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Sex Position, Marital Status, and HIV Risk Among Indian Men Who Have Sex with Men: Clues to Optimizing Prevention Approaches

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Abstract

A divide exists between categories of men who have sex with men (MSM) in India based on their sex position, which has consequences for the design of novel HIV prevention interventions. We examine the interaction between sex position and other attributes on existing HIV risk including previous HIV testing, unprotected anal intercourse (UAI), and HIV serostatus among MSM recruited from drop-in centers and public cruising areas in the twin cities of Hyderabad and Secunderabad, India. A survey was administered by trained research assistants and minimally invasive HIV testing was performed by finger-stick or oral testing. HIV seropositive MSM underwent $CD4^+$ lymphocyte count measurement. In our sample ($n=676$), 32.6% of men were married to women, 22.2% of receptive only participants were married, and 21.9% of men were HIV seropositive. In bivariate analysis, sex position was associated with previous HIV testing, UAI, HIV serostatus, and $CD4^+$ lymphocyte count at diagnosis. In multivariate analysis with interaction terms, dual unmarried men were more likely to have undergone an HIV test than insertive unmarried men (odds ratio [OR] 2.8; 95% confidence interval [CI] 1.2–6.5), a relationship that did not hold among married men. Conversely, dual married men were less likely than insertive married men to engage in UAI (OR 0.3; 95% CI 0.1–0.6), a relationship that did not hold among unmarried men. Further implementation research is warranted in order to best direct novel biologic and behavioral prevention interventions towards specific risk behaviors in this and other similar contexts.

Introduction

According to official Indian Government estimates, 2.5 million people in India were infected with HIV in 2006.[1] Within India, the state of Andhra Pradesh has the largest number of people living with HIV; population-based studies suggest that over 1% of the general population of the state is infected with the virus.[2]

The populations of Indian men who were initially identified as high risk for HIV acquisition included heterosexual truck drivers,[3] migrant workers,[4] and injection drug users.[5] Heterosexual men in the broader population initially demonstrated low rates of condom usage, with one large population-based survey of a predominantly heterosexual population in a high-prevalence district of India in 2005 finding that half of men reported more than one lifetime female partner or at least one partner who was a sex worker, but fewer than 10% of men had used a condom in the previous 6 months.[2] Fewer than 20% of the men in that district were estimated to have ever undergone HIV testing, and fewer than 30% of the men who had reported previous intercourse with a sex worker had undergone HIV testing.[6] Subsequently, interventions to promote safer sex among truck drivers[7] and customers of female sex workers[8] have been developed and implemented, but specifically do not address male sexual partners.

In India, men who have sex with men (MSM) were not initially identified as a high-risk group for the acquisition of HIV. As recently as a decade ago, even MSM who were

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familiar with HIV did not recognize that the disease existed in their communities.[9] However, more recently, surveys of MSM approached in clinics in Pune[10] and Mumbai[11] and recruited through peers in Chennai[12] have shown a high prevalence of HIV infection in this population.

A significant body of research exists regarding interventions among MSM to promote safer sex practices and prevent the spread of HIV.[13] However, significant cultural differences exist between MSM in the West, where most of this research has been conducted, and MSM in India. One of these differences is the divide between different MSM based on sex position, a divide that is not unique to India.[14] In general, men in India may describe insertive sex with other men as merely "*masti*" (play) and consider themselves heterosexual.[15] Those who practice receptive sex with other men constitute a distinct population for whom engaging in sex with other men is more central to their identity.[16] Men who practice both insertive and receptive sex with other men constitute yet another distinct group, although it is important to note that even among these men, only a small proportion identify with the term "gay."[9] The importance of sex position as a biologic determinant of HIV transmission has been reported in epidemiologic studies.[17] In these Western contexts, strategic positioning has become a form of HIV prevention, reflecting the majority of MSM who do not identify with a single sex position.[18] In the Indian context, most studies have not reported on sex position and HIV serostatus.[10,12,19–21] and in those that have, analyses have been unadjusted[22,23] or have excluded the dual position category.[22] Additionally, critical relationships between UAI, HIV testing history, and sex position have not been previously described in this population.

Another fundamental social difference between MSM in the West and MSM in India is the significant proportion of MSM in India who are married. Even men who fundamentally prefer sex with other men find it difficult to resist the intense cultural and familial pressures to marry that are widely present in South Asia.[15] Most wives of MSM are unaware of their husbands' extramarital activities,[24] and the need to keep one's activities secret could impact a man's ability or willingness to obtain condoms or other prevention tools for use with male partners, since condoms are typically associated in India with extramarital partners only,[25] or to seek out HIV testing. Setia[22] and Kumta,[11] performing similar analyses on overlapping samples of MSM from the same clinic in Mumbai, came to opposite conclusions about the impact of marital status on HIV serostatus, with the Kumta analysis suggesting that married MSM were more likely to be HIV seropositive, and the Setia analysis showing no significant difference in HIV prevalence between married and unmarried MSM, adjusting for age. The above suggests the need for further study of the role of marital status in the spread of HIV.

