Prevalence of HIV/STIs and correlates with municipal characteristics among female sex workers in 13 Mexican cities

Thomas L Patterson, PhD,[1] Steffanie A Strathdee, PhD,[2] Shirley J Semple, PhD,[1] Claudia V Chavarin, MD,[1] Daniela Abramovitz, MSc,[2] Tommi L Gaines, D in PH,[2] Doroteo Mendoza, MA,[3] Hugo Staines, MD,[4] Gregory A Aarons, PhD,[1] Carlos Magis Rodríguez, MD, MPH, PhD.[5]

Patterson TL, Strathdee SA, Semple SJ, Chavarin CV, Abramovitz D, Gaines TL, Mendoza D, Staines H, Aarons GA, Magis Rodríguez C.
Prevalence of HIV/STIs and correlates with municipal characteristics among female sex workers in 13 Mexican cities.
Salud Publica Mex. 2019;61:116-124.
https://doi.org/10.21149/8863

Abstract

Objective. To identify correlates of HIV/STI prevalence among 13 cities with varying sizes of female sex worker (FSW) populations and municipal characteristics in Mexico. **Materials and methods.** FSWs underwent interviews and testing for HIV, syphilis, gonorrhea and chlamydia. Logistic regression explored variations in HIV/STI prevalence. **Results.** Among FSWs (n=1 092), prevalence across 13 sites was: HIV: 0.4% (range: 0%-1.4%): syphilis: 7.8% (range: 0%-17.2%); chlamydia: 15.3% (range: 5.7%-32.2%); gonorrhea: 2.9% (range 0%-13.8%), and any HIV/STI: 23% (range: 9.9%-46%). Municipalities with high human development scores and a lower municipal marginalization index had higher odds of combined HIV/STI prevalence. After controlling for site-specific variability in municipal characteristics, greater risk of HIV/STIs was associated with lower education, having a spouse diagnosed or treated for an STI, unaffordability of condoms, and having non-Mexican clients. **Conclusions.** Prevalence of HIV/STIs varies across Mexican municipalities indicating the need for surveillance to identify hotspots for targeted resource allocation.

Keywords: sex worker; females; HIV; sexually transmitted infections; epidemiology; prevalence; Mexico

Patterson TL, Strathdee SA, Semple SJ, Chavarin CV, Abramovitz D, Gaines TL, Mendoza D, Staines H, Aarons GA, Magis Rodríguez C.
Prevalencia de VIH/ITS y correlaciones con características municipales entre trabajadoras sexuales en 13 ciudades mexicanas.
Salud Publica Mex. 2019;61:116-124.
https://doi.org/10.21149/8863

Resumen

Objetivo. Identificar correlaciones de la prevalencia de VIH / ITS entre 13 ciudades con diferentes tamaños de población de trabajadoras sexuales y características municipales en México. **Material y métodos.** Las trabajadoras sexuales fueron entrevistadas y recibieron pruebas de VIH, sífilis, gonorrea y clamidia. La regresión logística exploró las variaciones en la prevalencia del VIH/ITS. **Resultados.** Entre las trabajadoras sexuales (n = 1 092), la prevalencia en 13 sitios fue: VIH: 0.4% (rango: 0-1.4%): sífilis: 7.8% (rango: 0-17.2%); clamidia: 15.3% (rango: 5.7-32.2%); gonorrea: 2.9% (rango 0-13.8%) y cualquier VIH/ITS: 23% (rango: 9.9-46%). Los municipios con altos puntajes de desarrollo humano y menor índice de marginación municipal tuvieron una mayor probabilidad de prevalencia combinada de VIH/ITS. Después de controlar la variabilidad específica del sitio en las características municipales, el mayor riesgo de VIH / ITS se asoció con menor educación, tener un cónyuge diagnosticado o tratado para una ITS, imposibilidad de conseguir condones y tener clientes no mexicanos. **Conclusiones.** La prevalencia de VIH/ITS varía entre los municipios mexicanos, lo que indica la necesidad de una vigilancia para identificar *hotspots* para la asignación selectiva.

