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Using surveillance data to evaluate a large-scale HIV highway intervention targeting female sex workers in the Terai region of Nepal

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Abstract

Objectives: To evaluate the effectiveness of the scaled-up 'Safe Highway' HIV intervention program among female sex workers (FSWs) in the Terai region of Nepal after a quasi-experimental pre-surveillance study demonstrated the efficacy of the program on a limited scale.
Methods: Analysis of data from multiple rounds of behavioral surveillance surveys (BSS, 1998-2002) and integrated bio-behavioral surveys (IBBS, 1999, 2003, 2006) conducted among FSWs.
Results: Surveillance trend data indicates that there have been steady and statistically significant increases in key condom use indicators and decreases in HIV prevalence over time during which time the Safe Highway program was scaled up and coverage increased significantly. Condom use during last sex with a client increased steadily from 42.1% in 1999 to 68.0% in 2006 ($P<0.001$). HIV prevalence decreased steadily from 3.9% in 1999 to 1.5% in 2006 ($P<0.05$). Syphilis prevalence also decreased significantly during this time from 11.7% in 1999 to 4.3% in 2006 ($P<0.001$) but no decreases were observed for gonorrhea or Chlamydia prevalence. Multiple logistic regression analysis of the 2006 data that adjusted for potential confounding variables showed statistically significant associations ($P<0.001$) between exposure to numerous intervention program components (peer education/outreach work, community awareness events, and STI clinic visits) and condom use with clients.
Conclusions: The results suggest that the Safe Highway intervention program has significantly contributed to increasing condom use between FSWs and their clients along the East-West highway districts in the Terai region of Nepal.

OBJECTIVES

Nepal's first HIV case was officially reported in 1988 and by the end-of-2005 it is officially estimated that there were 75,000 (41,000 – 180,000) persons living with HIV in the country [1]. Early in the epidemic, available data indicated that the HIV epidemic in Nepal was being fueled by large number of Nepali migrant workers, including male laborers and female sex workers (FSWs), who were infected with HIV while working in major urban centers in India and subsequently transmitting the virus upon their return to Nepal [2-5].

The East-West highway runs 1,014 km along the entire length of the Terai region of southern Nepal and serves as the major land transportation route between the porous border between India and Nepal. High levels of commercial sex occur along the Terai highway, one of the many settings where mobile men with money travel long distances in poverty-stricken areas with high rates of unemployment and displacement [6-11]. In 2005, the Government of Nepal estimated that there were 14,000-18,000 FSWs in the Terai highway districts serving between 291,000 – 375,000 clients [12].

Other forms of male migration as well as internal conflict have also been linked to HIV transmission in Nepal. A study of male migrant-returnees in far-western Nepal found that 8% were HIV-infected and 22% had syphilis, and some observers have suggested that this migration and HIV transmission could have been further exacerbated by the widespread violent Maoist political conflict that affected the country, particularly the Far West Region [4, 13].

The Safe Highway program was designed and supported by FHI in 1993 in partnership with the Government of Nepal with financial support from the U.S. Agency for International Development (USAID) to deliver HIV/STI prevention activities in nine Terai highway districts [14]. The intervention strategy is based on the dual and complementary targeting of both FSWs and male occupational groups that are typical clients of FSWs in Nepal such as long-distance truckers, other transport workers, laborers, and policemen [7,15-17]. The initial scope of program activities were focused on behavior change interventions (BCI) using multiple and integrated channels. This included interpersonal communication focused on repeated outreach and peer education, condom social marketing and distribution through retail and non-traditional outlets, awareness-raising community events such as street dramas and mobile video shows, and mass media campaigns using TV, radio, billboards, print media and special events. The scope and intensity of the Safe Highway program activities have been scaled up extensively over time and its geographical coverage has expanded from 9 to 22 highway districts (Figure 1). Prevention-to-care activities such as networks of targeted Drop-In Centers (DIC), STI and VCT services were phased in as well in the late-1990s. DICs have printed and audio-visual IEC materials, provide free condom supplies, condom use demonstrations and basic counseling services. STI and VCT services were integrated at numerous sites as well but were also free-standing where the capacity for this integration did not exist. In addition, capacity-building, advocacy, research and design-related activities have increasingly been developed. The number of local non-governmental organizations who partnered with FHI to implement the Safe Highway program increased from one in 1993 to 44 by 2006.

