



Original Contribution

How Does Sex Trafficking Increase the Risk of HIV Infection? An Observational Study From Southern India

Kathleen E. Wirth*, Eric J. Tchetgen Tchetgen, Jay G. Silverman, and Megan B. Murray

* Correspondence to Dr. Kathleen E. Wirth, Department of Epidemiology, Harvard School of Public Health, 677 Huntington Avenue, Suite 501, Boston, MA 02115 (e-mail: kwirth@hsph.harvard.edu).

Initially submitted December 28, 2011; accepted for publication July 24, 2012.

Studies have documented the substantial risk of human immunodeficiency virus (HIV) infection endured by sex-trafficked women, but it remains unclear how exposure to trafficking puts its victims at risk. We assessed whether the association between sex trafficking and HIV could be explained by self-reported forced prostitution or young age at entry into prostitution using cross-sectional data collected from 1,814 adult female sex workers in Karnataka, India, between August 2005 and August 2006. Marginal structural logistic regression was used to estimate adjusted odds ratios for HIV infection. Overall, 372 (21%) women met 1 or both criteria used to define sex trafficking: 278 (16%) began sex work before age 18 years, and 107 (5%) reported being forcibly prostituted. Thirteen (0.7%) met both criteria. Forcibly prostituted women were more likely to be HIV-infected than were women who joined the industry voluntarily, independent of age at entering prostitution (odds ratio = 2.30, 95% confidence interval: 1.08, 4.90). Conversely, after adjustment for forced prostitution and other confounders, no association between age at entry into prostitution and HIV was observed. The association between forced prostitution and HIV infection became stronger in the presence of sexual violence (odds ratio = 11.13, 95% confidence interval: 2.41, 51.40). These findings indicate that forced prostitution coupled with sexual violence probably explains the association between sex trafficking and HIV.

female sex workers; HIV; human immunodeficiency virus; India; marginal structural models; sex trafficking; sexual violence

Abbreviations: AIDS, acquired immunodeficiency syndrome; CI, confidence interval; HIV, human immunodeficiency virus; IBBA, Integrated Behavioral and Biological Assessment; OR, odds ratio.

The trafficking of women and girls for the purpose of forced prostitution represents a major human rights violation with potentially devastating health consequences for its victims (1–3). The US Department of State has described it as modern-day slavery (4). In India, sex trafficking often occurs when young women from rural communities or neighboring countries are lured by acquaintances, distant relatives, and strangers under the pretense of employment or marriage and sold to a brothel owner (5, 6). Within a debt bondage system, these women work without pay in order to pay off “debt” supposedly incurred through their recruitment, transportation, and sale (4).

Although previous studies have demonstrated the substantial risk of human immunodeficiency virus (HIV) infection faced by sex-trafficked women, it is unclear how

exposure to trafficking, in contrast to other entry mechanisms, puts its victims at risk (1, 2, 7–9). Brothel owners use intimidation, physical violence, and repeated rape to compel newly trafficked women into submission (5, 6). These practices may form an important pathway between trafficking and HIV, as physical and sexual violence may increase the risk of HIV infection (10, 11). Violence may increase transmission through direct injury to the vagina, leading to mucosal breaks and inflammation that increase the risk of infection given exposure. It may also damage a woman’s self-esteem, potentially undermining both her motivation to protect her health and her ability to effectively negotiate condom use (12, 13). Indeed, a study in West Bengal, India, found 2-fold increased odds of HIV infection among female sex workers who had experienced

sexual violence soon after joining the sex trade (14). Results from a South African prospective cohort study confirmed this relationship in a general population of young adult women. Over a 2-year follow-up period, women who experienced multiple episodes of physical or sexual violence were 50% more likely to acquire HIV (15).

The age at which sex-trafficked persons enter prostitution may also contribute to higher HIV infection rates. Sex-trafficked women tend to be younger than those who enter the industry voluntarily, and young women may be more vulnerable to HIV due to larger areas of cervical ectopy (i.e., immature epithelium of the cervix) (16, 17). The association between young age and trafficking directly reflects the formal definition of trafficking put forward by the United Nations: “the recruitment, transportation, transfer, harboring or receipt of persons by means of threat or use of force or other forms of coercion ... for the purpose of exploitation, [including] ... prostitution of others or other forms of sexual exploitation” (18, p. 2). However, any woman who engaged in sex work before age 18 years is also considered trafficked irrespective of the use of force, because minors cannot meaningfully consent to prostitution (18). Traffickers also target underage women to satisfy increasing demand by clients who perceive them to be virgins free of HIV and other infections (5).

Unfortunately, much of the current knowledge about sex trafficking and HIV comes from convenience samples of women who have been rescued by nongovernmental organizations (7, 19, 20). It is difficult to draw inferences from these data, because the studies often lack appropriate control groups and are subject to selection bias. Women who are trafficked into prostitution and continue to work in the industry may differ from women who are rescued in terms of sex-work history and infection status. The few studies which have examined trafficking within a representative population of female sex workers have been unable to conduct subgroup analyses because of small sample sizes (21).