This study was conducted in response to a PEPFAR CDC Global AIDS Program (GAP) Stakeholders Conference in 2007, held in Hyderabad, India, which elicited formal Indian MSM community concerns about how little was known about the HIV epidemic amidst diverse sexual identities within the community in the absence of MSM-targeted HIV voluntary counseling and testing and care (VCT) services. In response, we sought to develop foundational knowledge about how MSM sex position might be associated with men's sex behavior, HIV testing history, and the likelihood of being HIV seropositive in order to refine existing and future HIV prevention interventions. Relatively novel biologic prevention interventions that could be of potential benefit to this specific population, such as circumcision, microbicides and pre-exposure prophylaxis, will likely require study trial designs which accounts for diverse MSM subgroupings such as sex position—groupings that could affect outcome measurement and intervention uptake.

Methods

Participants and setting

The study was conducted at six MSM drop-in centers and 10 "cruising areas" managed by two government sponsored MSM Community Based Organizations (CBOs), Darpan and Mithrudu, in the Hyderabad and Secunderabad twin cities, the capital of Andhra Pradesh, India between August 2008 and August 2009. Drop-in centers are small private apartments/office spaces where MSM CBOs organize and provide social services (e.g., counseling) to the community. Cruising areas are public venues such as bus stations, parks, and waterfront walkways where paid and unpaid sexual encounters occur. The CDC GAP stakeholders conference was held in Andhra Pradesh because this state has the highest numbers of HIV infected in India,[26] and the first rigorous MSM sex behavior assessment study in India was performed on this population,[19] which formed the basis for the measurements utilized in this study. MSM between the ages of 18 and 45 who were fluent Hindi or Telugu speakers, identified as men, and reported that they had anal intercourse with another man in the past 12 months were eligible for participation. Participants were approached from a nonrandomly generated sample, as was the practice of the locally run Andhra Pradesh State AIDS Control Society (APSACS) HIV prevention program that utilizes peer outreach workers to provide government services: behavior change communication, sexually transmitted infection care, condom promotion, and the creation of a supportive environment.[27] Of 1067 men who attended a drop-in center at least once during the recruitment period, 687 men were approached for enrollment, and 397 of those 687 men (57.8%) were actually enrolled in the study. An actual count of the number of men present in the cruising areas was not feasible, but of the 575 men who were approached in the field, 278 (48%) were enrolled in the study. One of two trained research assistants performed the interview, collected written informed consent, and conducted the HIV VCT procedures on all eligible and consenting study participants who were approached by peer outreach workers in the field or who presented to one of the MSM drop-in centers. HIV test results were available for all 676 subjects in the study.

Data collection procedures

Confidential interviews were administered in person by one of two trained research assistants with at least 5 years of experience working with this population. Each research assistant had previous experience in quantitative interviews and was further trained by the study's principal investigators. Interviews were conducted to obtain social strata information and other risk factors that may be associated with the acquisition of HIV in this population. Social strata information included age, education, income, and marital status. Information relevant to this article included number of male

sex partners in the past 1 month, sex position with male partners (e.g., insertive, receptive, dual), HIV testing history (e.g., date of last test, location, and results), and UAI with last male sex partner. Marital status was categorized in a binary fashion as currently married or not currently married (i.e., never married, divorced, or widowed) due to our belief that the ultimate parameter of interest that would be most closely associated with the outcomes of interest was the presence or absence of a wife at the time of the survey. Only seven men were either divorced or widowed in our sample, which precluded a separate subgroup analysis for these men. HIV testing was conducted using standard methods and kits for detecting HIV-1/2, and included three sequential enzyme-linked immunosorbent assays (ELISAs) in accordance with national guidelines and incorporated minimally invasive testing strategies (e.g., finger-stick or oral test). Drop-in center samples were tested with First Response HIV 1-2.0 (PMC Medical, Mumbai, India) Determine HIV 1/2 (Inverness Medical, Princeton, NJ) Capillus HIV-1/HIV-2 (Trinity, Bray, Ireland) and cruising area samples with OraQuick HIV-1/2 (OraSure, Bethlehem, PA), Vironostika HIV Uni-Form Ag/Ab, (bioMerieux, Marcy l'Etoile, France), Vidas HIV Duo Ultra (bioMerieux). $CD4^+$ lymphocyte testing was conducted after successful referral to one of three partnering treatment and care facilities. Study participants had the opportunity to receive test results from a dedicated posttest counselor but could also opt-out from receiving test results and subsequent referrals. The protocol and procedures were approved by relevant ethics committees at the University of Chicago, Chicago, Illinois, and SHARE-India, Hyderabad.