Palabras clave: trabajadores sexuales; mujeres; VIH; infecciones de transmisión sexual; epidemiología; prevalencia; México

(1) Department of Psychiatry, University of California. San Diego, CA, USA.
(2) Department of Medicine, University of California. San Diego, CA, USA.
(3) Unidad de Investigación y Evaluación , Fundación Mexicana para la Planeación Familiar. Mexico City, Mexico.
(4) Departamento de Ciencias Biomédicas, Universidad Autónoma de Ciudad Juárez. Chihuahua, Mexico.
(5) Departamento de Cuidado Integral, Centro Nacional para la Prevención y el Control del VIH y el Sida, Secretaría de Salud. Mexico City, Mexico.

Received on: June 13, 2017 • **Accepted on:** August 30, 2018
Corresponding author: PhD Thomas L Patterson. University of California. 9500 Gilman Dr, La Jolla. 0680, San Diego, California, USA.
E-mail: tpatterson@ucsd.edu

Female sex workers (FSWs) are highly vulnerable to HIV and other sexually transmitted infections (STIs), particularly in low- to middle-income countries.[1] In a review of HIV in Mexico, del Rio and Sepulveda[2] concluded that from 1980 to 2000, HIV seroprevalence among FSWs was less than 1%. However, more recent estimates in Tijuana and Ciudad (Cd.) Juarez yielded HIV prevalences ranging from 6% among non-injecting FSWs to 12% in FSW-IDUs.[3] In contrast to HIV, STI prevalence among FSWs in Mexico has been high for decades. In the late 1990s, the prevalences of active syphilis, chlamydia, and gonorrhea among FSWs in Mexico City were 23.7, 12.8 and 11.6%, respectively;[4] the prevalence of HSV-2 was 60%.[5] Among FSW-IDUs residing in Tijuana or Cd. Juarez, 50% had at least one active STI, compared to 25% among non-IDU FSWs.[3]

The present study used a social ecological framework to explore the prevalence of HIV and other STIs and their correlates among 1 092 FSWs in 13 sites across Mexico. The Social Ecological Model describes five levels of influence on behavior, including individual (e.g., education), interpersonal (e.g., substance use with clients), institutional (e.g., work venue), community (e.g., poverty, access to health care), and policy (e.g., policing).[6] Given recent emphasis in prevention research on the "risk environment",[7] which includes all levels of influence described in our conceptual model, we hypothesized that site-specific, community-level, municipal characteristics might explain variations in HIV/STI prevalence independent of individual-, interpersonal-, institutional, and policy-level factors. We also hypothesized that settings with fewer resources and less-educated populations would have FSWs who were riskier. The availability in Mexico of two government-monitored indices, the Human Development Score (which comprises life expectancy, education, income, and other factors) and the Marginalization Index (an indicator of decreased access to basic public services and greater poverty), provided us with ready-made potential predictor variables related to the risk environments of the sites studied. If correlations could be found, the findings could help rationalize the allocation of limited resources for HIV/STI prevention and treatment.

Materials and methods

Data for this analysis were obtained from baseline interviews and HIV/STI screenings of 1 092 FSWs enrolled in the *Mujer Segura* implementation study.[8] This hybrid type-2 study simultaneously tested the efficacy of the *Mujer Segura* safer-sex intervention and a train-the-trainer implementation strategy at multiple sites.[9] The protocol was reviewed and approved by the Institutional Review Boards of the University of California, San Diego; *Universidad Autónoma de Ciudad Juárez*, which provided training to staff; and the Mexican Foundation for Family Planning (Mexfam), which operates the clinics at which the study was carried out. All participants provided written informed consent.

Study sites

The study was carried out from 2011 to 2015 at 13 community-based clinics operated by Mexfam, which is a non-profit, non-governmental organization, headquartered in Mexico City, that operates sexual and reproductive health programs in 22 states in Mexico. An initial list of 23 sites was drawn up that met minimum capacity criteria and reflected a broad geographic distribution.[8] Sites were intentionally chosen to represent a cross-section of clinic sizes (large versus small) and locations (urban versus rural). From the initial list,12 sites were randomly selected for participation. A thirteenth site was added after the publication of the protocol description.