In 2003, with the support of the Indian government, the Bill and Melinda Gates Foundation provided initial funding for the Avahan India AIDS Initiative. Avahan was designed to provide HIV prevention services for more than 80% of high-risk individuals in the 6 Indian states which account for the majority of HIV infections in the country (22). A series of cross-sectional surveys dubbed the Integrated Behavioral and Biological Assessment (IBBA) was also commissioned to evaluate Avahan’s impact on prespecified behavioral and biological indicators. Unlike previous studies based on convenience samples, the IBBA recruited participants using probability sampling methods. Given its large, systematically selected sample and extensive information on sex-work history, the IBBA is uniquely suited to further explore the relationship between sex trafficking and HIV. Using IBBA data collected from the southern state of Karnataka, we investigated whether the relationship between sex trafficking and HIV could be explained by forced entry into prostitution, young age at entry into prostitution, or both. We also assessed whether sexual violence modified either of these associations.

MATERIALS AND METHODS

Study population

We used data from the IBBA survey carried out among female sex workers in 4 districts (Bangalore, Bellary, Belgaum, and Shimoga) in Karnataka, India, from August 2005 to August 2006. Survey participation was restricted to women aged 18 years or older who reported having exchanged sex for money at least once in the previous month. Research teams first identified locations where female sex workers could be recruited using district-specific maps developed in partnership with a local nongovernmental organization. Within each district, these primary sampling units

Table 1. Self-reported Reason for Entering Prostitution Among 1,814 Adult Female Sex Workers Operating in Karnataka, India, 2005–2006

	No.	Weighted % ^a
Widowed	226	13.1
Deserted by husband	275	13.3
Trafficked	107	5.1
Needed to support drug use	18	0.8
Wanted a better life	1,493	82.8
Other ^b	393	21.5
Devadasi tradition ^c	113	7.8
Poverty ^d	77	3.9
Needed to support family, family problems ^e	70	3.6
Caring or providing for children ^f	56	2.7
Husband unemployed, incarcerated, ill, or alcoholic	19	1.1
Sexual satisfaction, love, happiness, or friendship	20	0.9
Don't know/no answer	7	0.3

^a Weighted percentage accounting for the probability of selection into the sample using the survey weights provided by the Integrated Behavioral and Biological Assessment. Percentages sum to more than 100 because participants could select or provide more than 1 response for the question, “For which reason(s) did you get into sex work?”

^b Forty-seven women provided an open-ended response that could not be reliably classified or interpreted (e.g., “to look,” “to give,” or “running,” among others).

^c A form of sex work in which women are dedicated to a deity or temple and perform associated duties and rituals, including the provision of sexual services to priests and other members of the temple.

^d Open-ended responses which contained 1 or more of the following words: poverty, income, economic problem, money problem, debt, or food.

^e Open-ended responses which contained 1 or more of the following words: support family, family problems, family responsibility, mother, sister’s marriage, in-laws, or care of parent.

^f Open-ended responses which contained 1 or more of the following words: children, son, or daughter.

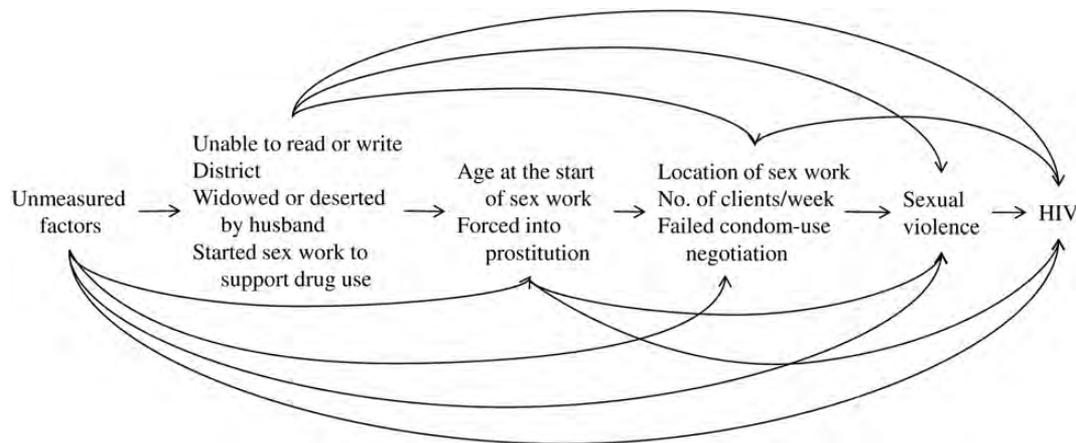


Figure 1. Causal relationships between forced prostitution, age at the start of sex work, sexual violence, and human immunodeficiency virus (HIV) infection among 1,814 adult female sex workers in Karnataka, India, 2005–2006.

were selected with probability proportional to size. For female sex workers operating in brothels, homes, lodges, and dabhas (roadside eating establishments), individuals were enumerated on the basis of location and then randomly selected for inclusion in the study. For street-based female sex workers, individuals were enumerated on the basis of time and location and then randomly selected. Because the actual number of eligible respondents at any time-location cluster may have changed over time, adjustments to the final sampling probabilities were made to reflect the actual population size at the time of the survey rather than the size estimated by the presurvey maps. After obtaining informed consent, trained field staff administered face-to-face interviews in the local language, Kannada, in a private setting at the sex worker's usual place of work or at a nearby location, usually within 0.5 km. Among 2,129 eligible women identified, 1,836 completed a face-to-face behavioral interview and provided a biological specimen for HIV testing, resulting in an 86% overall response rate. We excluded 22 (1.2%) participants for whom HIV status or either of the primary exposures was unavailable, for a sample size of 1,814. Further details regarding the sampling and data collection procedures are available elsewhere (23).

