

LONDON
SCHOOL of
HYGIENE
& TROPICAL
MEDICINE



Isac, S; Ramesh, BM; Rajaram, S; Washington, R; Bradley, JE; Reza-Paul, S; Beattie, TS; Alary, M; Blanchard, JF; Moses, S (2015) Changes in HIV and syphilis prevalence among female sex workers from three serial cross-sectional surveys in Karnataka state, South India. *BMJ Open*, 5 (3). e007106. ISSN 2044-6055 DOI: <https://doi.org/10.1136/bmjopen-2014-007106>

Downloaded from: <http://researchonline.lshtm.ac.uk/2137980/>

DOI: [10.1136/bmjopen-2014-007106](https://doi.org/10.1136/bmjopen-2014-007106)

Usage Guidelines

Please refer to usage guidelines at <http://researchonline.lshtm.ac.uk/policies.html> or alternatively contact researchonline@lshtm.ac.uk.

Available under license: Creative Commons Attribution Non-commercial
<http://creativecommons.org/licenses/by-nc/3.0/>

BMJ Open Changes in HIV and syphilis prevalence among female sex workers from three serial cross-sectional surveys in Karnataka state, South India

Shajy Isac,^{1,2} B M Ramesh,^{1,2} S Rajaram,² Reynold Washington,^{1,2} Janet E Bradley,¹ Sushena Reza-Paul,¹ Tara S Beattie,³ Michel Alary,⁴ James F Blanchard,¹ Stephen Moses¹

To cite: Isac S, Ramesh BM, Rajaram S, *et al*. Changes in HIV and syphilis prevalence among female sex workers from three serial cross-sectional surveys in Karnataka state, South India. *BMJ Open* 2015;**5**:e007106. doi:10.1136/bmjopen-2014-007106

► Prepublication history for this paper is available online. To view these files please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2014-007106>).

Received 5 November 2014
Revised 12 January 2015
Accepted 13 January 2015



¹Department of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba, Canada

²Karnataka Health Promotion Trust, Bangalore, Karnataka, India

³Department of Global Health and Development, London School of Hygiene & Tropical Medicine, London, UK

⁴Département de médecine sociale et préventive, Université Laval, Québec, Canada

Correspondence to
Dr Shajy Isac;
shajyisac@khpt.org

ABSTRACT

Objectives: This paper examined trends over time in condom use, and the prevalences of HIV and syphilis, among female sex workers (FSWs) in South India.

Design: Data from three rounds of cross-sectional surveys were analysed, with HIV and high-titre syphilis prevalence as outcome variables. Multivariable analysis was applied to examine changes in prevalence over time.

Setting: Five districts in Karnataka state, India.

Participants: 7015 FSWs were interviewed over three rounds of surveys (round 1=2277; round 2=2387 and round 3=2351). Women who reported selling sex in exchange for money or gifts in the past month, and aged between 18 and 49 years, were included.

Interventions: The surveys were conducted to monitor a targeted HIV prevention programme during 2004–2012. The main interventions included peer-led community outreach, services for the treatment and prevention of sexually transmitted infections, and empowering FSWs through community mobilisation.

Results: HIV prevalence declined significantly from rounds 1 to 3, from 19.6% to 10.8% (adjusted OR (AOR)=0.48, $p<0.001$); high-titre syphilis prevalence declined from 5.9% to 2.4% (AOR=0.50, $p<0.001$). Reductions were observed in most substrata of FSWs, although reductions among new sex workers, and those soliciting clients using mobile phones or from home, were not statistically significant. Condom use 'always' with occasional clients increased from 73% to 91% (AOR=1.9, $p<0.001$), with repeat clients from 52% to 86% (AOR=5.0, $p<0.001$) and with regular partners from 12% to 30% (AOR=4.2, $p<0.001$). Increased condom use was associated with exposure to the programme. However, condom use with regular partners remained low.

Conclusions: The prevalences of HIV infection and high-titre syphilis among FSWs have steadily declined with increased condom use. Further reductions in prevalence will require intensification of prevention efforts for new FSWs and those soliciting clients using mobile phones or from home, as well as increasing condom use in the context of regular partnerships.

Strengths and limitations of this study

- This study tried to address the challenge of identifying or recruiting a representative sample of 'hidden' population groups. The programme regularly updated locations where sexual services were provided, so we most likely selected a representative sample of participants from the universe of female sex workers (FSWs) at the time of surveys. Furthermore, we used a time-location cluster approach to address the seasonality and movement of FSWs, within individual days as well as between days.
- The geographical coverage was the same for all the three rounds of surveys, and the five study districts accounted for about 60% of the urban FSWs in Karnataka state. Thus, there was consistent geographic coverage of a large proportion of FSWs in the state.
- A limitation of the study is that each survey was cross-sectional, and it was not possible to link individuals across surveys, so causality cannot be determined with certainty.
- Another limitation is that there was no control group, so it is possible that the observed declines in HIV and syphilis prevalence may have been due to other factors. However, the link between exposure to various programme elements and levels of condom use suggests that programme efforts played an important role in increasing condom use, and most likely in reducing risk for HIV and syphilis.
- A final study limitation is that due to the first surveys being undertaken 8–16 months after programme initiation, they most likely overestimated true pre-programme condom use.