Analysis

Our primary objectives were to investigate the prevalence of previous HIV testing, UAI, and HIV seropositivity in the MSM population and to verify the associations of previous HIV testing, UAI, and HIV serostatus with demographics and sex position. Bivariate analyses were performed using the χ^2 or Fisher's exact statistics for categorical variables and the Mann–Whitney or Kruskal-Wallis statistics for continuous variables. Stratified analyses were performed, and effect modification was assessed using the Mantel-Haenszel test of homogeneity. Multiple logistic regression models were used to assess the significance of potential predictor variables. Potential predictor variables were selected either because they were associated with the outcome of interest in bivariate analysis or because they were of theoretical importance. Covariates of theoretical importance were also included even when not significant themselves because of the potential for significantly altering the magnitude of the estimates of key predictors being considered, resulting in estimate bias. Associations are reported as odds ratios (OR) with their relevant 95% confidence intervals (95% CI]. We included terms to test for the potential interaction between marital status and sexual positioning status in each model. This approach contrasts with standard logistic regression without interaction terms, which assumes that the odds ratios between groups distinguished by a categorical variable do not depend on the values of the other variables included in the model.[28] STATA (version 11.0, StataCorp, College Station, TX) was used for statistical analyses. The odds ratio obtained from the coefficient of an interaction term is difficult to interpret, as it represents the degree of effect modification present on a multiplicative scale (i.e., an odds ratio of 1.0 represents no effect modification). Accordingly, linear combination of interaction terms using standard techniques[29] was used to derive more easily interpretable results. p values less than 0.05 were considered statistically significant.

Results

Sociodemographic and behavioral characteristics

A total of 676 men were surveyed. Basic demographic information is provided in Table 1. Nearly all men reported

Table 1. Characteristics of Men Who Have Sex with Men in Hyderabad, South India ($N=676$)[a]

Factor	n *(%)*
Age (years)	
≤20	56 (8.3)
21–25	235 (34.9)
26–30	220 (32.7)
>30	162 (24.1)
Monthly income in rupees ($US)	
≤3000 ($75)	125 (22.0)
3001–5000 ($75–125)	230 (40.4)
5001–7000 ($125–175)	116 (20.4)
>7000 ($175)	98 (17.2)
Education	
None	83 (12.9)
Primary (class<6)	56 (8.7)
Secondary (6–10)	270 (41.9)
Intermediate (11–12)	120 (18.6)
Postgraduate (>12)	115 (17.8)
Other	1 (0.2)
Marital status	
Unmarried	443 (67.4)
Married	219 (32.6)
Sex position	
Receptive	370 (56.6)
Insertive	117 (17.9)
Dual	165 (25.2)
None	1 (0.2)
Other	1 (0.2)
Location of recruitment	
Drop-in center	398 (58.9)
Cruising area	278 (41.1)
Previous HIV test	
No	420 (62.3)
Yes	254 (37.7)
Location of previous HIV test	
Private facility	67 (26.0)
Government facility	191 (74.0)
Prior HIV test results	
Negative	201 (90.5)
Positive	21 (9.5)
UAI	
No	476 (71.9)
Yes	186 (28.1)
HIV serostatus	
Negative	528 (78.1)
Positive	148 (21.9)

[a]Data missing: 5 for age, 7 for income, 31 for education, 14 for marital status, 3 for previous HIV test, 36 for reported test results, 22 for sex position, and 12 for unprotected anal intercourse (UAI).

primary residence in the twin cities of Hyderabad and Secunderabad. In our sample, 58.9% of men were recruited from drop-in centers, and 41.1% were recruited from cruising areas. In all, 32.6% of men surveyed were married at the time of the survey, and 67.4% were never married or had been previously married but were divorced or widowed. Of the 654 men for whom an answer regarding sex position was available, 56.6% self-identified as receptive only, 17.9% as insertive only, and 25.2% as dual. Overall, 28.1% of men reported UAI during their most recent sexual encounter with a man. The median number of male partners in the prior 1 month was 5 (range, 0–150). Only 37.7% of men reported having undergone a previous HIV test, of whom 88.6% were aware of the previous test results. In HIV seropositive men, the median $CD4^+$ lymphocyte count was 335 per microliter (range, 41–1244).