Exposure and covariate assessment

All participants were asked, "For which reason(s) did you get into sex work?," with the following possible responses: "Became a widow," "Was deserted by husband," "Was trafficked," "Needed to support drug use," or "Wanted a better life." Participants were instructed to check all reasons that applied and were also given the opportunity to respond in an open-ended format. Table 1 presents a complete description of the self-reported reasons for entering prostitution. We classified participants as forcibly prostituted if they reported "trafficking" as a reason for entering the sex trade, regardless of the age at which they had entered the sex trade. Two independent data analysts

separately assessed the open-ended responses and categorized women as to whether or not they had been forced into prostitution, based on the criteria set by the United Nations (18). We also classified women who entered the sex trade before age 18 years as trafficked.

The IBBA also collected information on the following potential risk factors for HIV infection: location of sex work, number of clients entertained per week, and ability to read and write. The survey contained multiple questions on condom use, including use according to partner type, possession of a condom at the time of the interview, and condom-use negotiation. We elected to use a measure of unsuccessful condom negotiation (i.e., "Was there a time during the past month when you wanted to use a condom but did not?") because sex-trafficked women are thought to be less able to negotiate condom use with clients (21). Finally, we classified women as having been exposed to sexual violence if they responded affirmatively to the question, "In the past 1 year, were you ever beaten or otherwise physically forced to have sexual intercourse with someone even though you didn't want to?"

Outcome assessment

Blood and urine samples were obtained for HIV testing and were screened using the Detect HIV 1/2 system (BioChem ImmunoSystems, Montreal, Quebec, Canada). Positive tests were confirmed by means of the Genedia HIV 1/2 ELISA 3.0 (Green Cross Life Science Corporation, Kyunggi, South Korea). Further details on the handling of clinical specimens and quality control measures implemented in the district and state laboratories can be found elsewhere (23).

Statistical analyses

We used survey-weighted logistic regression models to estimate the following associations with HIV infection:

Table 2. Demographic and Sex-work Characteristics of 1,814 Adult Female Sex Workers in Karnataka, India, According to Forced Entry Into Prostitution, 2005–2006^a

Characteristic	No Forced Prostitution (<i>n</i> = 1,707)		Forced Prostitution (<i>n</i> = 107)		<i>P</i> Value ^b
	Weighted % ^c	Mean (SD)	Weighted % ^c	Mean (SD)	
District (<i>n</i> = 1,814) ^d					0.0005
Bangalore	37.0		11.9		
Belgaum	19.2		30.1		
Bellary	23.2		21.8		
Shimoga	20.6		36.3		
Current age, years (<i>n</i> = 1,814)		31.2 (10.2)		29.9 (10.8)	0.23 ^e
Current marital status (<i>n</i> = 1,813)					0.003
Never married	24.0		15.1		
Married	32.5		36.0		
Deserted or separated	20.7		38.2		
Divorced, widowed, or other	22.8		10.7		
Unable to read or write (<i>n</i> = 1,814)	60.3		52.6		0.27
Devadasi tradition ^f (<i>n</i> = 1,814)	7.6		4.2		0.32
Age at entry into prostitution, years (<i>n</i> = 1,814)		24.6 (9.4)		23.0 (7.5)	0.04 ^e
Entered prostitution because widowed or deserted by husband (<i>n</i> = 1,814)	27.2		10.8		0.003
Entered prostitution to support drug use (<i>n</i> = 1,813)	0.8		0.8		0.96
Duration of sex work, years (<i>n</i> = 1,814)		6.6 (10.2)		6.9 (9.1)	0.76 ^e
Sex-work setting (<i>n</i> = 1,813)					0.0004
Public place ^g	36.1		23.7		
Brothel	12.4		30.9		
Home or other	51.5		45.4		
Amount charged per sexual encounter, US\$ ^h (<i>n</i> = 1,804)		4.6 (5.5)		3.7 (5.0)	0.06 ^e
Sexual violence in the past year (<i>n</i> = 1,811)	12.8		21.1		0.10
Total no. of clients per week (<i>n</i> = 1,786)		10.6 (14.9)		11.2 (13.4)	0.11
<5	28.1		35.9		
5–9	31.4		17.4		
10–19	27.0		26.1		
≥20	13.5		20.6		
Any condom nonuse with previous 10 clients (<i>n</i> = 1,797)	36.4		36.8		0.95
Unsuccessful condom negotiation in the past month (<i>n</i> = 1,758)	25.5		35.3		0.11
Demonstrated possession of condom at interview (<i>n</i> = 1,759)	25.6		18.0		0.26
Knowledge of HIV status prior to interview (<i>n</i> = 1,702)	25.4		31.7		0.31
HIV-seropositive at interview (<i>n</i> = 1,814)	16.0		34.3		0.001

Abbreviations: HIV, human immunodeficiency virus; SD, standard deviation.

^a Column percentage unless otherwise noted (percentages may not sum to 100 because of rounding).

^b *P* value from Wald χ^2 test unless otherwise noted.

^c Weighted percentage accounting for the probability of selection into the sample using the survey weights provided by the Integrated Behavioral and Biological Assessment.

^d *n*, total number of women with data.

^e *P* value from Student's *t* test.

^f A form of sex work in which women are dedicated to a deity or temple and perform associated duties and rituals, including the provision of sexual services to priests and other members of the temple.