INTRODUCTION

The HIV epidemic in India is highly heterogeneous¹ and is largely driven by heterosexual transmission, with unprotected commercial sex a major driver, particularly in the

southern states.^{1–3} Recent estimates indicate that there are 2.3 million HIV-infected individuals in India, making it the country with the third largest number of people living with HIV in the world,^{4,5} and accounting for almost 60% of South Asia's epidemic.⁶ Within India, the southern states of Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu have the highest HIV prevalence. While overall HIV prevalence has declined in India, the extent of the reduction varies in different geographic areas and among different population groups.^{4, 7–10} Profiles of female sex workers (FSWs)¹¹ and the determinants of HIV infection have been studied,^{11, 12} but there has been less work on understanding changing sex work characteristics and exposure to interventions, and how these factors have contributed to the epidemic.¹³

In 2003, the University of Manitoba, in partnership with the Government of Karnataka, established the Karnataka Health Promotion Trust (KHPT) to provide focused HIV prevention programmes and services for high-risk groups in 21 of 30 districts across the state. The programme, which was part of the *Avahan* India AIDS initiative of the Bill and Melinda Gates Foundation, has reached on a regular basis over 60 000 FSWs and 20 000 men who have sex with men and transgenders. Three main strategies were employed to address HIV prevention among FSWs and their clients: promotion of safer sex behaviour through a peer-mediated communications strategy, with particular focus on promotion of condom use; improved and intensive management of sexually transmitted infections (STIs); and enhancement of the enabling environment for the adoption of safer sex practices.¹⁴

To assess the impact of these activities on programme coverage, condom use and STI and HIV prevalence among FSWs over time, we conducted a series of anonymised, integrated behavioural and biological assessments (IBBAs) with random samples of FSWs in five districts across the state during 2004–2011. We have previously described the results from the first two survey rounds,¹³ but in this paper we analyse data collected from all three rounds, and also describe the changing nature of sociodemographic and sex work characteristics over time.

METHODS

Study design and sampling

We selected five districts for the IBBAs, using the selection criteria of sociocultural region and size of the FSW population. The five districts selected account for over 60% of FSWs in the 21 *Avahan* districts. Prevention programmes were initiated in each of these districts between January 2004 and April 2005, with three rounds of cross-sectional surveys conducted between 2004 and 2011. Round 1 (R1) was conducted 8–16 months after programme initiation; the round 2 (R2) and round 3 (R3) surveys were conducted 28–37 and 27–34 months, respectively, after the previous round.

The target sample size per district was fixed at 400 completed interviews (including blood samples), and the sample size in Bangalore Urban was enhanced to 800, to better represent the two main sex work typologies (public place-based and non-public place-based) in this large city. Full details of the survey design can be found in Saidel *et al.*¹⁵

Survey and laboratory methods

The survey was conducted anonymously, with no names or personal identifiers recorded. Consent was obtained separately for the interview and for giving biological samples.

In all survey rounds, venous blood samples or dried blood spots (DBS) using a finger-prick specimen (where serum samples were not provided) were tested for HIV and syphilis. HIV antibody was detected using Micro ELISA (J. Mitra and Company, India), and positive tests were confirmed using Genedia HIV ELISA 3.0 (Green Cross Life Science Corporation, South Korea). If the participant refused to provide blood or finger-prick samples, urine samples were tested for HIV by Calypte (Biomedical Corporation, Berkeley, California, USA), and confirmed by urine western blot. Syphilis was tested for using RPR (Span Diagnostics, Sachin, India) and TPHA (*Treponema pallidum* Hemagglutination Assay test, Omega Diagnostics Ltd., Alloa, Scotland). RPR titres were taken, and participants were considered syphilis positive if both the RPR (any titre) and TPHA tests were positive. If the RPR titre was 1:8 or greater, and the TPHA test was positive, then the participant was considered to have high-titre syphilis.

Survey instruments

A behavioural questionnaire was designed to be culturally sensitive and context specific, as previously described.^{12, 13, 15} The questionnaire contained questions on: (1) sociodemographic characteristics, including age, age at sexual debut, marital status, literacy, sources of income other than sex work, local residential status and migration for sex work; (2) sex work characteristics, including age at starting sex work, duration in sex work, usual place of solicitation, sex client volume and income from sex work; (3) 'agency', including membership in a collective (sex worker association or organisation) and exposure to HIV prevention programmes; and (4) condom use. All interviews were conducted in the local language (*Kannada*) by trained interviewers. As no identifying information was collected, data could not be linked between rounds.

Statistical analyses

Data were double-entered using CSPro V.4.0 (Methodology and Software Development Branch, International Programs Center, US Bureau of the Census, Washington, DC, USA). All statistical analyses were performed using SPSS V.22.0. Appropriate weights were computed to account for the sampling probabilities at district, primary sampling unit and individual levels, as well as non-

response rates. The primary outcomes were the prevalence of HIV and high-titre syphilis. The secondary outcomes were: (1) condom use at last sex and always, with occasional and regular commercial clients, and with regular partners; and (2) exposure to the intervention programme elements (peer contact, clinic and drop-in centre (DIC) visit, and received condom demonstration). ORs were used as the measure of association, and the Wald χ^2 test was the statistical test employed. The survey round was incorporated as an exposure variable, and the following variables that were significantly different between survey rounds were included in the multivariate model as control variables: (1) district; (2) age; (3) marital status; (4) age at starting sex work; (5) duration in sex work; (6) place of solicitation; (7) work other than sex work; (8) place of origin; (9) practised sex work in other districts; (10) weekly income from sex work; (11) proportion of clients who were new and (12) whether the FSW had a regular sexual partner.

