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The burden and determinants of HIV and sexually transmitted infections in a population-based sample of female sex workers in Goa, India

M Shahmanesh,^{1,2} F Cowan,¹ S Wayal,^{2,5} A Copas,¹ V Patel,^{2,3,4} D Mabey³

¹ Centre for Sexual Health and HIV Research, University College London, London, UK; ² Positive People, St Inez, Panjim, Goa, India; ³ London School of Hygiene and Tropical Medicine, London, UK; ⁴ Sangath, Porvorim, Goa, India; ⁵ Brighton and Sussex Medical School, Falmer, UK

Correspondence to:
Dr M Shahmanesh, Centre for Sexual Health and HIV Research, Royal Free and University College Medical School, 3rd Floor, Mortimer Market Centre, off Capper Street, London WC1E 6AU, UK; bamaryjoon@yahoo.co.uk, maryams@gum.ucl.ac.uk

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ABSTRACT

Background: Interventions targeting sex workers are central to the National AIDS Control programme of India's third 5-year plan. Understanding the way in which societal and individual factors interact to shape sex workers' vulnerability would better inform interventions.

Methods: 326 female sex workers, recruited throughout Goa using respondent-driven sampling, completed interviewer-administered questionnaires. Biological samples were tested for *Trichomonas vaginalis*, *Neisseria gonorrhoea*, *Chlamydia trachomatis* and antibodies to herpes simplex virus type 2 (HSV-2) and HIV. Multivariate analysis was used to define the determinants of HIV infection and any bacterial sexually transmitted infection (STI).

Results: Infections were common, with 25.7% prevalence of HIV and 22.5% prevalence of bacterial STI; chlamydia 7.3%, gonorrhoea 8.9% and trichomonas 9.4%. Antibodies to HSV-2 were detected in 57.2% of women. STI were independently associated with factors reflecting gender disadvantage and disempowerment, namely young age, lack of schooling, no financial autonomy, deliberate self-harm, sexual abuse and sex work-related factors, such as having regular customers and working on the streets. Other factors associated with STI were Goan ethnicity, not having an intimate partner and being asymptomatic. Having knowledge about HIV and access to free STI services were associated with a lower likelihood of STI. HIV was independently associated with being Hindu, recent migration to Goa, lodge or brothel-based sex work and dysuria.

Conclusion: Sex workers working in medium prevalence states of India are highly vulnerable to HIV and STI and need to be rapidly incorporated into existing interventions. Structural and gender-based determinants of HIV and STI are integral to HIV prevention strategies.

The HIV epidemic in India, the world's second most populous country, is of global importance.¹ Targeting core groups, such as sex workers, is pivotal to HIV prevention in India.² The National AIDS Control Organisation estimates 0.6–0.7% of the adult female urban population is engaged in transactional sex.¹ The National AIDS Control Programme's third 5-year plan calls for 100% coverage of sex workers through community mobilisation.² Data on this heterogeneous group remain patchy,^{3–6} however, and outside of India's six high-prevalence states, coverage of these at-risk populations is suboptimal.¹

Individual behavioural change and changing sociocultural norms have been advocated as strategies to reduce sex workers' vulnerability to HIV

and sexually transmitted infections (STI).⁷ The manner in which individual, community and societal factors interact to shape this vulnerability⁶ in different epidemiological contexts⁸ needs to be better understood.

Goa is a small state with a concentrated HIV epidemic.⁹ As an annual destination for more than 1.5 million tourists and the accompanying seasonal migrants,¹⁰ its epidemiological importance outweighs its size. Nonetheless, there is a dearth of data on the size of high-risk groups such as sex workers, the epidemiology of HIV and STI, and how individual and structural factors interact to shape vulnerability to HIV.¹

Here we describe the determinants of STI and HIV in a population-based sample of sex workers in Goa, following the demolition of the red-light area. In particular we explore the relationship between the underlying social and the proximal behavioural and sex work factors.

METHODS

Study setting

The study was set in Goa, a small coastal state with a population of 1.37 million.¹¹ In June 2004 the demolition of Baina, Goa's main red-light area, ended the dominance of homogeneous brothel-based sex work in Goa.¹² The study was conducted throughout Goa in collaboration with Positive People; the largest and most experienced HIV organisation in Goa. Recruitment took place from December 2004 to December 2005.

Study population

Sex workers were defined as women who provide sexual services in exchange for goods or money.

Sampling method

The sex workers in the survey were recruited using respondent-driven sampling (RDS).¹³ This variant of chain sampling delves deeper into the hidden networks by rationing the number of recruits per respondent, increasing the number of waves of recruitment and providing financial incentives to the "recruiter". The probability of recruitment is calculated from network size and relationships.¹⁵

Ten researchers spent over 5000 h of participant observation and ethnographic mapping throughout the urban centres and coastal tourist belt of Goa. They identified the different settings and categories of sex work. The initial recruiters (seeds) were purposively selected from various sex work typologies, ethnicities, ages and areas of

Table 1 Demographic and psychosocial characteristics of female sex workers in Goa