^g Examples of public places provided by the interviewer included parks, streets, cinema halls, bus stops, and train stations.

^h Rupees were converted to US dollars based on a rate of 44.4 rupees per US\$1.

Table 3. Demographic and Sex-work Characteristics of 1,814 Adult Female Sex Workers in Karnataka, India, According to Tertile of Age at Entry Into Prostitution, 2005–2006^a

Characteristic	Tertile of Age at Entry Into Prostitution						P Value ^b
	1 (≤19 years)		2 (20–27 years)		3 (≥28 years)		
	Weighted % ^c	Mean (SD)	Weighted % ^c	Mean (SD)	Weighted % ^c	Mean (SD)	
District (<i>n</i> = 1,814) ^d							<0.0001
Bangalore	20.8		39.6		49.3		
Belgaum	32.4		15.3		10.0		
Bellary	34.1		19.5		14.3		
Shimoga	12.7		25.7		26.5		
Current age, years (<i>n</i> = 1,814)		27.6 (12.0)		29.4 (6.0)		37.7 (8.0)	<0.0001 ^e
Current marital status (<i>n</i> = 1,813)							<0.0001
Never married	51.1		10.6		6.3		
Married	19.3		40.2		39.4		
Deserted or separated	15.3		27.9		21.1		
Divorced, widowed, or other	14.3		21.3		33.2		
Unable to read or write (<i>n</i> = 1,814)	62.1		57.0		61.1		0.07
Devadasi tradition ^f (<i>n</i> = 1,814)	16.8		3.0		1.4		<0.0001
Forced entry into prostitution (<i>n</i> = 1,814)	6.4		5.7		2.7		0.38
Entered prostitution because widowed or deserted by husband (<i>n</i> = 1,814)	16.8		29.2		34.6		<0.0001
Entered prostitution to support drug use (<i>n</i> = 1,813)	0.9		0.9		0.5		0.66
Duration of sex work, years (<i>n</i> = 1,814)		10.3 (12.7)		4.9 (5.4)		4.3 (6.2)	<0.0001 ^e
Sex-work setting (<i>n</i> = 1,812)							0.002
Public place ^g	29.1		37.2		41.3		
Brothel	18.6		11.2		9.7		
Home or other	52.3		51.6		49.0		

Table continues

1) forced entry into prostitution versus voluntary entry, adjusting for age at entry into prostitution, and 2) younger age at entry into prostitution versus older age, adjusting for forced entry into prostitution. We first assessed the dose-response relationship between age at entry into prostitution and HIV infection by fitting a series of quadratic splines with knots at the tertile, quartile, and quintile cutpoints. We found no evidence of a nonlinear relationship and thus modeled age as a linear factor.

We adopted a propensity score weighting approach to adjust for confounding (24–28). Specifically, each respondent in our sample was weighted by the inverse of the probability of receiving the exposure that she actually received, conditional on a set of observed confounding variables. In the resulting weighted sample, the exposure-disease relationship was preserved, but the probability of exposure was made independent of observed confounders. A crude analysis can be conducted in the weighted sample (under the assumption of no unmeasured confounding) to recover the effect of exposure one would have obtained had, contrary to fact, the latter been randomized. For a single-point exposure, inverse-probability weighting is well

known to be equivalent to direct standardization (29, 30). The methodology provides appropriate confounding adjustment when assessing the joint effects and the possible interaction of such longitudinal exposures in their effects on HIV infection risk (31, 32).

We estimated the inverse-probability weights for the exposures “forced entry into prostitution” and “age at entry into prostitution” using predicted probabilities obtained from survey-weighted logistic and linear regression models, respectively. Given the heterogeneity in HIV prevalence and sex-work characteristics across districts, we fitted separate models for each district. The district-specific models included the following confounding variables based on subject-matter knowledge: having entered prostitution because one was widowed or deserted by one’s husband, having entered prostitution to support drug use, and inability to read or write. We also included age at entry into prostitution in the model for the weights for forced entry into prostitution and vice versa.

In our sample, women who reported recent sexual violence were more likely to work in brothels, entertain larger numbers of clients, and report unsuccessful condom-use

Table 3. Continued

Characteristic	Tertile of Age at Entry Into Prostitution						P Value ^b
	1 (≤19 years)		2 (20–27 years)		3 (≥28 years)		
	Weighted % ^c	Mean (SD)	Weighted % ^c	Mean (SD)	Weighted % ^c	Mean (SD)	
Amount charged per sexual encounter, US\$ (n = 1,805) ^h		4.2 (5.6)		4.8 (5.1)			0.09 ^e
Sexual violence in the past year (n = 1,811)	14.1		15.1		9.4		0.07
Total no. of clients per week (n = 1,787)		13.5 (17.8)		10.3 (14.7)		7.5 (8.6)	<0.0001 ^e
<5	22.5		26.9		38.3		
5–9	24.5		34.0		33.9		
10–19	31.7		26.6		21.5		
≥20	21.3		12.5		6.3		<0.0001
Any condom nonuse with previous 10 clients (n = 1,797)	27.8		40.4		41.9		<0.0001
Unsuccessful condom negotiation in the past month (n = 1,758)	20.7		31.5		25.3		0.002
Demonstrated possession of condom at interview (n = 1,759)	23.6		25.6		26.8		0.61
Knowledge of HIV status prior to interview (n = 1,702)	25.2		28.0		23.1		0.37
HIV-seropositive at interview (n = 1,814)	22.8		15.1		12.0		0.001

Abbreviations: HIV, human immunodeficiency virus; SD, standard deviation.

