, less education, being married, HSV-2 positivity and having more male sex partners were significantly associated with higher HIV prevalence. History of UAI in the prior year was associated with higher HIV prevalence and having a main male partner was associated with lower HIV prevalence, but these associations did not attain statistical significance.

In the final multivariate model (Table 2), neither age nor being married remained statistically associated with higher HIV prevalence but they were retained in the final model. Lower levels of education remained significantly associated with higher HIV prevalence (PR comparing no education to secondary/university: 2.35; 95% CI: 1.30, 4.23) as did HSV-2 seropositivity (PR: 3.20; 95% CI: 1.88, 5.45). Having more male sexual partners remained significantly associated with higher HIV prevalence (PR for 50 partners vs. 5 partners: 2.98; 95% CI: 1.12, 7.89). Additionally, having at least one main partner became significantly associated with lower HIV prevalence (PR: 0.54; 95% CI: 0.33, 0.88) as did a history of UAI in the prior year. Results did not change substantially when eight men who were aware of their HIV status were excluded.

We further examined correlates of ulcerative STIs (Table 3). In univariate analysis, both syphilis and HSV-2 prevalence were associated with older age, lower educational attainment, marriage and a higher number of male partners in the prior year. Having a main male partner in the prior year was not associated with either and always UAI was associated with higher prevalence of HSV-2 and lower prevalence of syphilis but neither was statistically significant. In multivariate analysis, older age and higher number of male partners in the prior year remained significantly associated with prevalence of syphilis and HSV-2. Lack of education remained associated with higher HSV-2 but not syphilis prevalence.

Risk Behaviors and Prevalence of HIV/STIs among Married MSM

Overall, one-third ($n = 247$) were married; of these, 85% reported sexual intercourse with a woman in the prior year. Sex with women was more common among married versus unmarried MSM (85 vs. 22%, $p < 0.001$). Sixty-two percent of married MSM reported only one female partner in the prior year, while 23% had multiple female partners [median: 4 (IQR: 3–8)]. Married MSM also had significantly higher prevalence of HIV/STIs compared to unmarried MSM (Fig. 2). The prevalence of HIV was lower among married MSM who had sex with multiple female partners versus those who reported sex with no women or one female partner in the prior year (8.8% vs. 14.8%; $p = 0.06$). Prevalence was lowest among MSM who were not married but reported sex with women (4.4%). Among the married MSM, 83% reported vaginal intercourse and 68% reported unprotected vaginal intercourse. Additionally, 21% of the married MSM reported exchanging money for sex with a non-spousal female partner.

Discussion

These findings substantiate the existence of a burgeoning HIV epidemic among MSM in TN highlighting several important public health issues. First, RDS is feasible for recruiting community-based MSM samples. Second, these findings confirm the existence of HIV epidemics among MSM in non-urban settings in India. Third, this study substantiates incomplete access to VCT and health care services among MSM. Finally, the high prevalence of HIV and STIs among married MSM supports the hypothesis that MSM may serve as a “bridge population”.

Tamil Nadu has historically been one of six states considered to have a high HIV prevalence in India [22]. However, HIV prevalence declined from 0.67% in 2004 to 0.25% in 2007 among antenatal clinic attendees [7]. Concurrently, HIV prevalence among MSM in TN increased from 4.2% in 2003 to 6.6% in 2007 according to sentinel surveillance [9]. The few community-based reports of MSM in TN also suggest high HIV prevalence among MSM; Go and colleagues previously reported an HIV prevalence of 6.5% in Chennai [23] and a more recent report estimated the HIV prevalence among 2025 MSM and *hijras* in TN to be 7.5% in 2007, which is comparable to our prevalence of 9% [24].