Comparison of sociodemographics, sexual risk, and HIV preventive behaviors, with sex position and marital status among self-identified MSM

The results of bivariate analyses with MSM sex position category as the independent variable are presented in Table 2. Marital status varied significantly by sex position, with 22.2% of receptive, 40.2% of insertive, and 53.4% of dual MSM being married ($p < 0.001$). Receptive MSM were more likely to report more than 10 male partners in the previous 1 month compared with dual or insertive MSM (22.7% versus 12.2% versus 6.1%, respectively; $p < 0.001$). While 50.3% of dual MSM and 34.9% of receptive MSM had undergone a prior HIV test, only 25.6% of insertive MSM had been previously tested ($p < 0.001$). While 44.9% of insertive MSM reported UAI during their most recent sexual encounter with a man, only 23.3% of receptive and 27.3% of dual MSM reported UAI during their most recent sexual encounter ($p < 0.001$). Insertive MSM, in bivariate analysis, were less likely to be HIV seropositive (10.3%) than receptive MSM (25.4%) and dual MSM (23.6%). While receptive MSM and dual MSM demonstrated a similar HIV prevalence, the median $CD4^+$ lymphocyte count of HIV seropositive receptive MSM was 296/μL, compared with a median $CD4^+$ lymphocyte count of 398 per microliter in HIV seropositive insertive MSM and 525 per microliter in HIV seropositive dual MSM ($p = 0.03$).

The results of bivariate analyses with marital status as the independent variable are provided in Table 3. Married MSM had fewer male partners than unmarried MSM, with 74.4% of married MSM reporting five or fewer partners in the previous 1 month, compared with 46.7% of unmarried MSM ($p < 0.001$). UAI did not significantly vary by marital status (31.6% for married versus 26.0% for unmarried MSM; $p = 0.138$). The percentage of married MSM who were HIV seropositive was 29.2%, versus 18.9% for unmarried or previously married MSM ($p = 0.002$). Marital status was not associated with $CD4^+$ lymphocyte count (median 300 per microliter for unmarried versus 339 per microliter for married; $p = 0.6$).

Stratified analysis of sex position, marital status, previous HIV testing, UAI, and HIV serostatus

In Table 4, we present the results of a stratified analysis of sex position, marital status, and three outcomes of interest (prior HIV testing, UAI, and HIV serostatus), adjusting for age. We adjust for age given the significant positive correlation between age and marital status (data not shown). In this analysis, within each MSM category, similar proportions of married and unmarried MSM reported UAI and previous HIV testing during their last sexual act with a man. Among married receptive MSM, 41.5% were found to be HIV seropositive, compared with 20.8% of unmarried receptive MSM, a difference of borderline statistical significance (OR 1.8; 95% CI, 1.0–3.2). However, similar proportions of dual married and dual unmarried MSM and insertive married and insertive

Table 2. Bivariate Analysis of Participating MSM Characteristics with Sex Position in Hyderabad, South India ($N = 676$)[a]

Factor	n *(% of total)*	n *(% of sex position)*			p *Value*[b]
		Receptive	*Insertive*	*Dual*	
Marital status					
Unmarried	434 (66.8)	288 (77.8)	70 (59.8)	76 (46.6)	< 0.001
Married	216 (33.2)	82 (22.2)	47 (40.2)	87 (53.4)	
Previous HIV test					
No	410 (62.9)	241 (65.1)	87 (74.4)	82 (49.7)	< 0.001
Yes	242 (37.1)	129 (34.9)	30 (25.6)	83 (50.3)	
Unprotected anal intercourse					
No	461 (71.8)	277 (76.7)	64 (55.1)	120 (72.7)	< 0.001
Yes	181 (28.2)	84 (23.3)	52 (44.8)	45 (27.3)	
HIV serostatus					
Negative	507 (77.8)	276 (74.6)	105 (89.7)	126 (76.4)	0.002
Positive	145 (22.2)	94 (25.4)	12 (10.3)	39 (23.6)	
Median (range) $CD4^+$ lymphocyte count at diagnosis (cells/μL)	343 (41–1244)	296 (41–1018)	398 (218–543)	525 (173–290)	0.026

[a]This table tabulates the results of subgroup analysis of a number of covariates segregated by sex position. Due to missing data, totals across tables may not match exactly.

[b]p values were obtained by χ^2 or Fisher's exact tests, as appropriate, for categorical variables and by the Mann–Whitney or Kruskal-Wallis test for continuous variables.

MSM, men who have sex with men.

Table 3. Bivariate Analysis of Sociodemographics with Marital Status of Participating MSM in Hyderabad, South India ($N=676$)[a]