^a Column percentage unless otherwise noted (percentages may not sum to 100 because of rounding).

^b P value from Wald χ^2 test unless otherwise noted.

^c Weighted percentage accounting for the probability of selection into the sample using the survey weights provided by the Integrated Behavioral and Biological Assessment.

^d n, total number of women with data.

^e Trend-test P values were computed by entering the median values of the tertiles into the model as a continuous variable.

^f A form of sex work in which women are dedicated to a deity or temple and perform associated duties and rituals, including the provision of sexual services to priests and other members of the temple.

^g Examples of public places provided by the interviewer included parks, streets, cinema halls, bus stops, and train stations.

^h Rupees were converted to US dollars based on a rate of 44.4 rupees per US\$1.

negotiation. Since these factors are also associated with HIV infection, adjustment for confounding was necessary to assess effect modification by sexual violence. However, as Figure 1 illustrates, these factors are downstream consequences of both forced entry into prostitution and young age at entry into prostitution. Including these factors as covariates in a logistic regression model would not appropriately account for confounding and could introduce bias. Because inverse-probability weighting is not subject to this potential bias, we also used it to assess effect modification by sexual violence (31, 32). Formally, our inverse-probability-weighted logistic regressions identified the parameters of a marginal structural model for the joint effect of forced entry into prostitution (or age at entry into prostitution) and sexual violence on HIV infection (24, 31). We created an additional set of inverse-probability weights (also district-specific) for sexual violence using a survey-weighted logistic regression model which included the following set of confounding variables: age at entry into prostitution, forced entry into prostitution, entering prostitution because one was widowed or deserted by one's husband, entering prostitution to support drug use, inability to read or write,

number of clients entertained per week, unsuccessful condom negotiation, and location of sex work.

Statistical analyses were conducted with SAS software, version 9.2 (SAS Institute Inc., Cary, North Carolina). The final models for all adjusted analyses used weights which were a product of the relevant inverse-probability weight and the survey weight to simultaneously adjust for confounding and the unequal probability of selection induced by the survey's complex sampling framework (33). To account for clustering and the additional uncertainty associated with the estimation of the inverse-probability weights, we used standard Taylor-series expansion arguments to derive accurate large-sample variance estimators (formulae are available upon request from the corresponding author) which we in turn used to construct Wald-type 95% confidence intervals with MATLAB 2007a (The MathWorks, Natick, Massachusetts).

RESULTS

The median age of the sample was 30 years (interquartile range, 25–36 years). At the time of the interview, 67%

were never married, divorced, widowed, or otherwise without a husband. On average, women reported beginning sex work at age 24 years. Most participants solicited clients from their homes (51%), followed by public places (35%) and brothels (13%). Overall, 372 (21%) women met one or both of the criteria used to define sex trafficking: 278 (16%) had started sex work before age 18 years and 107 (5%) reported having been forcibly prostituted. Thirteen (0.7%) women met both criteria.

Tables 2 and 3 show the characteristics of the sample according to forced entry into prostitution and age at entry into prostitution, respectively. Briefly, forcibly prostituted women were more likely to have been separated from or deserted by their husbands, more likely to be working in a brothel, and more likely to have experienced sexual violence in the past year (Table 2). Moreover, women forced into prostitution were more likely to report unsuccessful condom negotiation during the past month. Women who had entered the sex trade at younger ages were more likely to be unmarried and to entertain more clients per week but were more likely to charge less per sexual encounter (Table 3).

In unadjusted analyses, forced prostitution was associated with a nearly 3-fold increase in the odds of HIV infection (odds ratio (OR) = 2.74, 95% confidence interval (CI): 1.41, 5.31) (Table 4). This association diminished after adjustment for age at entry into prostitution and potential confounders (OR = 2.30, 95% CI: 1.08, 4.90), but it remained significant. Increasing age at entry into prostitution was associated with a slight decrease in odds of HIV infection in the unadjusted analysis (for a 1-year increase in age, OR = 0.97, 95% CI: 0.94, 0.99) but became nonsignificant after adjustment (for a 1-year increase in age, OR = 0.97, 95% CI: 0.91, 1.02).

We observed significant heterogeneity in the association between forced entry into prostitution and HIV infection according to recent history of sexual violence (Wald *P* for interaction = 0.01). In the presence of recent sexual violence, forced prostitution increased the odds of being HIV-infected 11-fold (OR = 11.13, 95% CI: 2.41, 51.40) (Table 5). We found no evidence for a direct effect of forced prostitution on HIV infection in the absence of recent sexual violence (OR = 1.79, 95% CI: 0.74, 4.31). Recent sexual violence did not modify the relationship between age at entry into prostitution and HIV infection (Wald *P* for interaction = 0.41).

DISCUSSION

In this analysis, women forced into prostitution were more likely to be infected with HIV than were women who had joined the sex trade for other reasons, independent of the age at which they entered prostitution. However, after adjustment for forced prostitution and other confounders, the association between the age at which women entered prostitution and HIV infection was no longer evident. The association between forced prostitution and HIV infection became considerably stronger in the presence of recent sexual violence.