Community-based studies of HIV, STIs and other co-morbidities among MSM in India are few; the majority are based in STI clinics in large metropolitan cities. [13–17] The major barrier to recruitment of MSM for studies has historically been Section 377 of the Indian Penal Code [11]. Indeed, multiple reports including one from Chennai in 2007 have

characterized violence experienced by MSM from members of the community and police [25]. Even with the recent repeal of Section 377, it is likely that hidden pockets of MSM will remain because of the social pressures in Indian society to marry [12]. Thus, tools for recruitment of “hidden” populations including RDS and venue-time based sampling (VTBS) remain important. The previous report by Brahnam and colleagues substantiates the feasibility of VTBS [24]. In the current study, 721 MSM were recruited in less than two months from 18 different locations in Tamil Nadu using peer driven sampling, illustrating the feasibility of RDS. The primary differences between the two approaches is that RDS reaches populations that may not visit “gay” identified venues and RDS can also be utilized when no gay venues/locations exist, as may be the case in many smaller towns in India. The proportion of participants who refused participation in this study (5%) was lower than the VTBS study by Brahnam and colleagues (31%) [24] highlighting the usefulness of RDS.

Most studies of MSM in India have been restricted to larger cities primarily due to the belief that homosexuality is rare in rural areas. A survey conducted among 2,910 men from rural settings in five Indian states identified that 9.5% of single men and 3% of married men reported anal intercourse with another man in the prior year [26]. Our investigation identified high HIV and STI prevalence among MSM in many smaller towns in TN. In some of these semi-urban/rural settings, the HIV prevalence appeared to be comparable to large metropolitan cities. Epidemiologic studies and interventions will be more difficult in these settings as MSM are likely to be more hidden as homosexuality is less culturally acceptable. However, these data suggest a need for targeting such settings.

In this study, we observed a large variation in the HIV prevalence (0–21%) across the 18 sites. While we were limited by our sample size to examine these differences in-depth, it is possible that some real differences may exist. For example, Nilgiris had the highest prevalence of HIV across sites; Nilgiris is a hill station and a major tourist attraction for both Indians and foreigners. It is possible that MSM in this area have higher exposure to MSM from other regions with high HIV prevalence outside of Tamil Nadu. Further, in smaller cities it is likely that the MSM networks are themselves smaller, thereby facilitating HIV transmission within limited sexual networks. On the other hand, peer-driven recruitment may account for some of the variability in HIV prevalence. Larger studies which utilize RDS in these settings will provide more insight into these differences.

Fewer than half of the study participants had been previously tested for HIV and only 20% of the HIV-infected participants were aware of their status. These findings highlight the importance of not only improving access to VCT services but also impressing on sexually active MSM the need for regular HIV testing. Earlier diagnosis coupled with culturally-appropriate counseling at regular intervals could induce behavior change. One of the major barriers to health care in this group remains the high level of stigma and discrimination MSM face in social and medical settings [25]. There is a need for novel strategies to establish venues where MSM can receive the services they need free of such stigma. Beyond HIV-related services, it is important that these centers offer comprehensive medical and psychosocial services for conditions that are prevalent among MSM such as substance abuse and depressive symptoms [27].

Sexual concurrency has been suggested to lead to more rapid dissemination of HIV epidemics [28, 29]; in this setting, our finding of bisexual concurrency is particularly of concern. First, there is a high probability of transmission of HIV and STIs from these men to their monogamous wives (as has been observed with IDUs) [30, 31]. Second, some married MSM in this study were not only engaging in unprotected sexual intercourse with their wives but in some cases with other women as well including female sex workers (FSWs), as has been previously documented [24]. These MSM may serve as a “bridge population” not only to their married monogamous wives but also between FSWs and MSM particularly in regions with high HIV prevalence among FSWs.

Interestingly, it was only those men who were married and reported only *one* female sexual partner who had higher prevalence of HIV, suggesting that sexual practices among MSM who are preferentially bisexual are different from MSM who are forced to marry because of societal pressures. Presumably, married men who have sex with multiple female partners are more likely truly bisexual versus those who have sex only with their wives. These married men with only one female partner may engage in higher risk behaviors because of their need to hide their homosexuality. Indeed, much of the higher prevalence of HIV among married MSM was explained by higher risk behaviors; they were less likely to have a main male sexual partner and tended to have more male partners. It remains unlikely that many of these men have disclosed their same-sex behavior to their spouses making interventions targeting this group of men and their wives particularly challenging. Until Indian society accepts homosexuality and directs prevention efforts in a non-judgmental manner, it is likely that these behaviors and attitudes will prevail.