Currently, the Safe Highway program includes 167 DICs, 16 STI clinics and 20 VCT sites. Between 1999 and 2006, the primary program output data targeted at FSWs and male clients included distribution of over 2.2 million condoms distributed and 570,203 BCI materials; 274,985 one-on-one contacts by outreach workers and peer educators;, 594,000 persons reached through community awareness events; 299,810 visits to DICs; STI diagnosis and treatment among 31,195 persons; and HIV testing and counseling at VCT sites for 6,168 persons. In addition, an estimated 13 million radio listeners and 6 million television viewers were reached via mass media educational and promotional campaigns that encourage HIV prevention through safe sex messages.

During the pilot phase of the Safe Highway program (1994-1996), a quasi-experimental study was conducted that demonstrated the efficacy of the program on a limited scale [18,19]. In summary, at baseline (1994) FSWs were sampled in intervention and control areas along the Terai highway and were found to be similar with respect to key sociodemographic, knowledge and behavioral indicators. In 1996, follow-up surveys were repeated using the same methodology in the same intervention and control areas and the results revealed that condom use at last sex with clients had increased significantly from 35.0% to 61.0% ($P<0.0001$) while no significant corresponding changes were observed in the control area (48.4% to 49.1%, $P>0.05$). Supporting these findings, significant increases were observed among FSWs in the intervention area with regard to key HIV/AIDS and condom knowledge indicators and the provision of condoms to their clients while no significant increases were observed in the control areas.

The goal of this paper is to assess the overall effectiveness of the scaled-up Safe Highway program on FSWs by conducting surveillance-linked outcome and impact analysis between 1998 and 2006 using internationally recommended guidelines [20]. An in-depth evaluation of the Safe Highway program among truck drivers and laborers at high-risk of being clients of FSWs will be carried out in another separately planned paper.

METHODS

Study Design

This evaluation is based on the results of periodic cross-sectional surveillance survey data conducted among FSWs annually during 1998-2003 and also in 2006. Two types of repeated surveillance surveys were used for this purpose: behavioral surveillance surveys (BSS) and integrated bio-behavioral surveys (IBBS). The BSS was initially implemented in Nepal because of ease of implementation and cost limitations. As the cost of integrating biologic measures into the surveys decreased, and the collection of these data became more urgently needed and feasible, it was decided to conduct IBBS regularly. For evaluation purposes, these data were triangulated with routine program coverage data as well to the extent possible.

Sampling Strategy

Both the BSS and IBBS used probability-based venue-based two-stage cluster sampling. Extensive pre-surveillance mapping was conducted to identify and list venues where FSWs congregate. In the first stage, about 60 clusters (defined as locations where the estimated FSW population size was 20-30) were selected based on probability proportional to size (PPS). In the second stage, an equal number of FSWs were selected from each cluster randomly for inclusion in the sample. This approach resulted in self-weighted samples.

Eligibility Criteria

For both the BSS and IBBS surveys, the FSW eligibility criteria for recruitment were "women 16 years of age or older who reported providing sexual services in return for monetary or in-kind payment during the last six months.".

Data Source 1: Behavioral Surveillance Surveys (BSS)

Five BSS rounds were conducted among FSWs between 1998 and 2002 by the same local research organization, New ERA [21]. Trained interviewers conducted face-to-face interviews using standardized questionnaires 'on the spot' at the venue where they were identified or nearby. Standardized indicator data were collected with regard to sociodemographics, knowledge, attitudes and behaviors. In addition, a limited number of 'exposure to intervention' questions variables were included as well. FSWs were sampled from the 16 Terai highway districts between Jhapa in the east and Rupandehi in the west that comprised the Safe Highway intervention area during this time period. The sample size (n=400) was the same for each of the survey rounds.

Data Source 2: Integrated Biological and Behavioral Surveys (IBBS)

Integrated surveys were conducted among FSWs in 1999, 2003 and 2006 [22-24]. These surveys were jointly carried by New ERA and STD/AIDS Counseling and Training Services (SACTS). Once FSWs were identified they had to travel to one of the mobile study

sites where the face-to-face interviews were administered and biological samples were collected. The same sampling methods were used for all three IBBS rounds. In 1999, the sampling frame was limited to the 16 highway districts where program interventions were being implemented and the sample size was 410. In 2003 and 2006, the sampling frame was expanded to 22 districts to correspond to the expanding geographical scope of the Safe Highway program. To allow for geographical comparability in trend analysis over time, the 2003 and 2006 IBBS rounds consisted of two FSW sub-samples. One for the original 16 intervention districts sampled in 1999 (sample size n=400 in each round) and an additional sample for the six program expansion districts between Kapilvastu in the west to Kanchanpur in the far western region (sample size n=200). Information on FSWs' sociodemographics and limited data on knowledge, attitudes and behaviors was collected during all three IBBS rounds and in 2006 and in-depth 'exposure to intervention' module was added to the questionnaire for enhanced program evaluation purposes.