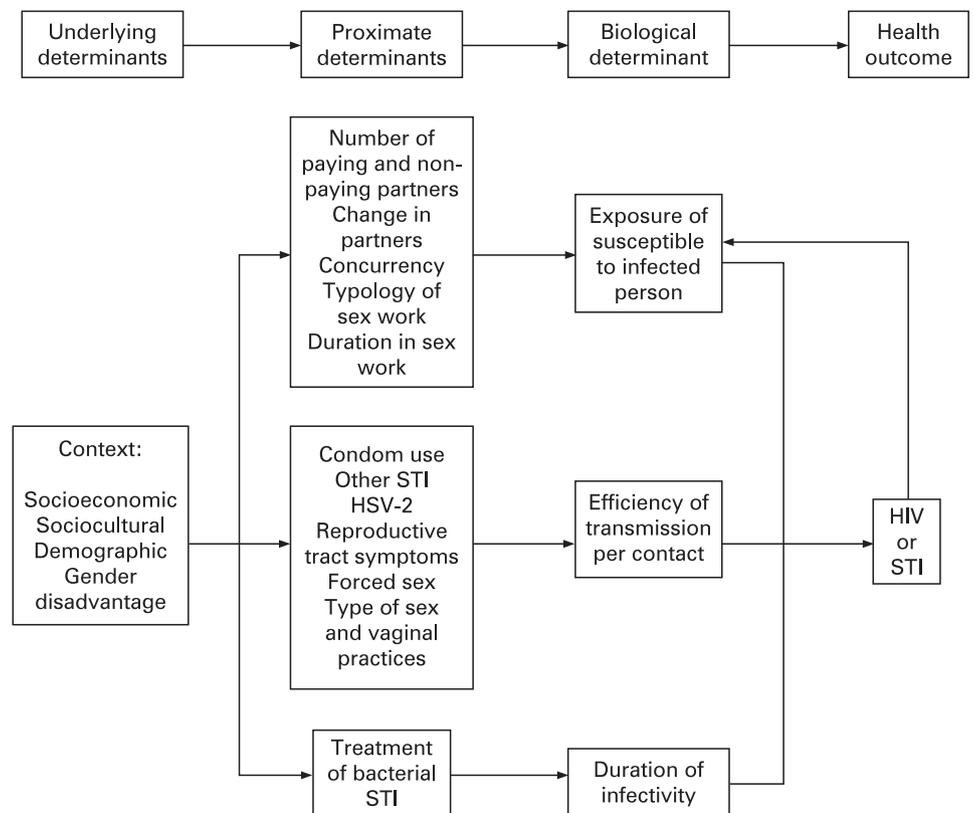
Variable	Number (N = 326)	Weighted prevalence, % (95% CI)
Age, years		
<20	35	8.7 (6.2 to 12.2)
21–25	100	29.0 (24.2 to 34.2)
26–30	79	25.7 (21.0 to 31.0)
31–35	43	13.8 (10.3 to 18.2)
36–40	40	13 (9.6 to 17.4)
>40	29	9.9 (6.9 to 14.0)
Ethnicity		
Goa	54	11.2 (8.6 to 14.5)
Karnataka	200	71.7 (66.9 to 76.1)
Andhra Pradesh	37	9.9 (7.2 to 13.4)
Other	35	7.2 (5.1 to 10.0)
Religion		
Hindu	223	72.3 (67.2 to 76.9)
Christian	41	10 (7.4 to 13.5)
Muslim	60	17.1 (13.4 to 21.6)
Other	2	0.6 (0.1 to 2.3)
Unable to read or write	255	82.1 (77.6 to 85.8)
Schooling		
None	199	67.1 (61.9 to 72.0)
Incomplete	117	30.9 (26.1 to 36.1)
Complete (12th standard)	10	2.0 (1.1 to 3.8)
Marital status		
Married	134	40.3 (34.9 to 45.9)
Widowed/separated	101	31.6 (26.5 to 37.1)
Never married	91	28.2 (23.3 to 33.6)
No of children		
None	72	19.2 (15.3 to 23.9)
One or two	183	57.6 (52.0 to 63.1)
More than two	71	23.2 (18.7 to 28.3)
Currently in debt	170	54.7 (49.1 to 60.3)
Home ownership	125	36.9 (31.6 to 42.5)
No of dependents		
None	43	11.3 (8.3 to 15.1)
Less than five	222	69.8 (64.4 to 74.6)
Five or more	61	19.0 (14.9 to 23.9)
Duration in Goa, years		
One or less	43	11.8 (8.9 to 15.9)
2–10	99	30.0 (25.2 to 35.4)
More than 10	92	33.3 (28.1 to 39.1)
From birth	92	24.7 (20.3 to 29.7)
Travel out of Goa in past year	185	57.4 (51.7 to 62.9)
Current alcohol use		
Never	141	42.7 (37.2 to 48.3)
Less than weekly	47	14.2 (10.7 to 18.7)
At least weekly	138	43.1 (37.6 to 48.8)
Lifetime intimate partner violence	124	35.0 (29.9 to 40.5)
Entrapment (forced to remain in sex work against her will)	29	9.2 (6.4 to 13.2)
Autonomy in use of money	220	65.1 (59.5 to 70.5)
Political empowerment (vote in elections)	170	55.1 (49.5 to 60.6)
Lack of social support (past week)	197	59.6 (54.0 to 65.1)
Police raid (since demolition)	50	14.0 (10.6 to 18.2)
Suicide attempt in past 3 months	73	18.7 (14.9 to 23.3)
Lifetime deliberate self-harm	51	12.8 (9.7 to 16.8)

Goa. They were given vouchers with unique numbers, which they in turn gave to three other members of their network who they recruited to the study. Each respondent was given a sum of 100 rupees (US\$2.50) for participating and a further sum of 50 rupees (US\$1.25) for each successfully recruited referral.