Eligibility criteria

Eligibility criteria from the original efficacy trial were retained.[8] Participants had to be biologically female; be at least 18 years of age; be able to speak Spanish (which cannot be assumed in some of Mexico's more rural, indigenous areas); have no plans to move out of the area for at least 6 months; self-identify as a female sex worker; report having traded sex for drugs, money, shelter, or other material benefit within the previous two months; have had unprotected vaginal or anal sex with a client at least once during the previous two months; have no previous HIV-positive test result; agree to be tested for HIV and STIs at baseline and at six-month follow-up; agree to accept free STI treatment at baseline (to distinguish prevalent from incident cases at follow-up); and be willing to provide informed consent.

Recruitment

At each site, outreach workers employed by Mexfam adopted a time-location sampling approach,[10] whereby they compiled a map of sex work venues (e.g., bars, brothels, shooting galleries, street corners) in red light districts and other areas with high concentrations of FSWs. Women who appeared to be engaged in sex work were

approached and engaged in conversation to assess study interest and eligibility. Among FSWs who met eligibility criteria, less than 1% refused to participate in the study.

Data collection

Participants were reimbursed the equivalent of $30 U.S. for completing an interviewer-administered, computerized questionnaire and brief counseling session. Sociodemographic and personal questions included age, educational attainment in years, and birthplace. Sexual risk behaviors included numbers of clients and of unprotected sex acts with clients during the previous four months. Drug use behaviors included lifetime and recent consumption and injection of various drugs. Alcohol use was assessed with the AUDIT-C, which reliability identifies drinkers who are hazardous or "at risk".[11] Data on the demographic, social, and economic characteristics of the municipalities hosting the participating clinics were derived from reports published by the Mexican National Institute for Statistics and Geography (INEGI).[12]

Assessment of HIV and STIs

Participating sex workers were screened for HIV using the Advanced Quality Rapid Anti-HIV (1 and 2) test. Reactive samples were shipped to the San Diego County Health Department Laboratory and tested using HIV-1, 2 serum antibody enzyme immunoassay (EIA) and indirect fluorescent antibody (IFA) tests. FSWs were also screened for syphilis, chlamydia, and gonorrhea. Syphilis serology included a rapid diagnostic screening for the qualitative detection of antibodies to *Treponema pallidum* in blood. All reactive samples were shipped to the San Diego County lab and subjected to the rapid plasma reagin (RPR) test and the *T. pallidum* particle agglutination assay (TPPA). Urine samples were collected using the Gen-Probe Aptima Combo 2W Assay for *C. trachomatis* and *N. gonorrhoeae*. HIV/STI test results were provided to participants by nurses within two weeks of testing. Those testing HIV-positive were referred to their municipal clinic for free medical care, while those who tested positive for another STI were treated at the study site. HIV reporting is mandatory throughout Mexico, and requirements are consistent across states. The reporting requirement was explained in the consent form along with possible adverse consequences (e.g., loss of license to practice sex work).

Statistical analyses

Due to the small number of HIV+ cases, we chose combined HIV/STI status (i.e., any of the measured STIs including HIV) as our binary dependent variable. Logistic regressions via generalized estimating equations were performed to identify site and participant characteristics related to HIV/STI prevalence. Since this is a multisite study, the data are heterogeneous, inducing intra-site correlation. Site was used as a cluster variable with an exchangeable correlation structure, where the correlation between any two observations within any particular site was assumed to be the same. Our model building approach involved conducting univariate analyses of all variables that were both conceptually relevant and important in the literature. Variables that yielded a significance <= 0.10 in the univariate analyses were considered for the multivariable model based on both conceptual and statistical relevance. The alpha for entrance into the multivariate model was chosen based on measurement error and potential lack of power considerations. To obtain the most parsimonious multivariate model, goodness of fit was conducted by comparing values of the quasi-likelihood under the Independence Model Information Criterion (QIC) and by ruling out interactions and multicollinearity. All the variables in the final multivariate model are significant at the 5% significance level while accounting for other variables in the model. Because site was not used as a fixed covariate, it does not appear in the final multivariate model.

Results

Site characteristics and participant risk profiles

Sites were spread across eight Mexican states (table I). The average population of the metropolitan areas hosting the participating clinics was 426 608 (range 14 751-1 495 189). Residents' average annual per capita income was 10 218 U.S. (range 4 045-15 117).Types of venue for sex work varied widely between sites, which ranged from urban (Mexico City, Guadalajara) to rural (Naranjos, Tlapa). The legal status of sex work varied from tolerated (Mexico City), to municipally sanctioned with specially constructed facilities (Tuxtla), to illegal (Ciudad Neza). Table II presents demographic, sex risk, and drug and alcohol risk variables for each study site.