Factor	n (% of total)	n (% of sex position)		p Value[b]
		Unmarried	Married	
Education				
None	83 (12.9)	53 (12.1)	30 (14.6)	0.071
Primary (class < 6)	56 (8.7)	31 (7.1)	25 (12.1)	
Secondary (6-10)	270 (42.0)	181 (41.4)	89 (43.2)	
Intermediate (11–12)	119 (18.5)	85 (19.5)	34 (16.5)	
Postgraduate (>12)	115 (17.9)	87 (19.9)	28 (13.6)	
Sex position				
Receptive	370 (56.9)	288 (66.4)	82 (38.0)	<0.001
Insertive	117 (18.0)	70 (16.1)	47 (21.8)	
Dual	163 (25.1)	76 (17.5)	87 (40.3)	
Location of recruitment				
Drop-in center	397 (59.1)	278 (61.4)	119 (54.3)	0.094
Cruising area	275 (40.9)	175 (38.6)	100 (45.7)	
Previous HIV Test				
No	419 (62.4)	294 (64.9)	125 (57.1)	0.051
Yes	253 (37.6)	159 (35.1)	94 (42.9)	
Previous HIV test				
No	28 (11.1)	23 (14.5)	5 (5.3)	0.036
Yes	225 (88.9)	136 (85.5)	89 (94.7)	
Prior HIV test results				
Negative	201 (90.5)	123 (90.4)	78 (90.7)	>0.999
Positive	21 (9.5)	13 (9.6)	8 (9.3)	
Unprotected anal intercourse				
No	475 (72.2)	328 (74.0)	147 (68.4)	0.138
Yes	183 (27.8)	115 (26.0)	68 (31.6)	
HIV serostatus				
Negative	525 (78.1)	370 (81.7)	155 (70.8)	0.002
Positive	147 (21.9)	83 (18.3)	64 (29.2)	
Median (range) $CD4^+$ lymphocyte count at diagnosis (cells/μL)	335 (41–1244)	300 (63–773)	339 (41–1244)	0.631

[a]This table tabulates the results of subgroup analysis of a number of covariates segregated by marital status. Due to missing data, totals across tables may not match exactly.

[b]p values were obtained by χ^2 or Fisher's exact tests, as appropriate, for categorical variables and by the Mann–Whitney or Kruskal-Wallis test for continuous variables.

MSM, men who have sex with men.

unmarried MSM were found to be HIV seropositive. Formal testing for effect modification using the Mantel-Haenszel test of homogeneity did not yield a significant test statistic for any of the outcomes of interest, though this test has previously been noted to lack sensitivity in epidemiologic settings.[30]

Multivariate analysis of sociodemographic and behavioral variables with previous HIV test, UAI, and HIV serostatus of MSM in Hyderabad

The results of three separate multiple logistic regression models with previous HIV testing, UAI, and HIV serostatus as the dependent variables are presented in Table 5. In a regression on previous HIV test, the obtained odds ratio for the married-receptive interaction term was 0.8 (95% CI 0.3–2.4; $p=0.7$), and for the married-dual interaction term was 0.3 (95% CI 0.1–1.1; $p=0.08$). After linear combination of the coefficients of interaction terms was performed, we found that dual unmarried MSM were more likely than insertive unmarried MSM to have undergone a previous HIV test (OR 2.8; $p=0.02$), but the same relationship did not hold between dual married MSM and insertive married MSM (OR 1.0, $p=0.9$). There was no statistically significant relationship between marital status and prior HIV testing for any sex position category. Age was a significant factor, with men over age thirty significantly more likely than younger men to have undergone an HIV test (OR 4.4; $p=0.002$). Men recruited in the field were more likely to report having undergone a previous HIV test (OR 4.9; $p<0.001$) than men recruited at drop-in centers. UAI during the most recent MSM encounter was negatively associated with having had a previous HIV test (OR 0.6; $p=0.04$). Education was not independently associated with previous HIV testing.

In a multiple logistic regression on UAI, the obtained odds ratio for the married-receptive interaction term was 1.8 (95% CI 0.6–5.1; $p=0.3$), and for the married-dual interaction term was 2.6 (95% CI 0.8–8.2; $p=0.1$). After further analysis, we found that sex position was predictive of UAI in receptive men regardless of marital status, with receptive unmarried MSM significantly less likely than insertive unmarried MSM

Table 4. Stratified Analysis of Sociodemographics with Sex Position and Age-Adjusted Odds Ratio of Various Outcomes in Participating MSM in Hyderabad, South India ($N = 676$)[a]

		n (% of sex position)									
		Receptive			Insertive			Dual			
Factor	n (% of total)	Unmarried	Married	Age-adjusted OR (95% CI)	Unmarried	Married	Age-adjusted OR (95% CI)	Unmarried	Married	Age-adjusted OR (95% CI)	p Value[b]
Previous HIV test											
No	410 (62.9)	190 (66.0)	51 (62.2)	0.9	57 (81.4)	30 (63.8)	1.7	38 (50.0)	43 (49.4)	0.9	
Yes	242 (37.1)	98 (34.0)	31 (37.8)	(0.5–1.5)	13 (18.6)	17 (36.2)	(0.5–5.3)	38 (50.0)	44 (50.6)	(0.4–1.7)	0.23
Unprotected anal intercourse											
No	461 (71.8)	219 (77.7)	58 (73.4)	1.3	41 (59.4)	23 (48.9)	1.5	54 (71.1)	65 (74.7)	0.8	
Yes	181 (28.2)	63 (22.3)	21 (26.6)	(0.7–2.5)	28 (40.6)	24 (51.1)	(0.5–4.2)	22 (28.9)	22 (25.3)	(0.4–1.7)	0.48
HIV serostatus											
Negative	507 (77.8)	228 (79.2)	48 (58.5)	1.8	66 (94.3)	39 (83.0)	3.0	60 (78.9)	65 (74.7)	1.1	
Positive	145 (22.2)	60 (20.8)	34 (41.5)	(1.0–3.2)	4 (5.7)	8 (17.0)	(0.3–27)	16 (21.1)	22 (25.3)	(0.5–2.4)	0.21