We failed to identify an association between commercial sexual encounters and higher HIV prevalence as has been identified in other settings [24]. One potential explanation is that the prevalence of commercial sex encounters was so high that it might have limited detecting an association. Further, the lack of association between persons who report always having UAI and HIV prevalence could be explained by the fact that they were engaging in sex with fewer and more stable partners. This is further supported by the strong association between number of partners and HIV prevalence as well as the protective association between having a main male partner and HIV prevalence. Thus, strategies that encourage monogamy and serostatus disclosure among MSM may facilitate HIV prevention efforts in this population.

The prevalence of ulcerative STIs in this population was markedly high and factors associated with ulcerative STIs were similar to correlates of HIV with some minor exceptions. As has been previously demonstrated, there was a strong age effect for HSV-2 [32] and syphilis which was absent for HIV. Further, there was no protective association between having a main male partner and STI prevalence nor was there a strong effect of UAI. This may reflect the higher transmissibility of such infections and the lack of protection conferred by condom use for HSV-2. The high prevalence of ulcerative STIs in this population coupled by the strong association between HSV-2 and HIV transmission/acquisition reflects that these men are at continual elevated risk for HIV infection.

The cross-sectional design of this study limited our ability to establish a temporal association between specific exposures and HIV. As most of the risk behavior data was

restricted to behaviors in the prior year, inferences cannot be made about lifetime behaviors. Sample size limited us from comparing HIV/STI prevalence and risk behaviors across sites. HBsAg testing was used to identify cases of chronic HBV infection; however, we did not have information on other markers of HBV (e.g., anti-Hbc) which would have provided information on exposure as well as allow us to rule out acute cases of HBV. All behaviors in this study were self-reported and therefore subject to socially desirable reporting. Lastly, we did not collect information on whether the men engaged in insertive versus receptive anal sex limiting the ability to compare HIV/STI prevalence and demographic characteristics across sexual practices. While RDS samples should approximate a random sample of the population, in this case, we were limited by restricting recruitment to three waves of RDS. Therefore, the generalizability of our findings to MSM in India is limited. However, given that there have been no studies to date with random samples of MSM in India and the findings of our study are similar to other community-based studies among MSM in India, it is probable that these findings reflect some of the key underlying issues faced by MSM in India.

Limitations notwithstanding, this study had several key findings. The observation of high HIV prevalence among married MSM and the existence of HIV epidemics among MSM in semi-urban and rural settings need to be addressed to further control the HIV epidemic in India. The abolition of Section 377 was the first step towards changing society's perceptions of homosexuality in India [18]. However, much work needs to be done and interventions targeted at MSM and wives/female sexual partners of MSM need to be designed, tested and implemented. India is at an important crossroads; there exists a unique opportunity for primary prevention of HIV in this population given the high prevalence of risk behaviors and the lack of regular HIV testing. Further, it is likely that similar social conditions and sexual practices prevail in other parts of the world including Africa and parts of Eastern Europe where MSM epidemics are rapidly emerging. There is a small window of opportunity to act before the epidemic in India and other such countries escalates further.

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References

1. Pneumocystis pneumonia—Los Angeles. MMWR Morb Mortal Wkly Rep. 1981; 30(21):250–2. [PubMed: 6265753]
2. UNAIDS. 2008 report on the global AIDS epidemic. Aug 1.2009 2008
3. Baral S, Sifakis F, Cleghorn F, Beyrer C. Elevated risk for HIV infection among men who have sex with men in low- and middle-income countries 2000–2006: a systematic review. PLoS Med. 2007; 4(12):e339. [PubMed: 18052602]
4. Simoes EA, Babu PG, John TJ, et al. Evidence for HTLV-III infection in prostitutes in Tamil Nadu (India). Indian J Med Res. 1987; (85):335–8. [PubMed: 3623641]
5. Gangakhedkar RR, Bentley ME, Divekar AD, et al. Spread of HIV infection in married monogamous women in India. JAMA. 1997; 278(23):2090–2. [PubMed: 9403424]