Data collection and management

Trained female interviewers administered a questionnaire that was translated and extensively piloted in four Indian languages (Hindi, Konkani, Kannada and Telugu). Sex workers were interviewed in a variety of settings, including hired rooms, lodgings, drop-in-centres, the project vehicle and clinics.

Figure 1 Proximate determinants conceptual framework for examining the risk of sexual transmission of HIV.¹⁴ HSV-2, herpes simplex virus type 2; STI, sexually transmitted infection.



The questionnaire, which took 60 minutes to complete, was a composite of questions derived from several sources on demographics, psychosocial factors, sex work and sexual risk, knowledge and exposure to HIV prevention interventions, reproductive health and health-seeking behaviour.^{15–19} An informal confidential voting interview collected responses to sensitive questions from each respondent.²⁰ Check questions were present for internal consistency. Two independent reviewers checked all questionnaires and inconsistencies were referred back to the field. Data were double entered into an Access database and underwent range and consistency checks.

Laboratory methods

Biological samples were collected using self-administered vaginal swabs, previously validated in Goa,²¹ and dried-blood spots (DBS). For women who refused to take a vaginal swab, first-void urine samples were collected to test for gonococcal and chlamydial infection. One vaginal swab was inserted into a sterile universal container and the other was inserted into an InPouch TV culture kit (Biomed Diagnostic, San Jose, California, USA). Five blood spots were taken according to protocol. All samples reached the laboratory within 24 h of collection. The InPouch TV culture was incubated at 37°C for up to 5 days and underwent daily microscopy for *Trichomonas vaginalis*. The other samples were stored in a –70°C freezer until processing. PCR using the Roche Amplicor system (Roche Molecular Systems, Alameda, California, USA) was used to diagnose chlamydial and gonococcal infection. DBS were tested for antibody to HIV using two ELISA tests, Vironostika Uni-Form II plus O (Organon Teknika, Boxtel, The Netherlands) and HIV enzyme immunoassay (Ani LabSystems Ltd, Oy, Vantaa, Finland). Discordant tests were confirmed by Murex HIV 120 (Abbott Laboratories, Abbott Park, Illinois, USA). DBS

were also tested for incident HIV using the BED assay (Calypte Biomed, Rockville, Maryland, USA), and herpes simplex virus 2 (HSV-2) using the ELISA test HerpeSelect (Focus Technologies, Cypress, California, USA). The laboratory participated in quality control for molecular (UK) diagnostics annual quality control and National AIDS Research Institute external quality control of the DBS.

Sample size considerations

Sample size was chosen in order to be able to estimate a bacterial STI prevalence of 8% within 3% at 95% confidence and HIV prevalence of 30% within 5%. This gave us a sample size of 318 and 310, respectively.

Statistical analysis

In order to adjust for potential biases in recruitment, data were weighted based on network size and relations, age, ethnicity and area, according to how these factors were related to recruitment, using the RDS analysis tool 5.4.0 (Cornell University, USA). Analyses were performed using Stata 8, incorporating the weights through the survey analysis functions. All percentages and odds ratios quoted are weighted with 95% CI. Frequency counts are unweighted.

Logistic regression was carried out with any STI (chlamydia, gonorrhoea or trichomonas) and HIV as the two outcome measures. Multiple logistic regression models were built separately for each outcome based on a simple conceptual framework shown in fig 1.^{14 22} First the sociodemographic factors that were found to be associated with the outcome in univariate analysis $p < 0.2$, or had been identified as a potential risk factor in the literature, were included in a stepwise forward model selection procedure ($p < 0.2$), which led to our base model. Next the association between each sex work,