[a]This table tabulates the results of stratified subgroup analysis of a number of covariates segregated by sex position and marital status. Age-adjusted odds ratios for outcomes of interest with 95% confidence intervals are provided. Due to missing data, totals across tables may not match exactly.

[b]p values were obtained by the Mantel-Haenszel test of homogeneity.

MSM, men who have sex with men; OR, odds ratio; CI, confidence interval.

to report UAI during their most recent sex act with a man (OR 0.4; $p = 0.006$), and receptive married MSM significantly less likely than insertive married MSM to report UAI as well (OR 0.2; $p < 0.001$). Marriage affected the odds ratio of UAI between dual and insertive MSM; whereas unmarried duals were not significantly less likely than unmarried insertive MSM to report UAI (OR 0.7; $p = 0.3$), married duals were significantly less likely than married insertive MSM to report UAI (OR 0.3; $p = 0.001$). Marital status was not significantly associated with UAI with the last male partner in any sex position category. Men who subsequently were found to be HIV seropositive, not surprisingly, were more likely to report UAI during the most recent sexual act with a man (OR 2.0; $p = 0.003$). Other variables such as age and location of recruitment were not significant in preliminary versions of the model and were subsequently dropped from the final model.

In a multiple logistic regression on HIV serostatus, the obtained odds ratio for the married-receptive interaction term was 0.9 (95% CI 0.2–4.2; $p = 0.9$), and for the married-dual interaction term was 0.4 (95% CI 0.1–1.9; $p = 0.2$). After further analysis, we observed a clear association between sex position and HIV serostatus for unmarried men, with receptive unmarried MSM (OR 5.8; $p = 0.005$) and dual unmarried MSM (OR 4.9; $p = 0.02$) more likely to be HIV seropositive than insertive unmarried MSM. The relationship between sex position and HIV serostatus was attenuated among married MSM, with receptive married MSM still significantly more likely than insertive married MSM to be HIV seropositive (OR 5.0; $p = 0.002$), but dual married subjects were not significantly more likely to be HIV seropositive than insertive married subjects (OR 1.8; $p = 0.3$). Marital status was not predictive of HIV serostatus among insertive ($p = 0.4$) or dual ($p = 0.4$) subjects, but trended towards being associated with HIV serostatus among receptive MSM (OR 1.8; $p = 0.08$). Men recruited from cruising sites were more likely to be HIV seropositive than men recruited from drop-in centers (OR 1.9; $p = 0.006$). Men over age 30 were significantly more likely to be HIV seropositive than men under age 20 (OR 2.8; $p = 0.03$). Increasing education was associated with a decreased likelihood of HIV seropositivity; MSM with a postgraduate education were significantly less likely than those with no education to be HIV seropositive (OR 0.5; $p = 0.04$). UAI was associated with an increased likelihood of HIV seropositivity (OR 2.0; $p = 0.003$).

Discussion

In this study, we found that MSM in the Hyderabad and Secunderabad twin cities are a high-prevalence population for HIV, with the HIV seroprevalence exceeding 20%. In multivariate analyses, UAI, previous HIV testing, and HIV seroprevalence were all strongly correlated with sex position. There was a higher HIV prevalence among receptive MSM than among other MSM categories in bivariate analysis, as has been described elsewhere,[23] in the setting of lower rates of UAI. Insertive MSM had lower rates of prior HIV testing, higher rates of UAI than other MSM, and a higher likelihood than receptive of being married. Nevertheless, insertive MSM had lower rates of HIV seropositivity than other groups. This is not surprising given the lower risk of acquiring HIV via insertive sex compared with receptive sex.[17] Even though the majority of dual MSM were married, dual MSM demonstrated

Table 5. Multiple Logistic Regression Analysis Including Sociodemographic and Behavioral Variables for Previous HIV Test, UAI, and HIV Serostatus of MSM in Hyderabad, South India ($N=676$)[a]