RESULTS

Changing sex worker characteristics

Overall, 7015 FSWs were interviewed and provided a blood sample over three rounds of surveys (R1=2277; R2=2387 and R3=2351). In R1, 88% of FSWs invited to participate agreed to the interview and provided at least one biological sample (serum, DBS or urine), increasing to 95–98%, respectively, in R2 and R3. Among those who provided a biological sample, most gave venous blood (97% in R1, 95% in R2 and 96% in R3). The proportion of young FSWs (<25 years) decreased from 19% to 14% over the survey rounds. About two-thirds of the respondents were illiterate and about 60% of FSWs earned money from other activities. The marital status of the study population changed over time, with those currently married increasing from 33% to 57% between R1 and R3, and the proportion who were separated, widowed or deserted decreasing from 46% to 26%. FSWs who came from places outside of their current district of residence declined from 37% in R1 to 25% in R2 and R3. The mean age at starting sex work increased by about 2 years between R1 and R3 (24–26 years). The proportion of FSWs practising sex work for less than 2 years declined from 21% to 14%, but the mean duration in sex work remained more or less constant, at just over 6 years. Nearly half of the sex workers solicited in public places, but those soliciting from home declined from 36% to 20%, and at brothels from 10% to 4%. There was a large corresponding increase in those soliciting using mobile phones, from none in R1 to 30% in R3. Client volume remained relatively constant, at about 10 clients per week. Most FSWs had occasional and regular clients, with about 60% of clients occasional. About 65% of FSWs had a regular partner at R1, declining significantly to 60% at R3. The average charge per sex act more than doubled between the R1 and R3 surveys (₹171–₹375, or about US\$2.80–US\$6.20).

Weekly income from sex work also doubled, from ₹1660 (\$27.60) to ₹3501 (\$58.30).

Condom use behaviour

We used two measures of reported condom use: always condom use and condom use at last sex with each partner type (occasional clients, regular clients, main regular partners). Condom use with clients was relatively high at R1, most likely a programme effect, as the surveys were carried out from 8 to 16 months after prevention programmes began.¹⁷ In R1, 73% of FSWs reported always using condoms and 86% using condoms at last sex with occasional clients, while 52% reported always using condoms and 63% using condoms at last sex with regular clients, with only 12% reporting always using condoms and 30% at last sex with regular partners (table 1). In both univariate and multivariate analyses, there were significant increases in reported condom use with all sexual partners at the follow-up surveys compared with R1. Thus, those reporting always using condoms with occasional clients increased from 73% to 81% to 91%, with regular clients from 52% to 75% to 86%, and with regular partners from 12% to 24% to 30%.

Exposure to the intervention programme

There was already high exposure to several programme elements at R1, most likely for the reasons indicated above. In R1, 82% of FSWs had been contacted by a peer educator, and 71% and 43% reported ever visiting the programme clinic and DIC, respectively (table 2). By R2, nearly all FSWs had been contacted by a peer educator, about 92% had ever visited the programme clinic and about two-thirds had ever visited a DIC. Those who reported ever seeing a condom demonstration increased from 73% at R1 to about 94% in R3.

Exposure to programme elements and condom use behaviour

We examined the relationship between various programme exposure elements and condom use behaviour. Table 3 presents the adjusted ORs (AORs) of using a condom at last sex with commercial clients and regular partners, according to exposure to different programme elements in R3 against the reference in R1.

Condom use at last sex with a regular partner remained unchanged among FSWs who were not exposed to different interventions over three rounds of surveys. However, FSWs who had been contacted by a peer educator, ever seen a condom demonstration and ever visited a programme run clinic and a DIC had almost 1.7–1.9 times the odds of using a condom at last sex with a regular partner in R3 compared with the R1 survey. Similarly, condom use at last sex with commercial clients remained unaffected from R1 to R3 surveys among the FSWs who were not exposed to programme elements. However, significant increases in condom use at last sex with commercial clients were observed among the FSWs who had ever been contacted by a peer

Table 1 Bivariate and multivariate analysis of condom use behaviour among respondents by survey round