For all three rounds, laboratory testing was conducted for HIV, syphilis, gonorrhea and Chlamydia. 7-10 ml of venous blood was taken by a field lab technician for HIV and syphilis testing using a disposable syringe. Serum samples were collected, separated from the collected blood samples and stored in a refrigerator in the field. The specimens were handed over to the SACTS laboratory in Kathmandu twice a week in a cold box. Prior to testing, the serum samples were stored at the SACTS laboratory at a temperature of -12 to -20 degrees C. Endocervical swab samples were collected by a trained field nurse using the AMPLICOR swab specimen collection and transport kit for Chlamydia and gonorrhea testing. The swab samples were transported in a separate cold box to the National Reference Laboratory (NRL) in Kathmandu twice a week where it was stored at room temperature. HIV antibodies were detected by repeat positives of two separate enzyme linked immunoassays (ELISAs) using internationally recommended guidelines - strategy 3 [25]. Syphilis was tested using Rapid Plasma Antigen Reagin (RPR) Card Tests (Becton, Dickinson and Company, New Jersey, USA), and confirmed using the Serodia *Treponema pallidum* particle agglutination (TPPA) test (Fujirebio Inc., Tokyo, Japan). Active syphilis was defined as a TPPA-positive sample with a reactive RPR test. Polymerase chain reaction (PCR) testing was performed for the detection of *Neisseria gonorrhea* and *Chlamydia trachamotis* using the AMPLICOR test kit (Roche Diagnostic systems, Inc., Branchburg, N.J., USA). Quality control was strictly maintained throughout the process of specimen collection, handling, and testing. All the tests were performed using internal quality controls. All positive serum samples and a 10% of negative samples collected were submitted for quality control assurance to an independent laboratory for HIV and syphilis testing. None of the samples failed the quality control checks.

Measures

The behavioral outcome for FSWs in the Safe Highway program was condom use with commercial clients. The key indicators assessed were (a) condom use during last sex act with a client, and (b) consistent condom use (use 'always' with all clients) over the last 12 months. The primary biological impact measure was HIV prevalence. Prevalence rates for specific STIs (syphilis, gonorrhea, and Chlamydia) was also assessed using laboratory testing. Exposure to intervention variables were used to estimate program coverage and to compare outcomes of interest in FSWs exposed vs. unexposed to interventions. The frequency of program exposure during the last 12 months and its association with condom use was also examined.