Factor	n (% of Total)	Adjusted odds ratio (95% CI)[b]		
		Previous HIV test	UAI	HIV serostatus
Age (years)				
≤20	56 (8.3)	1.0 (ref)	—	1.0 (ref)
21–25	235 (34.9)	2.0 (0.8–4.8)	—	1.1 (0.4–2.6)
26–30	220 (32.7)	4.2 (1.7–10.2)[c]	—	1.5 (0.6–3.6)
>30	162 (24.1)	4.4 (1.7–11.1)[c]	—	2.8 (1.1–7.0)[d]
Location of recruitment				
Drop-in center	398 (58.9)	1.0 (ref)	—	1.0 (ref)
Cruising area	278 (41.1)	4.9 (3.2–7.4)[e]	—	1.9 (1.2–3.1)[c]
Education				
None	83 (12.9)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Primary (class<6)	56 (8.7)	0.8 (0.4–1.8)	1.0 (0.4–2.1)	1.1 (0.5–2.3)
Secondary (6–10)	270 (41.9)	1.2 (0.6–2.1)	0.7 (0.4–1.3)	0.6 (0.4–1.2)
Intermediate (11–12)	120 (18.6)	1.2 (0.6–2.1)	0.5 (0.2–1.0)	0.5 (0.2–1.0)
Postgraduate (>12)	115 (17.8)	1.7 (0.9–3.3)	0.6 (0.3–1.3)	0.5 (0.2–1.0)[d]
UAI				
No	476 (71.9)	1.0 (ref)	—	1.0 (ref)
Yes	186 (28.1)	0.6 (0.4–1.0)[d]	—	2.0 (1.3–3.1)[c]
Marital status (insertive)				
Unmarried	70 (59.8)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Married	47 (40.2)	1.7 (0.7–4.5)	1.7 (0.8–4.0)	2.0 (0.5–9.0)
Marital status (receptive)				
Unmarried	288 (77.8)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Married	82 (22.2)	1.3 (0.7–2.4)	1.0 (0.5–1.9)	1.8 (0.9–3.3)
Marital status (dual)				
Unmarried	76 (46.6)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Married	87 (53.4)	0.6 (0.3–1.2)	0.7 (0.3–1.5)	0.7 (0.3–1.6)
Sex position (unmarried)				
Insertive	70 (16.1)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Receptive	288 (66.4)	1.9 (0.9–3.9)	0.4 (0.2–0.8)[c]	5.8 (1.7–19.8)[c]
Dual	76 (17.5)	2.8 (1.2–6.5)	0.7 (0.3–1.5)	4.8 (1.3–18.4)[d]
Sex position (married)				
Insertive	47 (21.8)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Receptive	82 (38.0)	1.5 (0.6–3.5)	0.2 (0.1–0.5)[e]	5.0 (1.8–13.7)[e]
Dual	87 (40.3)	1.0 (0.4–2.2)	0.3 (0.1–0.6)[e]	1.7 (0.6–4.8)
HIV serostatus				
Negative	528 (78.1)	—	1.0 (ref)	—
Positive	148 (21.9)	—	2.0 (1.3–3.2)[c]	—
Monthly Income in rupees ($US)				
≤3000 ($75)	125 (22.0)	—	1.0 (ref)	—
3001–5000 ($75–125)	230 (40.4)	—	0.8 (0.5–1.3)	—
5001–7000 ($125–175)	116 (20.4)	—	0.5 (0.3–1.0)	—
>7000 ($175)	98 (17.2)	—	0.5 (0.3–1.0)	—
Previous HIV Test				
No	420 (62.3)	—	1.0 (ref)	—
Yes	254 (37.7)	—	0.7 (0.4–1.0)	—

[a]Empty cells reflect that the variable was not included in the final model for the outcome in question.
[b]p values were obtained by the Wald test.
[c]$p<0.01$.
[d]$p<0.05$.
[e]$p<0.001$.
UAI, unprotected anal intercourse; MSM, men who have sex with men.

rates of UAI comparable to receptive MSM, and the highest likelihood of all MSM groups of having undergone previous HIV testing. They also were more likely than insertive MSM, though less likely than receptive MSM, to report greater than 10 male partners in the previous 6 months. The HIV seroprevalence among dual MSM was comparable to that among receptive MSM.

Men who have sex with men and women have previously been identified as a "bridge" population for the transmission of HIV in India.[22] However, an analysis which classifies all

such men as "bisexual" misses marked differences in sexual practices within groups such as "dual." Within this group, dual MSM may form a population uniquely at high risk for both acquisition of HIV (through participating in receptive anal sex) and transmission of HIV to both other MSM (through insertive anal sex) and women. Interestingly, our sampled population in Hyderabad/Secunderabad had a lower percentage of MSM with dual sex position identity when compared to a neighboring state capital of Chennai.[12] This follows the pattern of a state by state analysis, which demonstrated that our setting had the lowest rates of dual sex position, an identity most common in Western MSM settings.[31] This could be attributed to the state of Andhra Pradesh as a more traditional setting often symbolized by its large Muslim population. Regardless of the reason, there may be temporal trends in sex position as only 11% dual status was observed from a large study in this setting from 2003 to 2004,[19] compared to more than double that rate observed from this sample in 2008–2009 utilizing similar sampling and survey methods.