Our findings confirm previous reports that women forced into prostitution face levels of HIV risk above those typically conferred by sex work alone. Compared with 17%–38% as reported in prior studies conducted among female sex workers in India, 34% of forcibly prostituted women in our sample were HIV-infected. More striking was the further increased risk when these women were subjected to sexual violence. Indeed, early in the implementation of Avahan, reports from the field suggested that some women experienced violence when they attempted to negotiate condom use with clients and other partners (34). As a result, Avahan developed a multilevel, statewide intervention involving female sex workers, policy-makers, police, and the media. More than 12,000 police officers and 2,000 journalists received training designed to raise awareness of HIV/AIDS, reduce stigma, and clarify the legal rights of female sex workers. A 24-hour emergency response system was also established to immediately respond to any episode of violence, unlawful arrest, or sexual assault involving a female sex worker. A recent report provided compelling evidence that this intervention has been successful; in the 2 years following the program's implementation, the proportion of women reporting incidents of violence declined by nearly 40% (35).

Multiple studies from a variety of settings have observed higher HIV prevalence among young women (36–38). Some researchers hypothesize that cross-generational partnerships in which younger women have relationships with older men may contribute to the higher infection rates in young women (39), since these women may be unable to negotiate condom use and their older partners may be more likely to be HIV-infected (38, 39). Others have suggested that the increased HIV risk among young women may result from an increased susceptibility conferred by an immature cervix (17). We found no evidence of an association between the age at which a woman entered prostitution and HIV after adjusting for forced entry into prostitution and other confounders. One potential explanation for the discrepancy between our findings and those of previous studies may be survivor bias resulting from restriction of the study population to adult female sex workers. Women who began sex work at the youngest ages would only be included in our sample if they continued to sell sex until age 18 years. If young women contracted HIV soon after joining the sex trade and subsequently discontinued sex work, we will have underestimated the association between age at entry into prostitution and HIV infection. A prospective cohort design enrolling women at entry into the sex trade would safeguard against this type of selection bias. However, the ethical concerns of conducting research with minors actively involved in prostitution make this study design unrealistic.

These data provide compelling evidence of the need to eliminate sex trafficking, not only because it is a human rights violation but also for the prevention of HIV within a high-risk population. Ongoing efforts to prevent sex trafficking include increasing awareness of trafficking and safe migration practices, as well as heightened patrol of international borders to apprehend human traffickers. One intervention spearheaded by a Nepali nongovernmental organization

Table 4. Associations Between Forced Entry Into Prostitution and Age at Entry Into Prostitution and Risk of HIV Infection Among 1,814 Adult Female Sex Workers in Karnataka, India, 2005–2006

	Crude ^a		Adjusted ^b	
	OR	95% CI	OR	95% CI
Forced entry into prostitution	2.74	1.41, 5.31	2.30	1.08, 4.90
Age at entry into prostitution	0.97	0.94, 0.99	0.97	0.91, 1.02

Abbreviations: CI, confidence interval; HIV, human immunodeficiency virus; OR, odds ratio.

^a Estimated from a weighted logistic regression model with weights constructed to adjust for the unequal probability of selection induced by the survey's complex sampling strategy.

^b Estimated from a weighted marginal structural logistic regression model with district-specific weights constructed to simultaneously adjust for the unequal probability of selection induced by the survey's complex sampling strategy and the following confounders: literacy, whether the participant was widowed and/or deserted at the time of entry into the sex trade, and use of sex work to support drug use.

reported intercepting nearly 2,500 potential victims at various locations along the India-Nepal border (40). However, investment in such programs remains low, and none, to our knowledge, have been formally evaluated. Furthermore, trafficking status is not regularly assessed in existing surveillance, and indicators of forced entry into prostitution remain poorly defined.

Our study had a number of limitations. First, although the joint effect of forced prostitution and sexual violence strongly predicted HIV status, the numbers of co-affected women were small and there was thus substantial uncertainty regarding this estimate, as evidenced by the wide confidence interval (95% CI: 2.41, 51.40). Additionally, sexual violence was only measured for the previous year. Sex-trafficked women are more likely to experience initiation-related sexual violence during the first month of sex work as compared with nontrafficked women (41). If sex-trafficked women in our sample were exposed to sexual violence

earlier rather than later in their sex-work careers, we will have underestimated the role of sexual violence as an effect modifier. Secondly, although we classified participants as forcibly prostituted based on self-report, it is unclear how women in our sample used and understood this term. Indeed, utilizing a more descriptive definition of trafficking (i.e., “someone tricked me into coming to do this business”), a study carried out among HIV-infected female sex workers in Mumbai found a trafficking prevalence of nearly 40% (41) in contrast to the 5% reported in this study. Next, we were unable to verify that entry into the sex trade preceded HIV infection, as data on entry into prostitution were ascertained at the same time that HIV status was assessed. It is therefore possible that our results could have been due to reverse causation; that is, HIV infection may have precipitated or contributed to a woman's decision to begin sex work. Approximately one-quarter of the women in our sample knew their HIV status at the time of the interview, but this knowledge did not differ by either forced entry into prostitution ($P = 0.31$) or age at entry into prostitution ($P = 0.37$). Furthermore, when we excluded the 445 women who had previously received the results of an HIV test, our findings did not change qualitatively. Lastly, we note that despite the use of a probability-based sampling framework, the survey did not include women engaging in all forms of sex work. Women who solicit sex through massage parlors, bars, or cell phones may not have been sampled. Furthermore, the most marginalized and enslaved women are kept hidden within brothels, isolated from other female sex workers, and even transferred between brothels in order to avoid detection by authorities (5, 6). These factors, along with the frequent use of intimidation and violence by brothel owners, diminish the likelihood that these women will participate in large-scale public health programs such as Avahan.