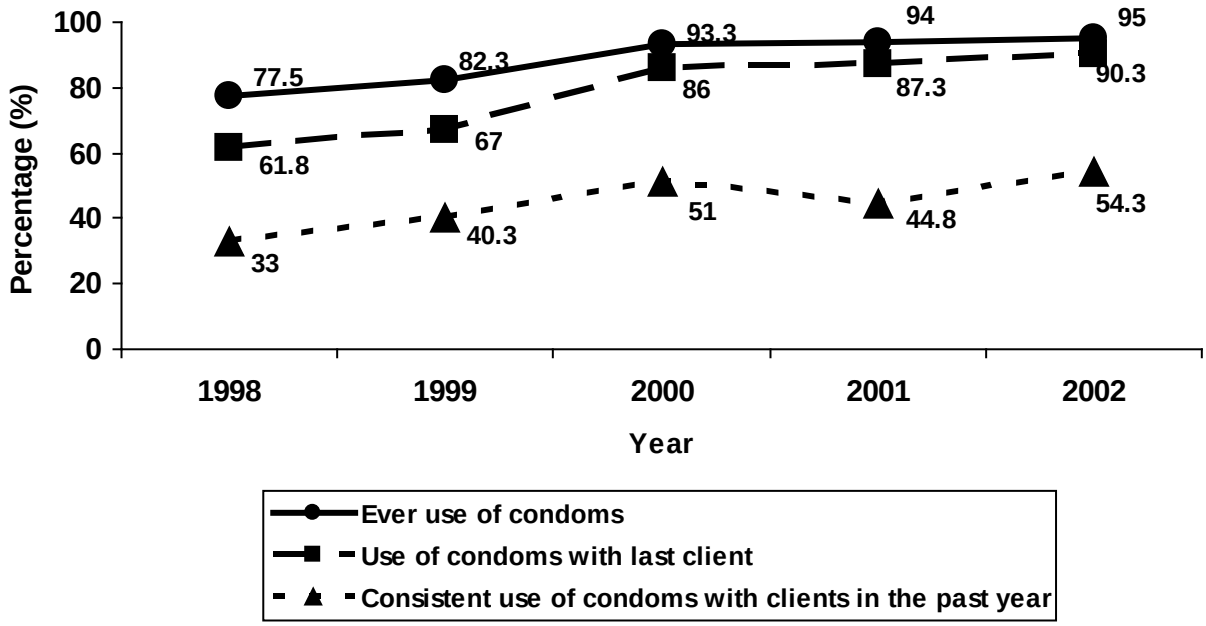
Statistical Analysis

Time-trend analysis was conducted for key BSS and IBBS survey rounds in relation to key variables of interest. These analyses were performed in the core intervention 16 highway districts to maintain geographic consistency over time. χ^2 tests for linear trend were used to assess to statistical significance over multiple time points.

In addition, crude and adjusted odds ratios (OR) and 95% confidence intervals (95% CI) were calculated to examine the relationship between intervention exposures and condom use with clients. To adjust for potential

Figure 2: Trends in condom use with clients among Female Sex Workers, BSS, 1998-2002

χ^2 test for trend $P<0.001$ for all variables.



confounding variables that could distort this association of interest, adjusted ORs and 95% CIs were calculated using multiple logistic regression analysis. Variables included age, ethnicity/caste, educational status, marital status, age at first sex, duration of sex work, employment other than sex work, having engaged in sex work in India, and having dependents on sex worker income.

χ^2 tests for linear trend analysis were used to examine the presence of dose-response relationships between the frequency of program exposure and condom use during the previous 12 months with clients. For all statistical analyses, $P<0.05$ was considered statistically significant. Data were analyzed using the Statistical Package for the Social Sciences for Windows, Version 11.0 (SPSS, Chicago, Illinois, USA).

Ethical Considerations

Ethical approval for all surveillance-related data collection activities was obtained from the Nepal Health Research Council (NHRC), the Government of Nepal's ethical clearance institution, and FHI's Protection of Human Subjects Committee (PHSC).

RESULTS

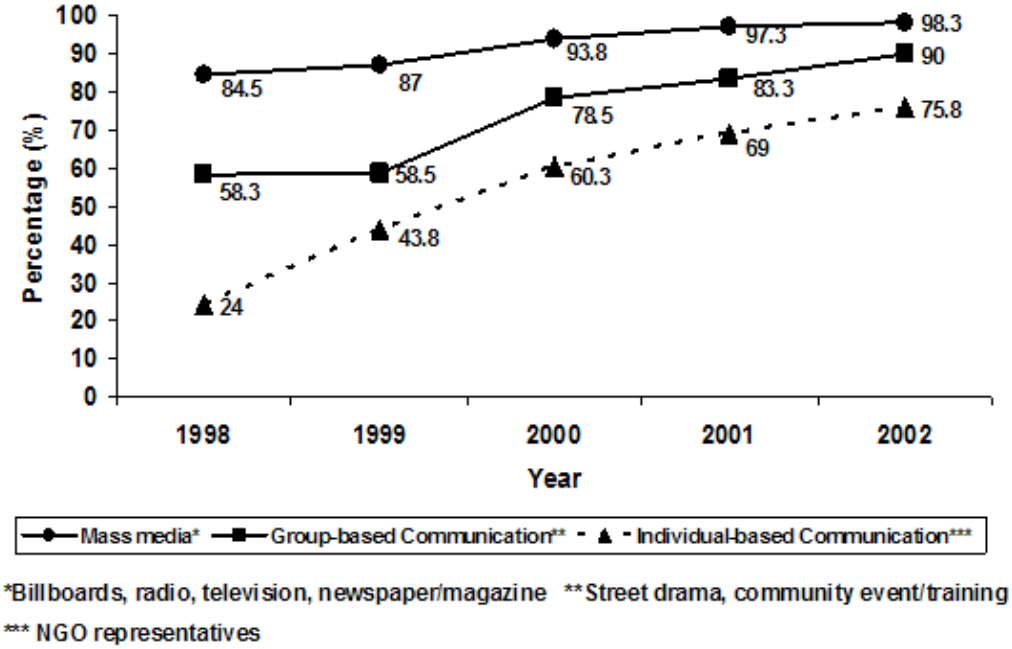
Time-trend analysis of BSS and IBBS surveillance data