Table 2 Work and sexual risk of female sex workers in Goa

Variable	Number* (N = 326)	Weighted prevalence % (95% CI)
Time in sex work, years		
<1	105	29.4 (24.7 to 34.7)
2–10	145	42.6 (37.2 to 48.2)
>10	76	28 (23 to 33.6)
Income from other source than sex work	140	43.9 (38.4 to 49.6)
Street-based sex work	77	22.7 (18.4 to 27.8)
Establishment (bar, lodge, brothel) sex work	192	57.8 (52.1 to 63.2)
Home-based sex work	89	28.0 (23.3 to 33.4)
More than one establishment/site for sex work	135	36.7 (31.6 to 42.2)
Started sex work under age of 16 years	64	20.6 (16.3 to 25.8)
No of customers in past week		
None	123	38.2 (32.9 to 43.9)
One to seven	179	56.3 (50.6 to 61.7)
More than seven	24	5.5 (3.6 to 8.3)
At least one customer per day	208	62.6 (56.9 to 67.9)
At least one regular paying customer	140	40.2 (34.5 to 45.7)
Intimate non-paying male partner		
None	79	24.2 (19.7 to 29.4)
One	200	61.4 (55.8 to 66.8)
More than one	47	14.4 (10.9 to 18.7)
Change in intimate male partner in past 3 months	19	5.4 (3.4 to 8.4)
Consistent condom use with customers	237	74.4 (69.3 to 78.9)
Consistent condom use with intimate partner	28	8.6 (5.9 to 12.3)
Condom breakage over past 3 months†	68	21.6 (17.1 to 26.9)
Ever have sex without condom for more money‡	46	15.3 (11.5 to 20.0)
Ever forced to have sex without condom§	95	29.7 (24.6 to 35.3)
Source of condom		
Customer brings	154	44.4 (38.9 to 50.0)
Buy	62	18.8 (14.8 to 23.5)
Free from NGO or government	59	21.1 (16.6 to 26.4)
Do not use condoms	51	15.8 (12.2 to 20.3)
Lifetime experience of non-consensual/coerced sex	36	8.9 (6.4 to 12.3)
Sexually abused as a child	18	4.6 (2.8 to 7.3)
Lifetime exposure to HIV prevention	111	38.7 (33.3 to 44.4)
HIV knowledge score		
0	100	30.7 (25.8 to 36.1)
1–49%	43	12.0 (8.9 to 16.0)
>50%	183	57.3 (51.7 to 62.8)
Lifetime HIV test	117	37.2 (31.9 to 42.9)
Lifetime pregnancy	295	91.5 (87.9 to 94.1)
Lifetime abortion	91	25.2 (20.7 to 30.3)
Any reproductive tract symptom in past 3 months	153	43.9 (38.5 to 49.6)

*Weighted percentages calculated by including missing data.

†N = 275, excluding women who did not use condoms.

‡N = 291, excluding women who did not answer this question because they did not use condoms.

§N = 295, excluding women who did not answer this question because they did not use condoms.

NGO, non-governmental organisation.

sexual risk and reproductive health factor and the outcome was individually tested after adjusting for the factors in the base model. Those factors found to be associated with the outcome ($p < 0.2$), after adjustment, or identified as a priori risk factors in the literature were included in our tables. These factors were then included in a stepwise forward model selection procedure ($p < 0.2$) alongside the factors identified in the base model to create the final model.

The main reason for missing values was that samples were not received or inhibition of the sample occurred during PCR. Seventeen (5%) of the STI samples were missing (four *Chlamydia trachomatis*, *Neisseria gonorrhoea*, *T vaginalis* not received, six *C trachomatis*, *N gonorrhoea* inhibitory and seven *T vaginalis* only not received). Only one (0.3%) HIV sample was

not received. Missing cases were excluded from the analysis. Continuous variables were converted to categories based on published studies (eg, age), or a priori categories. HIV incidence was calculated using the Centers for Disease Control and Prevention consensus formula:²³

$$\text{Incidence} = \left\{ \frac{(365/w)N_{\text{inc}}}{[N_{\text{neg}} + (365/w)N_{\text{inc}}/2]} \right\} \times 100$$

where W is the window period, N_{inc} is the number of recent HIV infections (based on Calpyte test) and N_{neg} is the number HIV seronegative.

Ethical considerations

Ethical approval was obtained from the Independent Ethics Commission, Mumbai and University College London's ethics committee. A community advisory board mediated community

Table 3 Association of underlying demographic and psychosocial factors associated with STI and HIV in female sex workers in Goa

Variable	Univariate OR for STI* (95% CI) N = 309	Univariate OR for HIV† (95% CI) N = 325
Age, years	p = 0.008	p = 0.9
<20	1	1
21–25	0.23 (0.10 to 0.57)	1.78 (0.60 to 5.34)
26–30	0.26 (0.11 to 0.66)	1.70 (0.54 to 5.20)
31–35	0.14 (0.04 to 0.47)	1.72 (0.51 to 5.81)
>36	0.27 (0.11 to 0.70)	1.73 (0.56 to 5.39)
Non-Goan ethnicity‡	p = 0.02	p = 0.2
	0.45 (0.24 to 0.87)	1.63 (0.75 to 3.55)
Religion	p = 0.2	p = 0.004
Hindu	0.69 (0.40 to 1.21)	2.54 (1.33 to 4.86)
Schooling	p = 0.9	p = 0.3
None	1	1
Incomplete	0.96 (0.55 to 1.68)	0.75 (0.43 to 1.34)
Complete	0.69 (0.14 to 3.43)	None have HIV
Indebted	p = 0.3	p = 0.6
	0.73 (0.43 to 1.26)	0.85 (0.50 to 1.45)
Home ownership	p = 0.07	p = 0.3
	0.61 (0.35 to 1.04)	1.36 (0.77 to 2.41)
No of dependents	p = 0.7	p = 0.17
None	1	1
Less than five	0.74 (0.33 to 1.65)	1.49 (0.63 to 3.50)
More than five	0.70 (0.26 to 1.85)	0.73 (0.25 to 2.15)
Duration in Goa§, years	p = 0.3	p = 0.03
One or less	1	1
2–10	0.49 (0.22 to 1.13)	0.61 (0.26 to 1.44)
More than 10	0.45 (0.19 to 1.05)	1.09 (0.47 to 2.17)
Since birth	0.55 (0.24 to 1.27)	0.37 (0.15 to 0.95)
Travel out of Goa in past year‡	p = 0.1	p = 1.0
	1.56 (0.90 to 2.68)	1.00 (0.59 to 1.72)
Political empowerment (vote in elections)	p = 0.2	p = 0.4
	1.42 (0.82 to 2.44)	1.45 (0.60 to 3.50)
Entrapment (unable to leave sex work)	p = 0.6	p = 0.1
	0.74 (0.25 to 2.14)	1.53 (0.89 to 2.65)
No financial autonomy	p = 0.07	p = 0.8
	1.61 (0.92 to 2.81)	1.06 (0.63 to 1.80)
No emotional support (past week)	p = 0.8	p = 0.02
	0.94 (0.54 to 1.63)	1.91 (1.12 to 3.27)
Police raid (since demolition)	p = 0.02	p = 0.02
	2.25 (1.14 to 4.46)	2.23 (1.14 to 4.39)
Deliberate self-harm	p = 0.002	p = 0.16
	2.90 (1.46 to 5.75)	1.65 (0.82 to 3.30)
Intimate partner violence	p = 0.16	p = 0.2
	1.58 (0.84 to 2.96)	0.67 (0.35 to 1.26)
Mental health score	p = 0.4	p = 0.1
	0.99 (0.95 to 1.03)	1.03 (0.99 to 1.07)