We used a logistic regression model featuring interaction terms between marital status and sex position categories. As explained above, our logistic regression models featuring interaction terms extend the analytic capabilities of typical models. However, interpretation of the output of logistic regression with interaction terms is significantly more difficult than that of regression without interaction terms.[29] Our model suggests a complex role for marital status in HIV testing behavior, UAI, and HIV acquisition. Being married eliminated the association between dual sex position (compared with insertive sex position) and an increased likelihood of previous HIV testing. Interventions to promote HIV testing have not targeted insertive MSM, and our findings may reflect that current interventions to promote HIV testing in dual MSM have been more effective in unmarried men than married men, after adjusting for confounders. Nevertheless, we found that not being married attenuated the relationship observed in married MSM between dual sex position (vs. insertive) and decreased UAI, and that being married attenuated the relationship between dual sex position (versus insertive) and an increased likelihood of being HIV seropositive observed in unmarried men. This would be consistent with the hypothesis that current interventions in dual MSM have been more successful at changing condom use and sexual behaviors in married men, an unexpected finding. Further interpretation of these findings will require qualitative and quantitative research specifically aimed at examining the differential impact of interventions targeted to various communities of MSM on married and unmarried men.

Our study contributes to the literature on HIV in India as an MSM-specific community-based study combining specific information on a number of social factors, including marital status and sex position, laboratory confirmation of HIV serostatus and $CD4^+$ lymphocyte count testing, and statistical modeling of significant predictors of HIV serostatus, including methods not frequently applied in this literature. The community-based study of MSM conducted by Brahmam *et al* gathered similar information, including HIV serostatus. However, differences between their study and ours in terms of sex position classification make direct comparison of the results of that study to ours difficult. The authors of that study did not attempt to statistically model the predictors of HIV seropositivity.[23] The community-based study of MSM conducted by Solomon et al.[21] using peer referral did not record sex position. In that study, 50.8% of HIV seropositive men, but only 32.3% of HIV seronegative men, were married; this was statistically significant, but marriage did not remain a statistically significant predictor of HIV status in a multiple regression model that incorporated number of partners and other social variables such as age. Several studies have yielded detailed information regarding MSM sexual behavior but did not include HIV testing.[19,32–36] Other studies that have included HIV testing were not MSM-specific and included relatively small numbers of MSM[2,20] or represented clinic, not community, populations.[10,11,22,37,38] Thomas and colleagues'[12]2009 study was a community-based MSM-centric study which included demographic variables, including sex position, and HIV testing. In that study, sex position and marital status were controlled for in the statistical analysis but themselves were not the focus of analysis, and the odds ratios for these variables in the logistic regression model used in the study were not reported.

Our study was limited by reliance on self-reported information for sex position, marital status, number of sexual partners, previous HIV testing, and UAI. Thus, recall or social desirability biases may color our results, and work underway is testing computer assisted interviewing in high-risk men in this region as well as social network methods for determining objective sex and partnering behavior. We are also limited by lack of information on female partners other than the wives of married men. Future research should examine the potential relationship between having female partners and sex position for all sex position categories. This may be a significant factor for onward HIV transmission to other groups. Our study was also limited by the use of convenience sampling from drop-in centers and known MSM cruising areas. However, these sites are typical locations for current—and likely future—government-run HIV prevention programs that will implement novel biologic prevention modalities. Finally, sex position is measured as a general measure. We do not get information on specific sex partners or a sexual network analysis per se, to determine recent positioning and its relation to the overall preference; however, a sexual identity based upon sex position is quite strong and consistent in this setting.[9]

Conclusion

We found that reported sex position is associated with UAI, HIV testing behavior, and HIV seroprevalence amongst MSM in Hyderabad and Secunderabad. Using logistic regression with interaction terms, we found that, even though marital status itself was not significantly associated with any of the three outcomes, the effect of sex position on these outcomes of interest depends upon marital status. Categories of married receptive and unmarried receptive have similar behaviors and seroprevalence rates, suggesting a need to shift focus to behavior rather than a social marital status. Although bisexuals as a group have been referred to as a "bridge" population both in India and in other countries, the subgroup of dual MSM may specifically represent a population central to the spread of HIV within MSM and general populations. Further research into the role of specific categories of MSM in sexual networks and novel bio-behavioral interventions targeting

specific sex position categories of MSM is warranted in this and other similar settings.

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Author Disclosure Statement

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