The analysis of BSS data revealed steady and statistically significant increases over time in key behavioral outcomes (Figure 2). Between 1998 and 2002, 'ever use' of condoms increased from 77.5% to 95% ($P<0.001$), condom use during last sex with clients increased from 61.8% to 90.3% ($P<0.001$), and consistent condom use with clients during the last year increased from 33% to 54.3% ($P<0.001$).

Further analysis of BSS data also demonstrates that Safe Highway program coverage among FSWs had also increased significantly over time (Figure 3). The most notable increases were observed in relation to reported exposure to individual-based behavior change communication messages which increased over three-fold from 24% in 1998 to 75.8% in 2002 ($P<0.001$). Reported exposure to group-based communications such as street drama performances and community-based events or trainings increased from 58.3% to 90% between 1998 and 2002 ($P<0.001$). Exposure to HIV/AIDS-related mass media messages such as

Figure 3: Program coverage behavior change communications interventions among Female Sex Workers, BSS, 1998 – 2002

χ^2 test for trend $P<0.001$ for all variables.



billboards, radio, television and newspaper/magazines increased from 84.5% in 1998 to 98.3% by 2002 ($P<0.001$). These reported increases were corroborated by an analysis of available program reports. The proportion of FSWs reached through interpersonal BCI contacts relative to estimated population size was 24% in mid-2003 and this had increased to 59% by mid-2005. These program coverage estimates track lower than those found for earlier period based on analysis of BSS data for 1998-2002 but are consistent in that they show an increasing trend over time.

Detailed analysis of the more recent IBBS round data conducted in 1999, 2003 and 2006 showed that while the distribution of many sociodemographic variables were comparable over time (Table 1). However, the data indicated that the proportion of illiterate FSWs decreased over time while at the same time the proportion of respondents with some schooling increased over time ($P<0.001$). Similarly, the proportion of currently married FSWs also increased over time ($P<0.001$).

The results of the IBBS-based trend analysis for key behavioral measures showed statistically significant changes over time (Table 1). The proportion of FSWs who reported having performed sex work in India decreased over time ($P<0.001$). The proportion of FSWs who reported having ever used condoms increased significantly over the three time points from 64.9% in 1999 to 84.7% in 2006 ($P<0.001$). Similarly, the proportion of FSWs who reported condom use during last sex with a client increased from 42.1% in 1999 to 68.0% in 2006 ($P<0.001$).

Consistent condom use with clients in the last year was not assessed in 1999 but more than doubled between 2003 and 2006 (23.3% in 2003 to 51.5% in 2006 ($P<0.001$)). However, consistent condom use with non-paying partners was very low and did not show any significant improvement between 2003 and 2006 (Table 1).

The prevalence of HIV infection among FSWs was 3.9% in 1999. In subsequent rounds, HIV prevalence decreased significantly over

Table 1: Key sociodemographic, behavioral, and HIV and STI prevalence data of female sex workers in 1999, 2003 and 2006: 16 Terai highway districts