*Age, ethnicity, schooling, home ownership, autonomy in use of money, police raid in past year and deliberate self-harm were independently associated with STI in multivariate analysis.

†Religion, number of dependents, migrant status, social support, police raid in the past year and deliberate self-harm remained independently associated with HIV in multivariate analysis.

‡Only included in STI multivariate model.

§Only included in HIV multivariate model.

OR, odds ratio; STI, sexually transmitted infection.

engagement. We campaigned against the demolition and provided material support in the immediate aftermath. All participants and their partners were offered presumptive treatment for bacterial STI as well as treatment based on laboratory tests. HIV results were anonymous; however, voluntary counselling and testing for HIV, treatment for STI and HIV risk reduction counselling was made available to participants and non-participants alike.

RESULTS

A total of 326 sex workers from 35 different networks throughout Goa were recruited. Of the 59 seeds that were approached, 35 recruited women into the study. The mapping study identified four to five networks from which there were no sex workers recruited. We thus estimate a response rate of 88% of identified networks. The size of recruitment networks ranged from small networks of one or two women to larger networks

Table 4 Factors associated with STI in 309 female sex workers in Goa*

Variable	Adjusted OR† (95% CI)	Adjusted OR‡ (95% CI)
	Adjusted for base model	Final model
I Demographic and psychosocial factors from baseline model		
Age, years	p = 0.005	p < 0.001
<20	1	1
21–25	0.18 (0.07 to 0.50)	0.13 (0.04 to 0.40)
26–30	0.23 (0.08 to 0.63)	0.14 (0.05 to 0.41)
31–35	0.12 (0.04 to 0.42)	0.05 (0.01 to 0.19)
>36	0.20 (0.07 to 0.57)	0.07 (0.02 to 0.23)
Non-Goan ethnicity	p = 0.03	p = 0.003
	0.39 (0.17 to 0.91)	0.23 (0.08 to 0.61)
Schooling	p = 0.03	p = 0.007
None	1	1
Incomplete	0.50 (0.23 to 1.09)	0.33 (0.14 to 0.80)
Complete	0.07 (0.01 to 0.53)	0.06 (0.01 to 0.40)
Home ownership	p = 0.16	p = 0.1
	0.41 (0.34 to 1.19)	0.58 (0.30 to 1.14)
No financial autonomy	p = 0.09	p = 0.004
	1.70 (0.93 to 3.13)	2.62 (1.36 to 5.04)
Police raid (since demolition)	p = 0.04	p = 0.21
	2.31 (1.03 to 5.19)	1.61 (0.75 to 3.46)
Deliberate self-harm	p = 0.009	p = 0.002
	2.88 (1.31 to 6.34)	3.73 (1.63 to 8.56)
II Sex work, sexual risk and reproductive health		
Having an intimate non-paying male partner	p = 0.02	p = 0.02
	0.46 (0.24 to 0.89)	0.43 (0.21 to 0.88)
Change in intimate partner over past 3 months	p = 0.16	
	1.97 (0.77 to 5.02)	
Time in sex work, years	p = 0.25	
<1	1	
2–10	0.79 (0.40 to 1.57)	
>10	0.45 (0.18 to 1.16)	
Income from source other than sex work	p = 0.5	
	0.81 (0.44 to 1.49)	
Street-based sex work	p < 0.001	p = 0.006
	3.35 (1.72 to 6.52)	2.96 (1.37 to 6.38)
Establishment (lodge/bar or brothel) sex work	p = 0.15	
	0.62 (0.33 to 1.19)	
Home-based sex work	p = 0.34	
	0.70 (0.34 to 1.46)	
No of customers/week	p = 0.12	p = 0.21
Less than one	1	1
One to seven	1.35 (0.71 to 2.58)	1.58 (0.77 to 3.23)
More than seven	3.11 (1.05 to 9.20)	3.22 (0.79 to 13.21)
At least one regular paying customers	p = 0.05	p = 0.007
	1.85 (1.00 to 3.41)	2.46 (1.28 to 4.73)
Consistent condom use with customers	p = 0.5	
	0.78 (0.41 to 1.51)	
Payment per sex act with customer (per 100 rupees rise)	p = 0.7	
	1.02 (0.94 to 1.10)	
Childhood sexual abuse	p = 0.02	p = 0.01
	3.35 (1.22 to 9.17)	3.79 (1.37 to 10.45)
Lifetime experience of non-consensual/forced sex	p = 0.6	
	1.59 (0.25 to 9.96)	
HIV knowledge score	p < 0.001	p = 0.01
	0.92 (0.89 to 0.96)	0.94 (0.90 to 0.98)
Lifetime exposure to HIV prevention	p = 0.004	
	0.38 (0.19 to 0.73)	
Seeks treatment in free STI clinic (public and non-governmental)	p = 0.08	p = 0.02
	0.10 (0.01 to 1.35)	0.13 (0.02 to 0.71)
No reproductive tract symptoms 3 months	p = 0.01	p = 0.005
	2.36 (1.20 to 4.63)	2.99 (1.40 to 6.42)