Table I

Structural Characteristics of Municipalities Involved in Study. Mexico, 2011-2015

Site	*State*	*Total population*	*UNDP Town size classification*	*Human development (HD) index (0-1)*	*Level of HD (per UNDP)*	*HD index rank**	*Annual per capita income (US$)*	*Degree of marginalization*	*M Index (0-100)*	*M Index Rank**	*Years of education*
01 Revolución	Delegación Cuauhtémoc	531 831	Urban large	0.8921	High	23	15 117	Medium low	4.6	13	11.32
02 Ciudad Neza	México	1 110 565	Metropolitan	0.8621	High	103	10 137	Medium low	8.9	114	9.5
03 Huajuapan	Oaxaca	69 839	Mixed	0.8248	High	333	6 781	Low	17.12	547	8.58
04 Iguala	Guerrero	140 363	Urban large	0.8343	High	261	8 346	Low	18.17	78	9.07
05 Ixtaltepec	Oaxaca	14 751	Mixed	0.8097	High	497	8 118	Medium	21.73	517	7.29
06 Naranjos	Veracruz	27 548	Urban medium	0.8453	High	189	9 106	Low	15.53	197	8.76
07 Guadalajara	Jalisco	1 495 189	Metropolitan	0.8882	High	34	14 281	Medium low	5.25	125	9.99
08 San Luis de la Paz	Guanajuato	115 656	Mixed	0.7418	Medium	1 487	5 721	Medium	25.34	16	6.76
09 San Luis Potosí	San Luis Potosí	772 604	Urban large	0.9011	High	14	16 758	Medium low	7.02	58	10.33
10 Tlapa	Guerrero	81 419	Urban medium	0.7174	Medium	1 788	4 045	High	33.63	54	6.74
11 Veracruz	Veracruz	552 156	Urban large	0.8848	High	41	14 859	Medium low	9.12	209	9.79
12 Tepeji del Río	Hidalgo	80 612	Mixed	0.8295	High	289	9 063	Low	15.98	66	8.22
13 Tuxtla	Chiapas	553 374	Urban large	0.855	High	140	10 502	Medium low	12.48	118	10.03
	Mean:	426 608.23				Mean:	10 218				

* Out of 2 546 municipalities in Mexico

UNDP: United Nations Development Programme
Town Size Classifications: Metropolitan: over 50% of the population living in cities of over one million inhabitants
Urban Large: over 50% of the population lives in towns between 100 thousand and less than one million inhabitants
Urban Medium: more than 50% of the population lives in towns between 15 000 and less than 100 000 inhabitants
Semi-urban: more than 50% of the population lives in towns from 2 500 to less than 15 thousand inhabitants
Rural: over 50% of the population lives in towns with less than 2 500 inhabitants
Mixed: The population is distributed in the above categories without a percentage greater than or equal to 50% population
Source: Sistema Nacional de Información Municipal[12]

Table II

Demographic, sex risk, and drug and alcohol use among FSWs in 13 sites in Mexico. 2011-2015