Condom use behaviour	Survey round	Per cent	Unadjusted		Adjusted	
			OR (95% CI)	p Value	AOR (95% CI)	p Value
Per cent condom use at last sex with occasional clients	Round 1	86.3	Reference		Reference	
	Round 2	93.3	2.1 (1.7 to 2.6)	<0.001	1.2 (0.9 to 1.6)	0.10
	Round 3	96.0	3.6 (2.7 to 4.7)	<0.001	1.8 (1.2 to 2.6)	<0.001
Per cent always condom use with occasional clients	Round 1	72.9	Reference		Reference	
	Round 2	81.4	1.5 (1.3 to 1.8)	<0.001	1.3 (1.1 to 1.6)	<0.001
	Round 3	90.5	3.3 (2.8 to 4.0)	<0.001	2.7 (2.1 to 3.4)	<0.001
Per cent condom use by the last regular client	Round 1	62.6	Reference		Reference	
	Round 2	86.0	3.5 (2.9 to 4.2)	<0.001	2.3 (1.8 to 2.8)	<0.001
	Round 3	92.7	7.3 (5.9 to 9.0)	<0.001	4.9 (3.7 to 6.4)	<0.001
Per cent always condom use with regular clients	Round 1	51.9	Reference		Reference	
	Round 2	75.0	2.6 (2.3 to 3.0)	<0.001	2.3 (2.0 to 2.7)	<0.001
	Round 3	85.9	5.3 (4.5 to 6.1)	<0.001	4.9 (4.0 to 6.0)	<0.001
Per cent condom use at last sex with regular partners	Round 1	30.8	Reference		Reference	
	Round 2	33.9	1.1 (0.9 to 1.3)	0.36	1.1 (0.8 to 1.4)	0.28
	Round 3	38.6	1.3 (1.1 to 1.6)	<0.001	1.7 (1.3 to 2.2)	<0.001
Per cent always condom use with regular partners	Round 1	12.2	Reference		Reference	
	Round 2	23.9	1.9 (1.5 to 2.5)	<0.001	2.5 (1.9 to 3.5)	<0.001
	Round 3	30.4	2.7 (2.1 to 3.5)	<0.001	4.3 (3.1 to 5.9)	<0.001

AOR, adjusted OR.

educator (AOR=1.7), ever seen a condom demonstration (AOR=2.0) and ever visited a programme run clinic for STI services (AOR=1.9).

Trends in HIV and high-titre syphilis prevalence

In R1, HIV prevalence was 19.6% among all women surveyed, with percentages ranging from 33.9% in Belgaum to 9.7% in Shimoga (table 4). Over time, there was a significant decline in HIV prevalence from 19.6% (R1) to 16.4% (R2) to 10.8% (R3), with a reduction seen in every survey round in each of the five districts surveyed. HIV prevalence declined in almost all sociodemographic and sex work groups. HIV prevalence tended to be highest in women who were separated/widowed/deserted, who did not have an additional income to sex work, who had ever sold sex outside the district and among brothel-based and street-based sex workers.

Although HIV prevalence declined significantly among FSWs in sex work for more than 2 years, it did not decline among new sex workers (in sex work for less than 2 years). It should be noted that there were no mobile phone-based FSWs identified at R1, but this increased to 161 at R2 and 760 at R3.

As high-titre syphilis is likely to be indicative of active or recent syphilis infection, trends in high-titre syphilis prevalence are presented in table 4. High-titre syphilis prevalence was 5.9% in R1, ranging from 14.7% in Mysore to 2.0% in Bellary. Over time, it declined significantly from 5.9% in R1 to 3.4% in R2 to 2.4% in the R3 survey. The decline was significant in most sociodemographic and sex work groups. Unlike for HIV infection, there was a significant reduction in high-titre syphilis prevalence among new FSWs, from 6.1% in R1 to 1.3% in R3.

Table 2 Bivariate and multivariable analysis of programme exposure indicators by survey round

Programme exposure	Survey round	Per cent	Unadjusted		Adjusted	
			OR and 95% CI	p Value	OR and 95% CI	p Value
Ever contacted by a peer educator	Round 1	82.4	Reference		Reference	
	Round 2	95.3	4.3 (3.5 to 5.4)	<0.001	3.8 (3.0 to 4.9)	<0.001
	Round 3	97.8	9.5 (7.1 to 12.8)	<0.001	7.7 (5.4 to 11.1)	<0.001
Ever seen a condom demonstration	Round 1	72.8	Reference		Reference	
	Round 2	89.5	3.2 (2.7 to 3.7)	<0.001	2.6 (2.2 to 3.1)	<0.001
	Round 3	93.6	5.5 (4.5 to 6.6)	<0.001	4.4 (3.5 to 5.7)	<0.001
Ever visited the programme clinic	Round 1	70.9	Reference		Reference	
	Round 2	85.6	2.4 (2.1 to 2.8)	<0.001	2.3 (1.9 to 2.7)	<0.001
	Round 3	91.8	4.6 (3.9 to 5.4)	<0.001	4.0 (3.2 to 5.0)	<0.001
Ever visited the programme drop-in centre	Round 1	43.0	Reference		Reference	
	Round 2	76.9	4.5 (3.9 to 5.1)	<0.001	4.4 (3.8 to 5.1)	<0.001
	Round 3	66.0	2.6 (2.3 to 2.9)	<0.001	2.1 (1.8 to 2.5)	<0.001

Table 3 Adjusted ORs for condom use at last sex with a commercial client and with a regular partner, by exposure to specific programme elements