	1999 (n=410)		2003 (n=400)		2006 (n=400)		P-value (χ^2 test)
	n	%	n	%	n	%	
Age group							*P*=0.42
<20 y	103	25.1	88	22.0	83	20.8	
20-24 y	92	22.4	88	22.0	82	20.5	
25-29 y	89	21.7	80	20.0	82	20.5	
30+ y	126	30.7	144	36.0	153	38.3	
Educational level							*P*<0.001
Illiterate	291	71.0	243	60.8	203	50.8	
Literate, no schooling	27	6.6	59	14.8	60	15.0	
Grade 1-5	50	12.2	63	15.8	80	20.0	
Grades 6 and above	42	10.2	35	8.8	57	14.2	
Marital status							*P*=0.006
Married	189	46.1	209	52.3	223	55.8	
Divorced/Separated	153	37.3	131	32.8	99	24.8	
Widowed	16	3.9	18	4.5	16	4.0	
Never married	52	12.7	42	10.5	62	15.5	
Age at first sex (years)							*P*=0.14
<15	156	38.0	181	45.3	153	38.3	
15-19	227	55.4	200	50.0	228	57.0	
>20	27	6.6	19	4.7	19	4.7	
Duration of sex work							*P*=0.07
<1 year	112	27.3	118	29.5	126	31.5	
1-2 years	77	18.8	102	25.5	93	23.3	
2-3 years	63	15.4	62	15.5	52	13.0	
>3 years	158	38.5	118	29.5	129	32.2	
Practiced sex work in India							P<0.001*
Yes	70	17.1	35	8.8	19	4.8	
No	340	82.9	365	91.2	381	95.2	
Ever use of condom							*P*<0.001*
Yes	266	64.9	291	72.8	339	84.7	
No	144	35.1	109	27.2	61	15.3	
Use of condom during last sex with client							*P*<0.001*
Yes	173	42.1	220	55.0	272	68.0	
No	93	22.6	180	45.0	128	32.0	
Consistent condom use with clients in last year							*P*<0.001
Yes	NA	NA	93	23.3	206	51.5	
No	NA	NA	307	77.8	194	48.6	
Consistent condom use with non-paying partners in last year							
Yes	NA	NA	10	5.6	16	7.5	*P*=0.44
No			170	94.4	198	92.5	
HIV status							*P*=0.04*
Positive	16	3.9	12	3.0	6	1.5	
Negative	394	96.1	388	97.0	394	98.5	
Active Syphilis							*P*<0.001*
Positive	48	11.7	17	4.3	20	5.0	
Negative	362	88.3	383	95.7	380	95.0	
Chlamydia							*P*<0.001*
Positive	38	9.3	49	12.3	73	18.3	
Negative	372	91.7	351	87.7	327	81.7	
Gonorrhoea							*P*=0.72*
Positive	37	9.0	72	18.0	39	9.8	
Negative	373	91.0	328	82.0	361	90.2	

*P-value s across three time points derived from $\chi 2$ tests for linear trend NA = Not Available

time to 3.0% in 2003 and then to 1.5% in 2006 (*P*=0.04). In 1999 and 2003, HIV prevalence was strongly associated with a history of engaging in commercial sex in India. In 1999, HIV prevalence was 17.1% among FSWs having worked in India compared to 1.2% who did not (OR = 17.40, 95% CI 4.97 – 66.42). In 2003, HIV prevalence among FSWs having worked in India was also 17.1% compared to 1.6% among FSWs (OR = 12.38, 95% CI 3.27 – 47.05). However, in 2006 while FSWs having worked in India still had a higher HIV prevalence than FSWs who did not (5.3% vs. 1.3%) this factor was no longer statistically significant (OR = 4.18, 95% CI 0.49 – 32.6).

The prevalence of active syphilis infection also decreased from 11.7% in 1999 before stabilizing at 4-5% in 2003 and 2005 (*P*<0.001). Gonorrhea prevalence did not show any clear time trend doubling from 9.0% to 18.0% between 1999 and 2003 before decreasing again to 9.8% (*P*>0.05). However, the prevalence of Chlamydia infection has increased significantly over time from 9.3% in 1999 to 18.3% in 2006, *P*<0.001 (Table 1).

Analysis of the association between program exposure and condom use with clients

Statistically significant associations were observed for all types of program exposures and both 'last time' and consistent condom use with clients based on analysis of the 2006 IBBS. These results were found in both crude analysis and in adjusted analysis that controlled for potential confounding variables (Table 2). In adjusted analysis, FSWs who participated in community awareness events/trainings were over three time more likely to use condoms during last sex with clients (OR=3.31, 95% CI 2.14 – 5.13) and over four times more likely to use condoms consistently with clients during the last year compared to FSWs without this exposure (OR=4.40, 95% CI 2.99 – 6.48). Exposure to community-based peer educators and/or outreach workers was also significantly associated with both 'last time' and consistent condom use with clients in both crude and adjusted analysis. The adjusted results were similar for both last time and (2.80, 95% CI 1.84-4.28) and consistent condom use with clients (OR=2.98, 95% 1.88 – 4.74). Having received VCT services was also strongly associated with both last time (OR =2.48, 95% CI 1.67 – 3.67) and consistent condom use (OR=2.83, 95% CI 1.99 – 4.04) with clients. In the adjusted analysis, having visited a DIC during the last 12 months was more strongly associated with condom use during last sex with a client (OR=2.47, 95% CI 1.66-3.67) than consistent condom use during the last year (1.47, 95% CI 1.03 – 2.09).