In summary, our findings not only confirm previous findings of an increased vulnerability of sex-trafficked women and girls to HIV infection but also highlight the role of sexual violence in magnifying risk among trafficked persons. Although further research is needed to confirm this result, the present findings strongly indicate the need to integrate sex-trafficking prevention efforts within HIV prevention services among female sex workers.

Table 5. Associations Between Forced Entry Into Prostitution and Age at Entry Into Prostitution and Risk of HIV Infection Among 1,814 Adult Female Sex Workers in Karnataka, India, According to Recent History of Sexual Violence, 2005–2006^a

	No Sexual Violence		Sexual Violence		P for Interaction ^b
	AOR	95% CI	AOR	95% CI	
Forced entry into prostitution	1.79	0.74, 4.31	11.13	2.41, 51.40	0.04
Age at entry into prostitution	0.96	0.78, 1.19	0.94	0.28, 3.13	0.97

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; HIV, human immunodeficiency virus.

^a Estimated from a weighted marginal structural logistic regression model with district-specific weights constructed to simultaneously adjust for the unequal probability of selection induced by the survey's complex sampling strategy and the following confounders: age at entry into prostitution, forced entry into prostitution, literacy, whether the participant was widowed and/or deserted at the time of entry into prostitution, use of sex work to support drug use, number of clients per week, failed condom-use negotiation, and location of sex work.

^b Wald χ^2 test.

ACKNOWLEDGMENTS

Author affiliations: Department of Epidemiology, Harvard School of Public Health, Boston, Massachusetts (Kathleen E. Wirth, Eric J. Tchetgen Tchetgen, Megan B. Murray); Department of Biostatistics, Harvard School of Public Health, Boston, Massachusetts (Eric J. Tchetgen Tchetgen); Division of Global Public Health, School of Medicine, University of California, San Diego, La Jolla, California (Jay G. Silverman); Department of Global Health and Social Medicine, Harvard Medical School, Boston, Massachusetts (Megan B. Murray); and Division of Global Health Equity, Brigham and Women's Hospital, Boston, Massachusetts (Megan B. Murray).

This work was supported by the US National Institutes of Health (grants AI 007433 and U54GM088558) and the Bill and Melinda Gates Foundation through the Avahan India AIDS Initiative (grant 43136).

The authors gratefully acknowledge Shahira Ahmed and Molly Franke for their assistance in coding the open-ended responses and the community representatives, field staff, and local nongovernmental organizations who implemented the survey across Karnataka.

The views expressed herein are those of the authors and do not necessarily reflect the official policy or position of the Bill and Melinda Gates Foundation, Avahan, Family Health International, or the Indian Council for Medical Research.

Conflict of interest: none declared.

REFERENCES

- Zimmerman C, Hossain M, Yun K, et al. The health of trafficked women: a survey of women entering posttrafficking services in Europe. *Am J Public Health*. 2008;98(1):55–59.
- Silverman JG, Decker MR, Gupta J, et al. Syphilis and hepatitis B co-infection among HIV-infected, sex-trafficked women and girls, Nepal. *Emerg Infect Dis*. 2008;14(6):932–934.
- Silverman JG, Decker MR, Gupta J, et al. HIV prevalence and predictors of infection in sex-trafficked Nepalese girls and women. *JAMA*. 2007;298(5):536–542.
- US Department of State. *Victims of Trafficking and Violence Protection Act of 2000: Trafficking in Persons Report, 2010*. Washington, DC: US Department of State; 2010.
- Nair P. *A Report on Trafficking of Women and Children in India: 2002–2003, Volume I*. New Delhi, India: Institute of Social Sciences, National Human Rights Commission, United Nations Development Fund for Women; 2004.
- Guthrie J. *Rape for Profit—Trafficking of Nepali Girls and Women to India's Brothels*. New York, NY: Human Rights Watch/Asia; 1995.
- Silverman JG, Decker MR, Gupta J, et al. HIV prevalence and predictors among rescued sex-trafficked women and girls in Mumbai, India. *J Acquir Immune Defic Syndr*. 2006;43(5):588–593.
- Silverman JG, Raj A, Cheng DM, et al. Sex trafficking and initiation-related violence, alcohol use, and HIV risk among HIV-infected female sex workers in Mumbai, India. *J Infect Dis*. 2011;204(suppl 5):S1229–S1234.
- Zimmerman C, Yun K, Shvab I, et al. *The Health Risks and Consequences of Trafficking in Women and Adolescents. Findings From a European Study*. London, United Kingdom: London School of Hygiene and Tropical Medicine; 2003.
- Campbell J, Jones AS, Dienemann J, et al. Intimate partner violence and physical health consequences. *Arch Intern Med*. 2002;162(10):1157–1163.
- Dunkle KL, Jewkes RK, Brown HC, et al. Gender-based violence, relationship power, and risk of HIV infection in women attending antenatal clinics in South Africa. *Lancet*. 2004;363(9419):1415–1421.
- Nduna M, Jewkes RK, Dunkle KL, et al. Associations between depressive symptoms, sexual behaviour and relationship characteristics: a prospective cohort study of young women and men in the Eastern Cape, South Africa. *J Int AIDS Soc*. 2010;13:44. (doi:10.1186/1758-2652-13-44).
- Golding JM. Intimate partner violence as a risk factor for mental disorders: a meta-analysis. *J Fam Viol*. 1999;14(2):99–132.
- Sarkar K, Bal B, Mukherjee R, et al. Sex-trafficking, violence, negotiating skill, and HIV infection in brothel-based sex workers of eastern India, adjoining Nepal, Bhutan, and Bangladesh. *J Health Popul Nutr*. 2008;26(2):223–231.
- Jewkes RK, Dunkle K, Nduna M, et al. Intimate partner violence, relationship power inequity, and incidence of HIV infection in young women in South Africa: a cohort study. *Lancet*. 2010;376(9734):41–48.
- Moss GB, Clemetson D, D'Costa L, et al. Association of cervical ectopy with heterosexual transmission of human immunodeficiency virus: results of a study of couples in Nairobi, Kenya. *J Infect Dis*. 1991;164(3):588–591.
- Myer L, Wright TC, Denny L, et al. Nested case-control study of cervical mucosal lesions, ectopy, and incident HIV infection among women in Cape Town, South Africa. *Sex Transm Dis*. 2006;33(11):683–687.
- United Nations. *United Nations Protocol to Prevent, Suppress, and Punish Trafficking in Persons, Especially Women and Children, Supplementing the United Nations Convention Against Transnational Organized Crime*. New York, NY: United Nations; 2000.
- McCauley HL, Decker MR, Silverman JG. Trafficking experiences and violence victimization of sex-trafficked young women in Cambodia. *Int J Gynaecol Obstet*. 2010;110(3):266–267.
- Crawford M, Kaufman MR. Sex trafficking in Nepal. *Violence Against Women*. 2008;14(8):905–916.
- Decker MR, McCauley HL, Phuengsamran D, et al. Sex trafficking, sexual risk, sexually transmitted infection and reproductive health among female sex workers in Thailand. *J Epidemiol Community Health*. 2011;65(4):334–339.
- Bill and Melinda Gates Foundation. *Avahan—The India AIDS Initiative: The Business of HIV Prevention at Scale*. New Delhi, India: Bill and Melinda Gates Foundation; 2008.
- 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–S34.
- Robins JM, Hernán MA, Brumback B. Marginal structural models and causal inference in epidemiology. *Epidemiology*. 2000;11(5):550–560.
- Hernán MA, Robins JM. Estimating causal effects from epidemiological data. *J Epidemiol Community Health*. 2006;60(7):578–586.