	Condom use at last sex with main partner						Condom use at last sex with commercial clients					
	Not exposed			Exposed			Not exposed			Exposed		
	Per cent	AOR and 95% CI	p Value	Per cent	AOR and 95% CI	p Value	Per cent	AOR and 95% CI	p Value	Per cent	AOR and 95% CI	p Value
Ever contacted by a peer educator	R1	19.4	Reference	35.6	Reference	Reference	71.0	Reference	Reference	90.0	Reference	Reference
	R2	11.2	0.5 (0.1 to 3.3)	0.48	1.2 (0.9 to 1.5)	0.26	88.1	1.3 (0.4 to 4.3)	0.69	94.0	1.1 (0.8 to 1.5)	0.63
	R3	15.1	0.2 (0.0 to 1.3)	0.10	1.8 (1.3 to 2.3)	<0.001	75.0	0.5 (0.2 to 1.5)	0.21	96.8	1.7 (1.2 to 2.5)	<0.01
Ever seen a condom demonstration	R1	16.7	Reference	40.4	Reference	Reference	68.6	Reference	Reference	91.9	Reference	Reference
	R2	20.4	1.5 (0.6 to 3.3)	0.36	1.1 (0.8 to 1.4)	0.64	83.2	0.9 (0.4 to 1.7)	0.64	94.9	1.1 (0.8 to 1.6)	0.63
	R3	22.2	0.7 (0.3 to 1.6)	0.36	1.7 (1.3 to 2.3)	<0.001	77.3	0.7 (0.4 to 1.4)	0.30	97.5	2.0 (1.3 to 3.2)	<0.01
Ever visited the programme clinic	R1	21.6	Reference	37.0	Reference	Reference	77.0	Reference	Reference	91.0	Reference	Reference
	R2	13.8	0.4 (0.2 to 1.0)	0.04	1.2 (0.9 to 1.7)	0.13	91.2	1.1 (0.5 to 2.0)	0.87	94.1	1.1 (0.8 to 1.5)	0.73
	R3	17.9	0.5 (0.2 to 1.3)	0.16	1.7 (1.3 to 2.3)	<0.001	86.2	0.5 (0.3 to 1.0)	0.05	97.2	1.9 (1.2 to 2.9)	<0.01
Ever visited the programme DIC	R1	32.7	Reference	30.7	Reference	Reference	84.7	Reference	Reference	91.8	Reference	Reference
	R2	29.1	1.0 (0.6 to 1.5)	0.94	1.1 (0.8 to 1.6)	0.58	91.2	1.2 (0.8 to 2.0)	0.37	94.5	0.9 (0.6 to 1.3)	0.52
	R3	31.4	1.1 (0.7 to 1.7)	0.69	1.9 (1.3 to 2.8)	<0.001	94.6	1.8 (1.1 to 2.9)	0.02	97.0	1.3 (0.8 to 2.3)	0.29

AOR, adjusted OR; DIC, drop-in centre; R1, round 1; R2, round 2; R3, round 3.

DISCUSSION

The prevalence of HIV infection and high-titre syphilis among FSWs in Karnataka declined significantly from 2004 to 2011, and this decline was observed in most sociodemographic and sex work subgroups. HIV prevalence among new FSWs, however, did not decline. Programmes experience challenges in reaching new sex workers, often taking 9 months or more to reach them after they first begin sex work.¹⁸ Thus, by the time programmes reach new FSWs, many of them have already acquired HIV infection. In R3, HIV prevalence was already 7.9% among new sex workers, and was 9.7% and 12.2% among those with 2–4 and 5–9 years in sex work, respectively, suggesting that a large proportion of infections occur during the early sex work period. This diminishing marginal increment in HIV prevalence as the duration in sex work increases has been reported previously, but has not been well characterised.^{12 19}

The proportion of FSWs who had migrated to their places of work declined over time, suggesting that migration earlier on in the HIV epidemic may arise from the desire to avoid ‘social humiliation’.²⁰ FSWs were also subject to severe stigmatisation in their daily lives, and particularly in their interactions with police and their families.²¹ There has been extensive work undertaken over the past decade to improve the risk environment, including activities such as active engagement with policymakers, addressing stigma and discrimination, addressing violence and harassment, sensitisation of police, legal empowerment training, and developing crisis management teams.^{14 22–25} Sex workers have also started sharing a sense of support and confidence, and have enjoyed increased access to information about social entitlements.^{14 22–26} This empowerment of FSWs^{26 27} has most likely mitigated the need to migrate to practise sex work. Female sex work typologies have also changed over time, as many FSWs who previously solicited at ‘hot spots’ in public places or in brothels now use mobile phones to pick up clients, and have sex in their houses or in suitable rented accommodation.^{28 29} This phenomenon has major programme implications, as reaching mobile phone-based FSWs is often challenging.²⁸ Although mobile phone solicitation may be less risky for HIV infection than solicitation in brothels or in public places, because of the more controlled nature of mobile phone solicitation, and possibly because of increased self-esteem to demand condom use, this phenomenon needs to be monitored very carefully, as data are sparse.

Condom use in our study increased significantly over time, even though there was already relatively high condom use reported in R1. It has proven very difficult to collect baseline information in a systematic way from a highly stigmatised population such as FSWs, without first offering some programmes and services that they recognise as being beneficial to them. It is most likely that the high level of condom use observed in the first

Table 4 Bivariate and multivariable analyses of the prevalences of HIV infection and high-titre syphilis, by characteristics of sex workers and survey round