6. Newmann S, Sarin P, Kumarasamy N, et al. Marriage, monogamy and HIV: a profile of HIV-infected women in south India. *Int J STD AIDS*. 2000; 11(4):250–3. [PubMed: 10772089]
7. Arora P, Kumar R, Bhattacharya M, Nagelkerke NJ, Jha P. Trends in HIV incidence in India from 2000 to 2007. *Lancet*. 2008; 372(9635):289–90. [PubMed: 18657701]
8. Kumar R, Jha P, Arora P, et al. Trends in HIV-1 in young adults in south India from 2000 to 2004: a prevalence study. *Lancet*. 2006; 367(9517):1164–72. [PubMed: 16616559]
9. National AIDS Control Organization. HIV Sentinel Surveillance and HIV Estimation in India. A Technical Brief. Oct 1.2008 2007
10. National AIDS Control Organization. [Accessed 12 Dec 2006] HIV Sentinel Surveillance 2006 India Country Report. 2006. http://www.nacoonline.org/Quick_Links/HIV_Data/
11. Herget G. India: UNAIDS claims law criminalizing homosexuality hinders HIV prevention. *HIV AIDS Policy Law Rev*. 2006; 11(1):35–6. [PubMed: 16805023]
12. Asthana S, Oostvogels R. The social construction of male ‘homosexuality’ in India: implications for HIV transmission and prevention. *Soc Sci Med*. 2001; 52(5):707–21. [PubMed: 11218175]
13. Nandi J, Kamat H, Bhavalkar V, Banerjee K. Detection of human immunodeficiency virus antibody among homosexual men from Bombay. *Sex Transm Dis*. 1994; 21(4):235–6. [PubMed: 7974077]
14. Gupta A, Mehta S, Godbole SV, et al. Same-sex behavior and high rates of HIV among men attending sexually transmitted infection clinics in Pune, India (1993–2002). *J Acquir Immune Defic Syndr*. 2006; 43(4):483–90. [PubMed: 17019372]
15. Hernandez AL, Lindan CP, Mathur M, et al. Sexual behavior among men who have sex with women, men, and Hijras in Mumbai, India—multiple sexual risks. *AIDS Behav*. 2006; 10(4 Suppl):S5–16. [PubMed: 16832600]
16. Setia MS, Lindan C, Jerajani HR, et al. Men who have sex with men and transgenders in Mumbai, India: an emerging risk group for STIs and HIV. *Ind J Dermatol Venereol Leprol*. 2006; 72(6): 425–31.
17. Shinde S, Setia MS, Row-Kavi A, Anand V, Jerajani H. Male sex workers: are we ignoring a risk group in Mumbai, India? *Ind J Dermatol Venereol Leprol*. 2009; 75(1):41–6.
18. Bose, Nilajana. [Accessed 1 Aug 2009] Closet thrown open: gay community overjoyed at high courts judgement. Jul 2. 2009 <http://ibnlive.in.com/news/closet-opens-gay-community-overjoyed-at-hc-order/96193-3.html>
19. Heckathorn D. Respondent-driven sampling: a new approach to the study of hidden populations. *Soc Probl*. 1997; 44(2):174–99.
20. Heckathorn DD. Respondent-driven sampling II: deriving valid population estimates from chain-referral samples of hidden populations. *Social Probl*. 2002; (49):11–34.
21. Behrens T, Taeger D, Wellmann J, Keil U. Different methods to calculate effect estimates in cross-sectional studies. A comparison between prevalence odds ratio and prevalence ratio. *Methods Inf Med*. 2004; 43(5):505–9. [PubMed: 15702210]
22. National AIDS Control Organization. [Accessed 26 Feb 2006] Observed HIV prevalence levels statewide: 1988–2004. 2005. at: http://www.nacoonline.org/facts_statewise.htm
23. Go VF, Srikrishnan AK, Sivaram S, et al. High HIV prevalence and risk behaviors in men who have sex with men in Chennai, India. *J Acquir Immune Defic Syndr*. 2004; 35(3):314–9. [PubMed: 15076248]
24. Brahman GN, Kodavalla V, Rajkumar H, et al. Sexual practices, HIV and sexually transmitted infections among self-identified men who have sex with men in four high HIV prevalence states of India. *AIDS*. 2008; 22(Suppl 5):S45–57. [PubMed: 19098479]
25. Chakrapani V, Newman PA, Shunmugam M, McLuckie A, Melwin F. Structural violence against Kothi-identified men who have sex with men in Chennai, India: a qualitative investigation. *AIDS Educ Prev*. 2007; 19(4):346–64. [PubMed: 17685847]
26. Verma RK, Collumbien M. Homosexual activity among rural Indian men: implications for HIV interventions. *AIDS*. 2004; 18(13):1845–7. [PubMed: 15316346]
27. Srikrishnan, AK.; Solomon, S.; Vasudevan, CK.; Sethulakshmi, CJ.; Solomon, S. Qualitative assessment of HIV risks among MSM in South India. 5th IAS conference on HIV pathogenesis treatment and prevention; Cape Town, South Africa. 2009. [abstract MOPEC034]