Site	Age Mean (SD)	Years of education completed Mean (SD)	Married or common law N (%)	Has children N (%)	Age when first traded sex Mean (SD)	Years spent as a sex worker Mean (SD)	Number of male clients* Mean (SD)	% sex acts w/o condom‡ Mean (SD)	Ever used heroin N (%)	Ever used meth N (%)	Ever used cocaine N (%)	AUDIT hazardous drinking N (%)	Used alcohol with client‡ N (%)
01	39.9 (11.7)	6.5 (3.4)	19 (26.8)	67 (94.4)	28.5 (10.6)	11.7 (10.1)	164.8 (179.7)	30 (20)	2 (2.8)	1 (1.4)	17 (23.9)	22 (31.0)	18 (25.4)
02	34.5 (9.0)	7.9 (2.4)	21 (25.9)	78 (96.3)	29.2 (8.0)	5.3 (5.4)	66.7 (87.9)	60 (30)	4 (4.9)	3 (3.7)	23 (28.4)	74 (91.4)	75 (92.6)
03	30.5 (7.8)	7.3 (3.2)	25 (29.4)	75 (88.2)	26.4 (7.1)	4.2 (4.5)	115.6 (118.7)	50 (30)	2 (2.4)	8 (9.4)	31 (36.5)	69 (81.2)	62 (72.9)
04	30.5 (7.7)	5.8 (3.1)	21 (25.9)	75 (93.8)	25.2 (6.6)	5.3 (5.8)	252.8 (209.5)	50 (30)	2 (2.5)	0 (0)	39 (48.8)	77 (96.3)	76 (95.0)
05	35.1 (8.2)	6.6 (3.4)	15 (18.5)	75 (92.6)	27.5 (7.7)	7.6 (7.6)	167 (229.1)	40 (30)	0 (0)	0 (0)	18 (22.2)	72 (88.9)	40 (49.4)
06	32.6 (8.9)	6.9 (2.9)	21 (24.4)	76 (88.4)	27.5 (8.5)	5.0 (4.9)	56.4 (107)	60 (30)	0 (0)	1 (1.6)	16 (18.6)	80 (93.0)	74 (86.1)
07	34.5 (10.0)	6.3 (3.4)	29 (33.0)	84 (95.5)	28.7 (9.9)	5.9 (6.7)	337.6 (235.9)	30 (20)	5 (5.7)	9 (10.2)	24 (27.3)	43 (48.9)	33 (37.5)
08	30.6 (8.9)	7.2 (3.4)	36 (40.0)	70 (77.8)	23.3 (6.4)	7.2 (6.3)	421.3 (135.2)	50 (20)	0 (0)	0 (0)	4 (4.4)	66 (73.3)	48 (53.3)
09	32.9 (10.1)	8.0 (3.7)	22 (26.2)	74 (88.1)	27.0 (8.7)	5.9 (7.2)	408.1 (302.9)	20 (20)	0 (0)	1 (1.2)	16 (19.1)	40 (47.6)	13 (15.5)
10	29.2 (8.7)	5.8 (3.6)	14 (16.1)	72 (82.8)	25.0 (7.6)	4.2 (4.7)	151.3 (191.6)	40 (20)	3 (3.5)	1 (1.2)	29 (33.3)	80 (92.0)	77 (88.5)
11	28.3 (8.3)	8.6 (2.7)	21 (25.0)	52 (61.9)	21.5 (5.1)	6.7 (7.0)	480 (232.7)	60 (30)	1 (1.2)	0 (0)	5 (6.0)	53 (63.1))	38 (45.2)
12	33.4 (9.6)	8.2 (2.5)	25 (28.4)	78 (88.6)	27.6 (8.4)	5.9 (6.4)	115.9 (176.3)	60 (30)	0 (0)	7 (8.0)	8 (9.1)	80 (90.9)	81 (92.1)
13	36.8 (10.4)	6.2 (4.0)	29 (33.3)	79 (90.8)	28.5 (7.3)	8.3 (7.0)	518.1 (289.8)	30 (20)	0 (0)	1 (1.2)	14 (16.1)	48 (55.2))	28 (32.2)
Overall	32.9 (9.7)	7.0 (3.3)	298 (27.3)	955 (87.5)	26.6 (8.2)	6.3 (6.8)	252.7 (255.8)	40 (30)	19 (1.7)	32 (2.9)	244 (22.3)	804 (73.6)	663 (60.7)

* in the previous six months
‡ in the previous month

Site Key (names of Mexfam clinics): 01 Revolución, 02 Ciudad Neza, 03 Huajuapan, 04 Iguala, 05 Ixtaltepec, 06 Naranjos, 07 Guadalajara, 08 San Luis de la Paz, 09 San Luis Potosí, 10 Tlapa, 11 Veracruz, 12 Tepeji del Río, 13 Tuxtla
Percentages may reflect denominators smaller than the N value given in the column head. These discrepancies are due to missing data