	HIV prevalence (%)			High-titre syphilis prevalence (%)			p Value			
	Round 1	Round 2	Round 3	AOR (95% CI)	Round 1	Round 2		Round 3	AOR (95% CI)	p Value
Total	19.6	16.4	10.8	0.48 (0.39 to 0.59)	<0.001	5.9	3.4	2.4	0.50 (0.34 to 0.74)	<0.001
District										
Belgaum	33.9	27.3	22.3	0.46 (0.32 to 0.64)	<0.001	3.3	2.9	1.1	0.16 (0.05 to 0.51)	<0.001
Bellary	15.7	14.1	6.3	0.46 (0.27 to 0.81)	0.01	2.0	4.8	3.2	2.28 (0.82 to 6.31)	0.11
Shimoga	9.7	9.0	7.0	0.48 (0.24 to 0.97)	0.04	2.7	1.9	0.4	0.29 (0.04 to 2.33)	0.24
Bangalore Urban	12.7	8.0	9.3	0.85 (0.50 to 1.46)	0.55	9.5	4.4	2.5	0.38 (0.16 to 0.94)	0.04
Mysore	26.1	24.2	10.9	0.43 (0.25 to 0.71)	<0.001	14.7	3.1	5.2	0.38 (0.14 to 0.98)	0.05
Age of respondents (years)										
<25	20.0	12.9	10.6	0.46 (0.28 to 0.76)	<0.001	6.6	3.7	4.4	0.38 (0.14 to 1.06)	0.06
25+	19.5	17.1	10.8	0.48 (0.38 to 0.59)	<0.001	5.8	3.3	2.1	0.49 (0.31 to 0.76)	0.00
Literacy										
Literate	15.1	13.3	10.8	0.50 (0.35 to 0.73)	<0.001	2.6	1.7	2.2	0.92 (0.42 to 2.04)	0.84
Illiterate	21.9	17.9	10.8	0.47 (0.37 to 0.60)	<0.001	7.6	4.2	2.5	0.41 (0.26 to 0.65)	<0.001
Work other than sex work										
Yes	18.1	14.7	10.1	0.43 (0.33 to 0.56)	<0.001	4.9	2.9	1.6	0.38 (0.21 to 0.67)	<0.001
No	22.5	18.6	12.1	0.53 (0.38 to 0.72)	<0.001	7.6	4.1	3.8	0.64 (0.38 to 1.10)	0.11
Marital status										
Unmarried	17.5	18.1	9.6	0.39 (0.18 to 0.82)	0.01	2.9	3.5	2.1	0.18 (0.03 to 1.29)	0.09
Currently married	13.7	12.5	8.4	0.51 (0.36 to 0.72)	<0.001	4.9	1.9	2.1	0.46 (0.23 to 0.90)	0.02
Separated/widowed/deserted	23.1	20.2	16.3	0.47 (0.34 to 0.64)	<0.001	8.2	5.6	3.3	0.46 (0.25 to 0.82)	0.01
Devadasi	30.6	20.2	11.0	0.42 (0.20 to 0.86)	0.02	2.6	1.7	2.1	0.17 (0.02 to 1.37)	0.10
Place of origin										
Local district	18.1	15.1	10.7	0.52 (0.40 to 0.67)	<0.001	2.7	3.3	1.6	0.72 (0.41 to 1.28)	0.26
Outside local district	22.1	20.1	11.1	0.45 (0.30 to 0.60)	<0.001	11.7	3.8	4.8	0.34 (0.18 to 0.65)	<0.001
Ever did sex work outside district										
Yes	31.8	38.0	29.0	0.40 (0.24 to 0.65)	<0.001	0.6	12.8	8.5	1.08 (0.40 to 2.92)	0.88
No	19.3	15.2	10.5	0.48 (0.39 to 0.60)	<0.001	6.1	3.1	2.3	0.30 (0.19 to 0.48)	<0.001
Age at start of sex work (years)										
≤19	22.3	18.8	11.7	0.48 (0.32 to 0.73)	<0.001	4.9	4.4	3.1	0.74 (0.32 to 1.69)	0.47
20–24	20.3	17.5	12.8	0.56 (0.39 to 0.82)	<0.001	5.5	1.6	3.5	0.62 (0.29 to 1.34)	0.22
25–29	18.7	17.2	10.3	0.44 (0.29 to 0.67)	<0.001	7.4	3.1	1.5	0.29 (0.11 to 0.74)	0.01
30–34	14.4	12.0	8.6	0.43 (0.24 to 0.77)	<0.001	4.2	4.9	0.8	0.21 (0.05 to 0.96)	0.04
35+	20.3	13.0	9.7	0.29 (0.14 to 0.61)	<0.001	9.0	4.2	3.2	0.40 (0.12 to 1.31)	0.13
Sex work duration (years)										
<2	10.5	13.4	7.9	0.88 (0.70 to 1.10)	0.26	6.1	2.6	1.3	0.43 (0.27 to 0.68)	<0.001
2–4	21.0	15.4	9.7	0.32 (0.22 to 0.45)	<0.001	7.0	3.3	3.4	0.52 (0.28 to 0.98)	0.04
5–9	24.2	16.8	12.2	0.57 (0.38 to 0.84)	<0.001	6.6	4.0	2.4	0.50 (0.23 to 1.10)	0.08
10+	21.4	19.1	12.8	0.56 (0.38 to 0.84)	<0.001	3.9	3.6	1.7	0.64 (0.25 to 1.68)	0.37
Typology										
Public place-based	21.3	17.8	12.3	0.48 (0.37 to 0.62)	<0.001	8.8	4.0	2.7	0.40 (0.25 to 0.65)	<0.001
Home-based	13.6	11.9	9.7	0.64 (0.41 to 0.99)	0.05	2.4	3.0	2.5	0.59 (0.21 to 1.65)	0.32