28. Morris M, Kretzschmar M. Concurrent partnerships and the spread of HIV. *AIDS*. 1997; 11(5): 641–8. [PubMed: 9108946]
29. Watts CH, May RM. The influence of concurrent partnerships on the dynamics of HIV/AIDS. *Math Biosci*. 1992; 108(1):89–104. [PubMed: 1551000]
30. Panda S, Kumar MS, Lokabiraman S, et al. Risk factors for HIV infection in injection drug users and evidence for onward transmission of HIV to their sexual partners in Chennai, India. *J Acquir Immune Defic Syndr*. 2005; 39(1):9–15. [PubMed: 15851908]
31. Panda S, Chatterjee A, Bhattacharya SK, et al. Transmission of HIV from injecting drug users to their wives in India. *Int J STD AIDS*. 2000; 11(7):468–73. [PubMed: 10919490]
32. Looker KJ, Garnett GP, Schmid GP. An estimate of the global prevalence and incidence of herpes simplex virus type 2 infection. *Bull World Health Organ*. 2008; 86(10):805–12. [PubMed: 18949218]

Fig. 1.
HIV prevalence among men who have sex with men across 18 cities in Tamil Nadu, India (2008)

Fig. 2.
HIV and sexually transmitted infection (STI) prevalence by marital status among men who have sex with men in Tamil Nadu, India (2008)

Table 1

Demographics, risk behaviors, health seeking behaviors and prevalence of STIs among men who have sex with men in Tamil Nadu, India ($n = 721$)