26. Cole SR, Hernán MA. Constructing inverse probability weights for marginal structural models. *Am J Epidemiol*. 2008;168(6):656–664.
27. Moodie EEM, Stephens DA. Marginal structural models: unbiased estimation for longitudinal studies. *Int J Public Health*. 2011;56(1):117–119.
28. Hernán MA, Brumback B, Robins JM. Marginal structural models to estimate the causal effect of zidovudine on the survival of HIV-positive men. *Epidemiology*. 2000; 11(5):561–570.
29. Sato T, Matsuyama Y. Marginal structural models as a tool for standardization. *Epidemiology*. 2003;14(6):680–686.
30. Suarez D, Borràs R, Basagaña X. Differences between marginal structural models and conventional models in their exposure effect estimates: a systematic review. *Epidemiology*. 2011;22(4):586–588.
31. Chiba Y, Azuma K, Okumura J. Marginal structural models for estimating effect modification. *Ann Epidemiol*. 2009; 19(5):298–303.
32. VanderWeele TJ. Marginal structural models for the estimation of direct and indirect effects. *Epidemiology*. 2009;20(1):18–26.
33. Moore CG, Lipsitz SR, Addy CL, et al. Logistic regression with incomplete covariate data in complex survey sampling: application of reweighted estimating equations. *Epidemiology*. 2009;20(3):382–390.
34. Bill and Melinda Gates Foundation. *The Power to Tackle Violence: Avahan's Experience with Community Led Crisis Response in India*. New Delhi, India: Bill and Melinda Gates Foundation; 2009.
35. Beattie TSH, 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. (doi:10.1186/1471-2458-10-476).
36. Sarkar K, Bal B, Mukherjee R, et al. Young age is a risk factor for HIV among female sex workers—an experience from India. *J Infect*. 2006;53(4):255–259.
37. Pettifor AE, Rees HV, Kleinschmidt I, et al. Young people's sexual health in South Africa: HIV prevalence and sexual behaviors from a nationally representative household survey. *AIDS*. 2005;19(14):1525–1534.
38. Glynn JR, Caraël M, Auvert B, et al. Why do young women have a much higher prevalence of HIV than young men? A study in Kisumu, Kenya and Ndola, Zambia. *AIDS*. 2001; 15(suppl 4):S51–S60.
39. Gregson S, Nyamukapa CA, Garnett GP, et al. Sexual mixing patterns and sex-differentials in teenage exposure to HIV infection in rural Zimbabwe. *Lancet*. 2002;359(9321): 1896–1903.
40. Maiti Nepal. *Maiti Nepal Annual Report, 2010*. Kathmandu, Nepal: Maiti Nepal; 2011.
41. Silverman JG, Raj A, Cheng DM, et al. Sex trafficking and initiation-related violence, alcohol use, and HIV risk among HIV-infected female sex workers in Mumbai, India. *J Infect Dis*. 2011;204(suppl 5):S1229–S1234.