DISCUSSION

To our knowledge this is the first reported evaluation of the long-term effectiveness of a scaled-up HIV prevention program targeting FSWs in Nepal and one of the few reported in the literature in general for an intervention targeting FSWs in a large geographic area covering multiple provinces of a country [26]. Conducting such evaluations is a priority for the Government of Nepal given the country's need to monitor the national response to the HIV epidemic. This evaluation helps to fill this void using surveillance-linked triangulation, the recommended methodology for the evaluation of large-scale public health interventions in routine settings [27-29].

The pre-surveillance controlled study conducted during 1994-1996 demonstrated the efficacy of the program on a limited scale [18-19] and surveillance trend data from multiple rounds of BSS and IBBS conducted on FSWs clearly demonstrates steady and significant improvements between 1998 and 2006 in key behavioral and biological measures. This coincides with the timing of the expansion and scale-up of the Safe Highway program which has been the only major HIV prevention program targeting FSWs and their clients implemented in the Terai region during this time. BSS data showed program coverage increasing steadily between 1998-2002 and this increasing trend over time in program coverage between 2003-2005 was corroborated by analysis of program report data.

Although the BSS and IBBS survey methodology was designed primarily to monitor trends and patterns in the HIV epidemic over time, the 2006 IBBS

Table 2: Crude and adjusted multiple logistic regression analyses of the relationship between exposure to prevention interventions by female sex workers and condom use with clients, 2006 IBBS: 22 *Terai* highway districts

Intervention exposure during the last 12 months	Condom used during last sex with client					Consistent condom use with clients in the last 12 months				
	%	OR_C	95% CI	OR_A	95% CI	%	OR_C	95% CI	OR_A	95% CI
Contact with peer educators or outreach workers										
Yes	71.4	2.79	1.86 – 4.17	2.80	1.84 – 4.28	48.0	2.92	1.87 – 4.58	2.98	1.88 – 4.74
No	47.2	1.00	---	---	---	24.0	1.00	---	---	---
Visited a drop-in center										
Yes	77.3	2.31	1.59 – 3.35	2.47	1.66 – 3.67	48.0	1.39	1.00 – 1.94	1.47	1.03 – 2.09
No	59.6	1.00	---	---	---	39.9	1.00	---	---	---
Visited an STI clinic										
Yes	73.9	1.68	1.14 – 2.46	1.60	1.08 – 2.37	52.1	1.75	1.21 – 2.43	1.67	1.17 – 2.40
No	62.9	1.00	---	---	---	38.8	1.00	---	---	---
Visited a VCT center										
Yes	78.1	2.41	1.64 – 3.53	2.48	1.67 – 3.67	58.6	2.71	1.92 – 3.83	2.83	1.99 – 4.04
No	59.7	1.00	---	---	---	34.3	1.00	---	---	---
Participated in HIV/AIDS awareness raising comm. events										
Yes	82.6	3.41	2.25 – 5.17	3.31	2.14 – 5.13	65.7	4.14	2.89 – 5.94	4.40	2.99 – 6.48
No	58.1	1.00	---	---	---	31.6	1.00	---	---	---

OR_C = Crude Odds Ratio

OR_A = Adjusted Odds Ratio controlling for age, ethnicity/caste, educational status, marital status, age at first sex, duration of sex work, history of sex work in India, employment other than sex work, dependents on sex worker

Table 3: Relationship between the frequency of prevention intervention exposure among female sex workers and consistent condom use with clients during the last 12 months

	Consistent condom use with clients					
	Yes		No		Odds Ratio	*P*-value (χ^2 test for trend)
	N	%	n	%		
No. of contacts with peer educators and/or outreach workers						*P*<0.001
None	30	24.0	95	76.0	1.00*	
Once	8	22.2	28	77.8	0.90	
2-3 times	71	31.3	82	33.5	2.74	
4-6 times	49	44.1	62	55.9	2.48	
7-12 times	46	52.9	41	47.1	3.52	
>12 times	53	62.3	32	37.7	5.19	
No. of drop-in center visits						*P*<0.001
None	148	39.9	223	60.1	1.00*	
Once	10	43.5	13	56.5	1.16	
2-3 times	43	46.7	49	53.3	1.32	
4-6 times	27	48.2	29	51.8	1.40	
≥7 times	30	51.7	28	48.3	1.61	
No. of visits to STI clinic						*P*<0.001
None	160	38.8	252	61.2	1.00*	
Once	45	43.3	59	56.7	1.20	
2-3 times	43	60.6	28	39.4	2.42	
≥4 times	10	76.9	3	23.1	5.25	
No. of visits to VCT clinic						*P*=0.47
None	253	65.7	132	34.3	1.00*	
Once	70	53.4	61	46.6	0.60	
2-3 times	46	65.7	24	34.3	1.00	
≥ 4 times	9	69.2	4	20.8	1.17	
No. of times participated in HIV/AIDS community awareness events						*P*<0.001
None	126	31.6	273	68.4	1.00*	
Once	31	53.4	25	44.6	2.69	
2-3 times	67	69.1	30	30.9	4.84	
≥ 4 times	32	69.6	14	30.4	4.95	