Variable	Entire sample ^a ($n = 721$)	HIV Negative ^a ($n = 656$)	HIV Positive ^a ($n = 65$)
Age ^{**}			
Median (IQR)	28 (23–36)	28 (22–35)	32 (27–41)
Marital status ^{**}			
Single	401 (55.6)	371 (56.6)	30 (46.1)
Married	247 (34)	212 (32.3)	33 (50.8)
Living with male partner	68 (9.4)	66 (10.1)	2 (3.1)
Widowed/divorced	5 (1)	(1.1)	0
Highest level of education ^{**}			
None	30 (4.2)	23 (3.5)	7 (10.8)
Primary	145 (20.1)	127 (19.4)	18 (27.7)
Secondary	400 (55.5)	371 (56.6)	29 (44.6)
University	146 (20.3)	135 (20.6)	11 (16.9)
Monthly income			
< USD 40	295 (40.9)	270 (41.2)	25 (38.5)
USD 40–125	346 (48)	311 (47.4)	35 (53.9)
> USD 125	80 (11.1)	75 (11.4)	5 (7.7)
Permanent residence			
Yes	704 (97.6)	640 (97.6)	64 (98.5)
No	17 (2.4)	16 (2.4)	1 (1.5)
Self identified sexual orientation			
Homosexual	287 (39.8)	262 (39.9)	25 (38.5)
Bisexual	434 (60.2)	394 (60.1)	40 (61.5)
Male partners in the prior year ^{**}			
Median (IQR)	15 (6–50)	15 (5–40)	25 (10–60)
Female partners in the prior year			
Median (IQR)	0 (0–1)	0 (0–1)	0 (0–1)
Had unprotected anal sex in past year ^b			
Yes	324 (44.9)	288 (43.9)	36 (55.4)
No	397 (44.9)	368 (56.1)	29 (44.6)
Engaged in commercial sex with male			
Yes	604 (83.8)	547 (83.4)	57 (87.7)
No	117 (16.2)	109 (16.6)	8 (12.3)
Ever been tested for HIV			
Yes	391 (54.2)	351 (53.5)	40 (61.5)
No	330 (45.8)	305 (46.5)	25 (38.5)
Most recent HIV test report ^b			
Negative	347 (88.8)	324 (92.3)	23 (57.5)

Variable	Entire sample ^a (n = 721)	HIV Negative ^a (n = 656)	HIV Positive ^a (n = 65)
Positive	9 (2.3)	1 (0.28)	8 (20)
Did not collect result	31 (7.93)	24 (6.84)	7 (17.5)
Don't know/refused to answer	4 (1.02)	2 (0.57)	2 (5)
Visited health care worker (HCW) in prior year ^{**}			
Yes	321 (44.5)	282 (43)	39 (60)
No	400 (55.5)	374 (57)	26 (40)
HSV-2 infection ^{**}			
Yes	186 (25.8)	148 (22.6)	38 (58.5)
No	535 (74.2)	508 (77.4)	27 (41.5)
Syphilis ^{**}			
Yes	58 (8.04)	41 (6.3)	17 (26.2)
No	663 (92)	615 (93.8)	48 (73.9)
Chronic HBV infection ^{**}			
Yes	17 (2.36)	12 (1.8)	5 (7.7)
No	704 (97.6)	644 (98.2)	60 (92.3)

^a All numbers represent *n*(%) unless otherwise specified

^b Only among those who were tested for HIV (*n* = 391)

^{**} *P* < 0.05 when comparing HIV positive and HIV negative participants

Table 2

Factors associated with prevalent HIV infection among men who have sex with men in Tamil Nadu, India ($n = 721$)

Variable	Unadjusted PR (95% CI)	Adjusted PR (95% CI)
Age (per 5 year increase)	1.16 (1.06, 1.27)	0.99 (0.90, 1.09)
Highest level of education		
Secondary/university	1	1
Primary	1.69 (1.13, 2.52)	1.23 (0.63, 2.37)
None	3.19 (1.96, 5.17)	2.58 (1.38, 4.83)
Marital status		
Unmarried	1	1
Married	1.98 (1.05, 3.71)	1.48 (0.90, 2.43)
Monthly income		
< USD 40	1	–
USD 40–125	1.19 (0.75, 1.91)	–
> USD 125	0.74 (0.31, 1.73)	–
HSV-2 IgG rostatus		
Negative	1	1
Positive	4.30 (2.29, 8.09)	3.42 (1.81, 6.47)
Number of male partners in the prior year		
5	1	1
6–15	3.24 (1.13, 9.30)	2.75 (0.78, 9.66)
16–49	4.25 (0.97, 18.6)	3.47 (0.70, 17.2)
50	5.47 (1.46, 20.5)	3.86 (0.86, 17.3)
Unprotected anal intercourse (UAI) in prior year		
Never	1	1
Sometimes	1.82 (0.82, 4.03)	1.70 (0.93, 3.10)
Always	1.15 (0.50, 2.62)	1.11 (0.55, 2.23)
Commercial sex with male in prior year		
No	1	–
Yes	1.20 (0.60, 2.42)	–
Have at least one male main partner		
No	1	1
Yes	0.61 (0.32, 1.15)	0.54 (0.33, 0.89)
Sex with a woman in prior year		
No	1	–
Yes	0.99 (0.54, 1.80)	–
Ever had HIV test		
No	1	–
Yes	1.11 (0.72, 1.69)	–