*Only variables that were entered into the final model are listed in tables 4 and 5. There are therefore differences in the variables in these two tables. †Adjusted for underlying factors from base model, ie, age, ethnicity, schooling, home ownership, autonomy in the use of money, police raid and deliberate self-harm. ‡Weighted adjusted odds ratio (OR) of the final model reported here. STI, sexually transmitted infection.

of approximately 30 women. We recruited up to six waves. All areas and types of sex work identified in mapping were represented in the sample.

STI and HIV

Seventy-seven women (25.7% CI 21.0 to 31.1) had prevalent HIV infection. The estimated incidence of HIV was 4.7% (CI 2.4 to 8.9) per annum. The prevalence of chlamydial infection was 7.3% (CI 5.1 to 10.5; $n = 30$), gonococcal infection was 8.9% (CI 6.2 to 12.7; $n = 30$) and *T vaginalis* infection was 9.4% (CI 6.6 to 13.2; $n = 31$). The prevalence of at least one of the three bacterial STI was 22.0% (CI 17.7 to 27.0; $n = 75$). Antibodies to HSV-2 were detected in 57.2% (CI 51.5 to 62.7; $n = 182$) of women. Of the 75 women in whom curable STI were detected and treated, 57 (76%) were traceable for retesting 3 months following adequate treatment, of whom nine (16%) had a new or repeat infection.

Table 1 shows that sex workers were mobile, predominantly non-Goan, young and illiterate. More than half were indebted and 90% supported dependents. They were unsupported and experienced high levels of intimate partner and sexual violence.

Sex work was diverse (table 2). Sex workers were widely dispersed; practising in 557 different lodges, establishments and areas, including 57 in states other than Goa. The median payment per customer was 100 rupees (US\$2), ranging from 10 to 5000 rupees (US\$0.2–200). Seven per cent (CI 5 to 10; $n = 30$) and 5% (CI 3 to 8; $n = 21$) performed oral and anal sex, respectively.

Risk-reduction strategies and exposure to interventions (table 2)

A total of 74.4% (CI 69.3 to 78.9; $n = 237$) of sex workers reported consistent condom use with customers, which was similar to the 71.3% (CI 66.0 to 76.1; $n = 233$) who reported condom use with their last customer in the secret ballot. Condom breakages, being forced by a customer to have sex without a condom, accepting more money in exchange for sex without condoms and lack of use with intimate partners were commonly reported. Exposure to HIV prevention interventions and knowledge about HIV was poor. A total of 46.2% (CI 37.9 to 54.7; $n = 65$) sought care from a private practitioner for their STI symptoms, whereas 44.5% (CI 36.4 to 53.0; $n = 70$) did not access any care at all.

Determinants of infections (tables 3, 4 and 5)

STI were independently associated with Goan ethnicity, youth, lack of schooling, no financial autonomy, deliberate self-harm, sexual abuse, having regular customers, working on the streets, not having an intimate partner and being asymptomatic. Having knowledge about HIV and access to free STI services was associated with a lower likelihood of STI.

HIV was independently associated with being Hindu, recent arrival in Goa, brothel and lodge-based sex work and dysuria. Those with prevalent HIV were more likely to have social support and less likely to have an intimate partner.

DISCUSSION

Following the demolition, sex work in Goa has become heterogeneous, widely dispersed with a high prevalence of STI and HIV. Youth and illiteracy, indebtedness and support of dependents, migrant status and exposure to violence, limited access to HIV preventative and STI treatment services, contribute to their vulnerability.

The presence of a treatable bacterial STI is a marker of recent sexual risk. Several structural factors, suggesting gender disadvantage, were independently associated with having a bacterial STI, namely youth, lack of schooling, childhood sexual abuse, deliberate self-harm and lack of financial autonomy. Street-based sex workers and those who had regular customers were particularly vulnerable. Our ethnographic study suggests there were additional pressures to forgo condom use with "more intimate" regular customers. Those who demonstrated greater knowledge of HIV prevention and who accessed free and dedicated STI services had a lower likelihood of having an STI; suggesting that sexual risk-reduction interventions were effective in either reducing high-risk behaviour or improving recognition and treatment of STI. The paradoxical association between no symptoms and the presence of an STI may be explained by the fact that women with symptoms were more likely to have visited a healthcare provider and thus to have received an antibiotic.