Table III
PREVALENCE OF HIV AND STIs IN 13 SITES IN MEXICO. 2011-2015

Site	*N*	*HIV (%)*	*Gonorrhea (%)*	*Chlamydia (%)*	*Syphilis titer (%)*	*Any syphilis (%)*	*HIV or any STI*
01 Revolución	71	1 (1.4)	2 (2.9)	9 (12.9)	3 (4.3)	10 (14.3)	20 (29.0)
02 Ciudad Neza	81	0 (0)	2 (2.5)	7 (8.6)	1 (1.2)	4 (4.9)	12 (14.1)
03 Huajuapan	85	0 (0)	0 (0)	14 (16.5)	1 (1.2)	4 (4.7)	18 (21.2)
04 Iguala	80	0 (0)	5 (6.3)	24 (30)	3 (3.8)	5 (6.3)	27 (33.8)
05 Ixtaltepec	81	1 (1.2)	4 (4.9)	10 (12.3)	1 (1.2)	11 (13.6)	22 (27.2)
06 Naranjos	86	0 (0)	0 (0)	19 (22.1)	1 (1.2)	6 (7)	25 (29.1)
07 Guadalajara	88	1 (1.1)	0 (0)	7 (8)	3 (3.5)	13 (15.1)	18 (20.7)
08 San Luis de la Paz	90	0 (0)	2 (2.2	10 (11.1)	0 (0)	0 (0)	12 (13.3)
09 San Luis Potosí	84	1 (1.2)	3 (3.6)	9 (10.7)	6 (7.2)	13 (15.7)	21 (25.3)
10 Tlapa	87	0 (0)	12 (13.8)	28 (32.2)	8 (9.2)	15 (17.2)	40 (46.0)
11 Veracruz	84	0 (0)	0 (0)	7 (8.6)	0 (0)	1 (1.2)	8 (9.9)
12 Tepeji del Río	88	0 (0)	0 (0)	18 (20.5)	0 (0)	0 (0)	18 (20.5)
13 Tuxtla	87	0 (0)	1 (1.1)	5 (5.7)	0 (0)	3 (3.4)	9 (10.3)
Totals	1 092	4 (0.4)	31 (2.9)	167 (15.3)	27 (2.5)	85 (7.8)	250 (23.0)

Variations in HIV/STI prevalence

The overall prevalence of HIV among the total sample was 0.4%, ranging from zero to 1.4% at the 13 sites (table III). The prevalence of other STIs varied widely: syphilis, 7.8% (range 0 to 17.2%); chlamydia, 15.3% (range 5.7 to 32.2%); gonorrhea, 2.9% (range 0 to 13.8); and any STI, 23% (range 9.9 to 46%).

Univariate associations with HIV/STI

Univariate analyses suggest that municipalities with high Human Development Scores had a 33% decrease in the odds of combined HIV/STI prevalence compared to those with medium scores (OR= 0.67; 95%CI: 0.47, 0.96, *p*=.0032). Furthermore, the odds of prevalent HIV/STIs increased by 30% for every 1–standard deviation increase in the municipal Marginalization Index (OR= 1.3; 95%CI: 1.28, 1.50, *p*= .0003). Also, having fewer years of education was associated with HIV/STI prevalence (OR= 0.90; 95%CI: 0.86, 0.94, *p*= .000). FSWs who reported that their spouse had been diagnosed or treated for an STI in the past 6 months were 2.6 times more likely to have ever tested positive for an STI or HIV (OR= 2.61; 95%CI: 1.22, 5.60, *p*= .014). FSWs who could afford to buy condoms had a lower odds of an STI or HIV (OR= 0.65; 95%CI: 0.49, 0.88, *p*= .005) as did FSWs who reported that most or all clients were from elsewhere than Mexico (OR= 0.56; 95%CI: 0.33, 0.95, *p*= 0.03). Among drug use factors, only cocaine use in the past month (OR= 1.74; 95%CI: 1.01, 2.99, *p*= .047) and binge drinking (OR= 1.38; 95%CI: 1.02, 1.87 *p*= .036) were significantly associated with having an STI or HIV.

Factors independently associated with HIV/STI prevalence

A final multivariate model (table IV) suggested that after controlling for site-specific variability in municipal characteristics, higher rates of STI/HIV infection were related to lower education, having a spouse who has been diagnosed or treated for an STI in the past six months, not being able to afford a condom, and having foreign clients.