Continued

Table 4 Continued

	HIV prevalence (%)			High-titre syphilis prevalence (%)						
	Round 1	Round 2	Round 3	AOR (95% CI)	p Value	Round 1	Round 2	Round 3	AOR (95% CI)	p Value
	Brothel-based	33.3	25.6	15.2	0.35 (0.16 to 0.77)	0.01	3.7	2.3	7.6	4.82 (0.59 to 39.5)
Mobile phone-based	NA	12.0	8.7	0.78 (0.45 to 1.35)	0.38	0.0	2.0	1.3	0.56 (0.11 to 2.80)	0.48
Number of occasional clients for every 10 clients entertained										
None	6.2	4.1	7.5	0.40 (0.24 to 0.66)	<0.001	3.0	1.2	2.2	0.23 (0.01 to 3.49)	0.29
1-4	17.7	15.7	9.7	0.41 (0.28 to 0.60)	<0.001	7.1	4.5	1.9	0.28 (0.08 to 0.94)	0.04
5-9	21.2	17.9	10.5	0.59 (0.44 to 0.79)	<0.001	4.9	3.6	2.6	0.59 (0.36 to 0.97)	0.04
All	20.4	16.2	16.9	0.71 (0.16 to 3.16)	0.65	16.3	2.6	2.5	0.15 (0.04 to 0.56)	<0.001
Has a regular sex partner										
No	25.9	20.8	13.3	0.60 (0.34 to 1.06)	0.08	8.5	4.0	2.8	0.40 (0.23 to 0.72)	<0.001
Yes	16.3	12.8	9.2	0.38 (0.30 to 0.49)	<0.001	4.6	2.9	2.1	0.76 (0.44 to 1.31)	0.33
Amount charged for sex per week (Indian rupees)										
<1500 (\$25)	20.2	17.0	10.7	0.41 (0.30 to 0.54)	<0.001	5.3	3.2	3.0	0.64 (0.37 to 1.12)	0.12
1500-2999 (\$25-\$50)	19.7	18.5	12.3	0.68 (0.44 to 1.05)	0.08	6.9	3.4	2.5	0.49 (0.21 to 1.14)	0.10
3000+ (\$50+)	16.9	13.7	9.8	0.56 (0.37 to 0.85)	0.01	7.1	3.7	1.9	0.35 (0.17 to 0.74)	0.01

AOR, adjusted OR; NA, not available.

survey was related largely to the programme, since condom use was much higher among those exposed to various programme elements, compared with those who were not exposed. However, continuing low levels of condom use with regular partners underlines the challenge faced in promoting condom use in this context. A recent study from Karnataka suggested that if an FSW starts sex work and subsequently acquires a regular sex partner, condoms are more likely to be used, compared with situations where marriage occurs first and sex work begins later on.³⁰ More work is required to understand and mitigate sexual risk and to increase condom use in the context of regular partnerships.

In summary, this study has confirmed continued increases in condom use following a focused HIV prevention programme, and corresponding declines over time in the prevalences of HIV infection and high-titre syphilis, among FSWs in Karnataka state. Sex work characteristics have changed over time, particularly a shift to mobile phone-based solicitation, which has important programme implications. More work is required for programmes to reach sex workers earlier in their sex work careers, as they are particularly vulnerable to HIV infection during that period, and a challenge remains to promote increased condom use in the context of regular partnerships.

Acknowledgements The authors thank the non-governmental organisations, community-based organisations and individuals who supported and participated in the surveys. They also thank Prakash Javalkar, Ravi Prakash and Bidhubhushan Mahapatra for their assistance in fieldwork and data compilation and analysis.

Contributors SI conceptualised the study, conducted the analysis, interpretation of results and writing of the manuscript. SI, BMR and SR-P were involved in the data collection and data management of all survey rounds. BMR, RW, MA, JFB and SM contributed to the project's conception, design and implementation, as well as the interpretation of the results and writing of the manuscript. SR contributed to the analysis of the data and writing of the manuscript. JFB, SR, TSB and SR-P contributed to the interpretation of results and review of the manuscript and provided extensive feedback.

Funding This work was supported by Bill & Melinda Gates Foundation's India AIDS Initiative (*Avahan*), grant number 52138.

Competing interests None.

Patient consent Obtained.

Ethics approval Statutory approval for the conduct of the IBAs and their protocol was obtained by the Indian Health Ministry's Screening Committee (HMSC), under the auspices of the Indian Council of Medical Research (ICMR), New Delhi. Ethical approval for the study was obtained from the Institution Ethical Review Board of St. John's Medical College and Hospital, Bangalore and the Health Research Ethics Board, University of Manitoba, Canada. The study fully adhered to the research ethics guidelines approved by the Institutional Review Boards.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