Non-Goan sex workers were less likely to have bacterial STI. Our qualitative study suggested that Goan sex workers who had entered sex work since the demolition of the red-light area worked in isolation through mobile phones and were less likely to be professional or networked. In contrast, non-Goan sex workers who were mostly from Karnataka had often entered sex work through the Devadassi tradition (dedicated to the temple). Many had practised in the Baina red-light area before the demolition, identified as sex workers, and were part of a larger network of independent sex workers. They may also have been exposed to the extensive HIV prevention interventions in their native Karnataka. The qualitative data also suggest that male clients were less likely to insist on condom use with Goan sex workers, who they perceived as less likely to carry HIV.

Recent migrants were more likely to have HIV. This, as in other settings,²⁴ probably reflects the higher prevalence in northern Karnataka, their place of origin.¹ Similarly, the association with being Hindu may be consequent to the prevalence of HIV in uncircumcised partners in the women's non-paying sexual networks.²⁵ Understanding these sexual networks, within which sex workers engage in unprotected sex, may identify more vulnerable subgroups to engage in HIV treatment programmes.

The importance of structural/environmental determinants of sexual risk corroborates findings from neighbouring Karnataka.⁶ It also adds to the evidence linking intimate partner violence and gender disadvantage with HIV and sexual risk.^{26, 27} Although the effectiveness of tackling structural factors on HIV risk is yet to be proved in a randomised controlled trial,²⁷ our study suggests that interventions to empower women in managing their finances and tackling violence from intimate partners and society warrants further evaluation.

In keeping with the evidence, we found a relationship between HIV knowledge and recent sexual risk.⁷ However, effective interventions, including those that tackle structural factors, have been based in geographically defined brothels and red-light districts. Intervention delivery to dispersed and clandestine sex work, such as that that emerged from the demolition of the red-light area, is difficult. One effective solution is collectivisation,²⁸ wherein empowered sex workers develop and deliver interventions themselves. Peer-delivered interventions have reached the majority of sex workers in parts of Karnataka.²⁹ Although the feasibility of effective collectivisation of disempowered and non-professional sex workers is in doubt,³⁰ our success at reaching some of the most hidden networks through RDS is encouraging for peer-driven interventions.

Table 5 Factors associated with HIV in 325 female sex workers in Goa*

Variable	Adjusted OR† adjusted for base model (95% CI)	Adjusted OR‡ final model (95% CI)
I Demographic and psychosocial factors from base model		
Age, years	p = 0.8	p = 1
<20	1	1
21–25	1.60 (0.47 to 5.47)	0.90 (0.21 to 3.85)
26–30	1.84 (0.50 to 6.74)	0.92 (0.21 to 4.10)
31–35	1.95 (0.48 to 8.03)	0.81 (0.14 to 4.62)
>36	2.13 (0.57 to 7.93)	1.18 (0.24 to 5.76)
Religion	p = 0.001	p = 0.002
Hindu	2.94 (1.54 to 5.62)	3.31 (1.53 to 7.13)
No of dependents	p = 0.06	p = 0.06
None	1	1
Less than five	1.32 (0.51 to 3.38)	1.71 (0.62 to 4.73)
Five or more	0.51 (0.16 to 1.61)	0.62 (0.18 to 2.25)
Duration in Goa, years	p = 0.09	p = 0.03
One or less	1	1
2–10	0.46 (0.19 to 1.13)	0.27 (0.09 to 0.85)
More than 10	0.66 (0.27 to 1.61)	0.33 (0.11 to 0.99)
Since birth	0.32 (0.11 to 0.92)	0.21 (0.07 to 0.66)
Lack of social support (past week)	p = 0.02	p = 0.04
	0.49 (0.27 to 0.94)	0.50 (0.26 to 0.95)
Police raid (since demolition)	p = 0.006	p = 0.08
	3.03 (1.39 to 6.63)	2.17 (0.92 to 5.11)
Deliberate self-harm (lifetime)	p = 0.07	p = 0.3
	2.15 (0.93 to 4.98)	1.66 (0.57 to 4.82)
II Sex work, sexual risk and reproductive health		
Having an intimate non-paying male partner	p = 0.09	p = 0.04
	0.56 (0.29 to 1.10)	0.47 (0.22 to 0.97)
Duration in sex work, years	p = 0.03	p = 0.07
<1	1	1
2–10	2.80 (1.27 to 6.15)	2.56 (1.14 to 5.75)
>10	2.72 (1.08 to 6.87)	2.19 (0.88 to 5.47)
Income from source other than sex work	p = 0.7	
	0.83 (0.48 to 1.61)	
Street-based sex work	p = 0.4	
	0.74 (0.35 to 1.55)	
Establishment (brothel, lodge or bar) sex work	p = 0.02	p = 0.04
	2.04 (1.12 to 3.73)	2.01 (1.02 to 3.95)
Home-based sex work	p = 0.03	
	0.46 (0.23 to 0.92)	
More than one establishment/site for sex work	p = 0.1	p = 0.08
	0.57 (0.29 to 1.11)	0.51 (0.24 to 1.09)
No of customers/week	p = 0.4	
Less than one	1	
One to seven	1.26 (0.69 to 2.19)	
More than seven	0.45 (0.09 to 2.19)	
At least one regular customers	p = 0.1	
	0.63 (0.35 to 1.14)	
Consistent condom use with customer§	p = 0.003	
	3.04 (1.45 to 6.31)	
Payment per sex act with customer (per 100 rupee increase)	p = 0.08	p = 0.1
	0.85 (0.71 to 1.02)	0.81 (0.62 to 1.06)
HIV knowledge score	p = 0.3	
	1.02 (0.98 to 1.06)	
Lifetime exposure to HIV prevention	p = 0.04	
	1.89 (1.03 to 3.46)	
Lifetime HIV test	p = 0.16	
	1.53 (0.84 to 2.76)	
HSV-2	p = 0.02	
	2.05 (1.10 to 3.82)	
Any curable STI	p = 0.8	
	0.93 (0.46 to 1.89)	