PR prevalence ratio, CI confidence interval estimated using robust standard errors, HSV-2 herpes-simplex virus type 2, The final multivariate model excluded eight men who knew they were HIV positive at the time of the survey; all variables listed were included in the final multivariate model;

the decision not to include specific variables was based on statistical significance and collinearity between variables. For example, marriage and sex with women were too highly correlated to both be included

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Table 3

Factors associated with ulcerative sexually transmitted infections among men who have sex with men in Tamil Nadu, India ($n = 721$)

Variable	Unadjusted PR syphilis (95% CI)	Adjusted PR syphilis (95% CI)	Unadjusted PR HSV-2 (95% CI)	Adjusted PR HSV-2 (95% CI)
Age (per 5 year increase)	1.33 (1.26, 1.40)	1.34 (1.27, 1.40)	1.23 (1.17, 1.29)	1.23 (1.17, 1.28)
Highest level of education				
Secondary/university	1	1	1	1
Primary	1.03 (0.44, 2.44)	0.89 (0.41, 1.92)	0.68 (0.47, 0.98)	0.69 (0.50, 0.94)
None	0.47 (0.23, 0.96)	0.55 (0.26, 1.18)	0.49 (0.34, 0.72)	0.64 (0.49, 0.85)
Marital status				
Unmarried	1	1	1	1
Married	1.79 (1.06, 3.02)	1.14 (0.76, 1.73)	1.45 (1.06, 1.97)	1.03 (0.81, 1.32)
Monthly income				
< USD 40	1	–	1	–
USD 40–125	1.09 (0.55, 2.14)	–	0.81 (0.66, 1.01)	–
> USD 125	1.34 (0.76, 2.37)	–	0.59 (0.37, 0.92)	–
Number of male partners in the prior year				
5	1	1	1	1
6–15	1.74 (0.76, 4.0)	1.59 (0.69, 3.67)	1.49 (0.97, 2.29)	1.58 (0.98, 2.54)
16–49	2.08 (0.75, 5.74)	1.78 (0.66, 4.8)	1.48 (0.98, 2.25)	1.44 (0.91, 2.28)
50	3.43 (1.36, 8.66)	2.76 (1.17, 6.52)	2.07 (1.27, 3.35)	1.96 (1.16, 3.32)
Unprotected anal intercourse (UAI) in prior year				
Never	1	1	1	1
Sometimes	1.15 (0.70, 1.91)	1.17 (0.74, 1.85)	1.23 (0.91, 1.67)	1.3 (0.97, 1.74)
Always	0.57 (0.29, 1.12)	0.57 (0.30, 1.09)	1.26 (0.83, 1.92)	1.33 (0.95, 1.85)
Commercial sex with male in prior year				
No	1	–	1	–
Yes	1.05 (0.68, 1.63)	–	1.19 (0.92, 1.54)	–
Have at least one male main partner				
No	1	1	1	1
Yes	1.01 (0.66, 1.55)	1.30 (0.84, 2.01)	0.97 (0.73, 1.29)	1/09 (0.82, 1.43)
Sex with a woman in prior year				
No	1	–	1	–
Yes	0.86 (0.52, 1.42)	–	0.94 (0.71, 1.24)	–
Ever had HIV test				
No	1	–	1	–
Yes	1.88 (0.86, 4.07)	–	1.17 (0.84, 1.63)	–

PR prevalence ratio, CI confidence interval estimated using robust standard errors; all variables listed were included in the final multivariate model; the decision not to include specific variables was based on statistical significance and collinearity between variables. For example, marriage and sex with women were too highly correlated to both be included