Open Access This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

REFERENCES

- UNAIDS. Asia: AIDS epidemic summary: regional summary, 2008. http://data.unaids.org/pub/Report/2008/jc1527_epibriefs_asia_en.pdf (accessed 7 Apr 2009).
- Halli SS, Blanchard J, Satihal DG, *et al.* Migration and HIV transmission in rural South India: an ethnographic study. *Cult Health Sex* 2007;9:85–94.
- Arora P, Cyriac A, Jha P. India's HIV-1 epidemic. *CMAJ* 2004;171:1337–8.
- National AIDS Control Organization, Ministry of Health and Family Welfare, Government of India. Epidemic analysis based on HIV sentinel surveillance 2010–11. 2012.
- National Institute of Medical Statistics and National AIDS Control Organization (NACO). *Technical Report India HIV Estimates*. New Delhi, India: NACO, 2012.
- Moses S, Blanchard JF, Kang H, *et al.* *AIDS in South Asia: understanding and responding to a heterogeneous epidemic*. Washington, DC: The World Bank, 2006.
- 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;367:1164–72.
- Arora P, Kumar R, Bhattacharya M, *et al.* Trends in HIV incidence in India from 2000 to 2007 [Letter]. *Lancet* 2008;372:289–90.
- Reza-Paul S, Beattie T, Syed HU, *et al.* Declines in risk behaviour and sexually transmitted infection prevalence following a community-led HIV preventive intervention among female sex workers in Mysore, India. *AIDS* 2008;22(Suppl 5):S91–100.
- Rajaram S, Bradley JE, Ramesh BM, *et al.* Is HIV prevalence declining in Southern India? Evidence from two rounds of general population surveys in Bagalkot district, Karnataka. *Sex Transm Dis* 2012;39:761–8.
- National AIDS Control Organization, Ministry of Health and Family Welfare, Government of India. National Behavioural Surveillance Survey (BSS) among Female sex workers in India. New Delhi, 2006.
- Ramesh BM, Moses S, Washington R, *et al.* Determinants of HIV prevalence among female sex workers in four south Indian states: analysis of cross-sectional surveys in twenty-three districts. *AIDS* 2008;22(Suppl 5):S35–44.
- Ramesh BM, Beattie TSH, Isac S, *et al.* Changes in risk behaviours and prevalence of sexually transmitted infections following HIV preventive interventions among female sex workers in five districts in Karnataka state, south India. *Sex Transm Infect* 2010;86(Suppl 1):i17–24.
- Gurnani V, Beattie TS, Bhattacharjee P, *et al.* An integrated structural intervention to reduce vulnerability to HIV and sexually transmitted infections among female sex workers in Karnataka state, south India. *BMC Public Health* 2011;11:755.
- Saidel T, Adhikary R, Mainkar M, *et al.* Baseline integrated behavioural and biological assessment among most at-risk populations in six high-prevalence states of India: design and implementation challenges. *AIDS* 2008;22(Suppl 5):S17–34.
- Magnani R, Sabin K, Saidel T, *et al.* Review of sampling hard-to-reach and hidden populations for HIV surveillance. *AIDS* 2005;19(Suppl 2):S67–72.
- Bradley J, Moses S, Blanchard JF, *et al.* Validating reported condom use among female sex workers in southern India through examination of condom availability. *Sex Transm Infect* 2010;86(Suppl 1):i44–8.
- Swasti and Karnataka Health Promotion Trust. Understanding New Female Entrants to Sex Work. Bangalore Urban, 2010.
- Alexander M, Mainkar M, Deshpande S, *et al.* Heterosexual anal sex among female sex workers in high HIV prevalence states of India: need for comprehensive intervention. *PLoS ONE* 2014;9:e88858.
- Simon Fan C, Stark O. A theory of migration as a response to occupational stigma. International Economic Review, Department of Economics, University of Pennsylvania and Osaka University. *Inst Soc Econ Res Assoc* 2011;52:549–71.
- Wong WC, Holroyd E, Bingham A. Stigma and sex work from the perspective of female sex workers in Hong Kong. *Sociol Health Illn* 2011;33:50–65.
- Thompson L, Bhattacharjee P, Anthony J, *et al.* *A systematic approach to the design and scale-up of targeted interventions for HIV prevention among urban female sex workers*. Karnataka Health Promotion Trust, 2012.
- Beattie TS, Bhattacharjee P, Ramesh BM, *et al.* Violence against female sex workers in Karnataka state, south India: impact on health, and reductions in violence following an intervention program. *BMC Public Health* 2010;10:476.
- Pillai P, Bhattacharjee P, Ramesh BM, *et al.* *Impact of two vulnerability reduction strategies—collectivization and participation in savings activities on risk reduction among sex workers*. Bangalore, India: Karnataka Health Promotion Trust, 2011.
- Parinita B, Prakash R, Pillai P, *et al.* Understanding the role of peer group membership in reducing HIV-related risk and vulnerability among female sex workers in Karnataka, India. *AIDS Care* 2013;22(Suppl 1):46–54.
- Blankenship KM, West BS, Kershaw TS, *et al.* Power, community mobilization and condom use practices among female sex workers in Andhra Pradesh, India. *AIDS* 2008;22(Suppl 5):S109–16.
- Blanchard AK, Mohan HL, Shahmanesh M, *et al.* Community mobilization, empowerment and HIV prevention among female sex workers in south India. *BMC Public Health* 2013;13:234.
- Mahapatra B, Saggurti N, Halli SS, *et al.* HIV risk behaviours among female sex workers using cell phone for client solicitation in India. *J AIDS Clin Res* 2012;S1:014.
- Integrated Behavioural and Biological Assessment (IBBA). *State summary report for Karnataka*. Karnataka Health Promotion Trust, 2013.
- Isac S, Prakash R, Ramesh BM, *et al.* Challenges in increasing condom use among female sex workers with their regular sex partners in Karnataka state, South India. *International AIDS Conference*; Washington, DC, July 2012.