Continued

Table 5 Continued

Variable	Adjusted OR† adjusted for base model (95% CI)	Adjusted OR‡ final model (95% CI)
Genital ulcer disease (3 months)	p = 0.01 3.21 (1.24 to 8.32)	p = 0.08 2.60 (0.88 to 7.64)
Dysuria (3 months)	p = 0.001 3.95 (1.74 to 8.95)	p = 0.002 5.58 (1.92 to 16.17)

*Only variables that were entered into the final model are listed in tables 4 and 5. There are therefore differences in the variables in these two tables.

†Adjusted to demographic and psychosocial factors, ie, age, religion, number of dependents, migrant status, social support, experience of a police raid in the past year, and deliberate self-harm.

‡Weighted adjusted odds ratio (OR) of the final model reported here.

§Consistent condom use adjusted for the other factors in the model is 1.93 (0.80 to 4.65) p = 0.15.

HSV-2, herpes simplex virus type 2; STI, sexually transmitted infection.

Bacterial STI were five times more common in the study participants compared with rural women in Goa.¹⁹ The prevalence of bacterial STI and HIV found in the sex workers in this study is also higher than in sex workers in the neighbouring districts of Karnataka and Maharashtra and more closely resembles the high prevalence red-light areas of Mumbai and Pune.³¹ Reducing this burden of infection through syndromic management is constrained by the absence of a relationship between symptoms and bacterial STI as well as high STI re-infection rates. A combined approach of providing presumptive treatment followed by regular algorithm-driven screening has been advocated for sex workers.⁷ However, again the challenge remains how to deliver treatment to such geographically dispersed women. One possibility is to utilise RDS type vouchers to refer cases to a mixture of accredited services; an alternative approach might be to delegate treatment delivery to experienced peers or outreach workers.

We conducted the study in a broad sample of sex workers, from different networks and typologies, many of who had never accessed services. We used pre-existing survey tools; the questionnaire was informed by the qualitative work, translated and extensively field tested. The close involvement of the researchers in advocacy against the demolition may have resulted in interviewer bias. To minimise social desirability bias we used externally verifiable outcomes, and triangulated behavioural data using different data collection methods. Formative work showed DBS to be more acceptable and feasible to collect than whole blood. Whereas the HIV kits used have been validated for DBS, this was not the case for the Focus HSV-2 kit. Although it is reassuring that, when compared against HSV-2 testing in serum, sensitivity and specificity analysis of DBS using 32 samples was 91% and 100%, respectively, this was a small sample and must be viewed with caution. The use of the BED detuned assay for incident HIV can

misclassify late infection as early, therefore the HIV incidence reported here must be interpreted with caution.^{32, 33} To reduce selection bias we used chain sampling, in which an approximate probability of recruitment can be calculated for each participant. This probability of recruitment is then inverted to form the weights, which were used in analysis. This gives an approximately unbiased analysis. Moreover, through our extensive mapping we are confident that nearly 90% of the networks were represented in the final sample. However, bias may arise in our analysis if the selection of network members for recruitment is based on factors related to our outcome measures. Furthermore, the full complexity of the RDS sample is not reflected in the standard errors, and so the CI and p values should be viewed as approximate. The long duration of recruitment reflects the difficulties of reaching this hidden population in the coercive environment following the demolition. Although this could theoretically lead to temporal changes in behaviour over time, we found behaviour was more closely related to the type of sex work and area of work than the time of recruitment.

CONCLUSIONS

Our study provides further evidence for structural and gender-based determinants of HIV and STI. Following the demolition of the red-light area, sex workers in Goa are a dispersed and heterogeneous group, with high levels of treatable bacterial STI and HIV and limited access to services. Given that those who accessed free STI services and had good HIV knowledge were at lower risk of bacterial STI, it is paramount that successful interventions are rapidly scaled up. Passing intervention delivery to empowered sex workers will probably raise the expectation that the underlying factors that increase their vulnerability to HIV and STI are also tackled. The challenge will be to move beyond tokenistic stakeholder involvement and secure sustainable funding for multifaceted individual and structural interventions.

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Key messages

- ▶ A heterogeneous and dispersed sex work emerged from the demolition.
- ▶ Sex workers in Goa are a vulnerable core group, with high levels of bacterial STI and HIV.
- ▶ Societal factors and in particular gender disadvantage are associated with sexual risk.
- ▶ Sex workers who access free and dedicated STI services and HIV prevention are less likely to have bacterial STI.
- ▶ Tackling structural determinants of sexual risk is integral to HIV preventions.

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