*The 'none' category is the reference group for the test for linear trend analysis.

demonstrated the feasibility of including an enhanced 'exposure to intervention' module to the survey questionnaire for the purposes of program evaluation. Detailed analysis of the 2006 IBBS data provides further evidence for the effectiveness of the Safe Highway program. The existence of a strong dose-response relationship between the frequency of program exposure and consistent condom use with clients provided further corroborating evidence of program effectiveness. The validity of improvements in self-reported safe sex behavior among FSWs has been further paralleled by the significantly decreasing HIV and syphilis prevalence over time. However, no corresponding decreases in prevalence trends of Chlamydia or gonorrhea were observed and the reasons for this are unclear. It is known that using STI prevalence as a proxy measure for the effectiveness of HIV prevention programs is problematic because such trends are not solely attributable to changes in behavior.

There are complex interrelationships and processes involved and the coverage, quality and effectiveness of treatment guidelines and programs will all impact upon the incidence of treatable STIs [30]. It is unlikely that the observed data are due to laboratory error due to the rigorous quality control procedures used. A detailed assessment of these issues is planned in the near future.

There are a number of limitations associated with this study. It is possible that the behavior change observed could come from non-programmatic informal communication or increasing awareness about persons who had died from HIV/AIDS. It is also possible that the decrease in HIV prevalence could have been partially attributed to mortality changes over time or to the observed decreased high-risk cross-border sex work in India. The estimated population size of FSWs has remained fairly constant between 1998-2006 [12] and the turnover rate is high (~30% of FSWs started selling sex in the last year, Table 1). It is also expected that HIV-related mortality has increased over time because as the epidemic matures the large cohort of FSWs infected early in the epidemic (before HIV prevention programs were scale-up) were expected to die. Until 2006, estimated antiretroviral therapy coverage in Terai was still low (<5%) and not expected to lead to increased survival on a population-level. However, it is unlikely that the observed HIV prevalence decline is related to mortality alone. The decrease in the proportion of FSWs selling sex in India is also a likely explanatory factor but behavior change related to exposure to Safe Highway program interventions is also thought to be important in this decline as well. In fact, it is possible that greater FSW risk awareness over time (due to intervention exposure) accounted to some extent to decreased cross-border sex work in India. Regardless, the statistically significant and consistent (a) increasing trends over time in condom use and program coverage and (b) associations observed between program exposure and increased condom use strongly indicate that the Safe Highways program has significantly contributed to reducing unsafe sexual behaviors with clients among FSWs along the East-West highway districts in the Terai region of Nepal.

Despite these successes, there is still room for program improvement as reported consistent condom use with clients was still less than 60% and less than 10% with non-paying partners in 2006. Moreover, the program is increasingly focused on improving STI treatment and on linking HIV-positive FSWs with care and treatment programs as part of a comprehensive prevention-care-treatment response. Also, given the high-risk of HIV infection associated with Nepali FSWs working in India, the scale-up of intervention programs in India for Nepali FSWs.

From a methodological perspective, it was interesting to note that the absolute values of reported condom use indicators between the IBBS and BSS surveys were dissimilar (tracked a lot higher for BSS than IBBS) even though they both showed the same parallel increasing trend over time. Although the reasons for this are not completely clear, it is thought that self-screening of participants may have been a factor [31]. Although survey refusal rates were not kept track of for either the BSS or IBBS, it is believed that the extra travelling time for participants to go to the mobile clinic sites may have been a barrier to study participation and FSWs practicing high risk behavior may have been more motivated to participate in the IBBS as they received free HIV/STI testing.

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Competing interests

The authors declare that they have no competing interests.

Author contributions

All authors contributed equally to this work.

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