Discussion

The prevalence of HIV among the participants was low at all of the study sites, and prevalence of other STIs varied widely, ranging from 9.9 to 46%. Similarly, self-reported sex risk varied widely, with rates of unprotected sex ranging from 20 to 60% between sites. While illicit drug use was low overall, alcohol abuse was common with 73% overall meeting criteria for hazardous drinking. Neither drug nor alcohol use correlated with STI prevalence in univariate analyses. In univariate

Table IV
Factors independently associated with HIV or any STI among FSWs in 13 sites in Mexico (n=1 092) (2011-2015)

Predictor	*Odds ratio estimate*	*Standard error*	*Lower wald 95%CI for OR*	*Upper wald 95%CI for OR*	*P-value*
Years of education	0.9009	0.0249	0.8535	0.9510	0.0002
Spouse has been diagnosed or treated for an STI past six months	2.9700	1.2271	1.3215	6.6750	0.0084
Can afford to buy her own condoms	0.6852	0.1013	0.5129	0.9154	0.0105
Most or all clients are from elsewhere than Mexico	1.9092	0.5101	1.1309	3.2232	0.0155

CI: confidence interval. OR: odds ratio
Controls for intra-site correlation by using site as a cluster variable with exchangeable corrletion structure in a GEE algorithm

analyses, a high Human Development Score decreased the odds of combined HIV/STI prevalence, but this variable was not significant in multivariate analyses. The Human Development Scores are broadly representative of each state and may not reflect the micro-environments inhabited by individual sex workers. Therefore, future research should focus on individual markers of economic status.

The prevalence of HIV among the sample of 1 092 FSWs was 0.4%. When combined with previous estimates,[3,13,14] data from the present study suggest that FSWs from the 13 study sites had about 5.7 times (0.40/.07%) the risk of HIV compared to women from the general population, but they have only 0.06 times the risk of HIV compared to FSWs in Mexico's northern border region, providing further evidence that sub-epidemics of HIV are occurring in specific regions and subpopulations in Mexico, particularly in border cities where migration patterns, drug trafficking routes, and sexual tourism contribute to higher risk behaviors among FSWs.[15]

Overall 23% of FSWs had either HIV or another STI. While this is comparable to STI rates observed historically among FSWs in Mexico,[4] it is high relative to the general population (e.g., 2.3% prevalence of syphilis among women in the general population in 2007),[16] suggesting high sex risk and thus the potential for an escalation of the HIV epidemic among FSWs in larger areas of Mexico. However, compared to FSWs in Tijuana and Cd. Juárez,[17] FSWs in the present study were at about half the risk (.48 times) of gonorrhea, similar in chlamydia risk (1.18 times), and at lower risk for active syphilis titers (.18 times).

The final multivariate model suggested that, after controlling for variability in municipal characteristics, a greater risk of STI/HIV infection was related to four factors: lower education, having a spouse who has been diagnosed or treated for an STI in the past six months, not being able to afford a condom, and having clients who were from outside of Mexico. These results suggest a number of targets for interventions. Poverty and low education among FSWs have been identified previously as risk factors for negative health outcomes, Hence, HIV/STI prevention interventions could include structural components such as microloans and small business training.[18]

Providing more free condoms is an obvious and relatively inexpensive structural intervention. However, even FSWs who receive free condoms might be induced not to use them by offers from clients of higher fees for unprotected sex. This disincentive to condom use could be counteracted by cash transfers that are dependent on FSWs' remaining free of sexually transmitted infections.[19]

The need for couples-based interventions is highlighted by our finding that having a spouse who has been diagnosed or treated for an STI in the past six months is related to increased risk for HIV/STIs. A number of investigators have tested couples-based interventions that, suitably adapted, could be effective for FSWs in Mexico.[20]

Finally, the correlation between having foreign-born male clients and being at elevated risk for HIV/STIs is of unclear significance. It is unclear whether the foreign-born clients reported in this study were primarily tourists, resident or transient migrants, or some combination. Sex tourism[21] is not a likely explanation for the presence of foreign-born male clients, since the sites were predominantly located in cities or towns in the interior of Mexico that are not well known for their tourist trades. If the foreign-born clients were predominantly migrants, then the literature that indicates higher HIV risk among migrant men[22] might shed some light on our

finding. Future studies should examine this question in greater detail.

A limitation of this study stems from our sampling design, which involved recruiting women in high-risk areas and venues through time location sampling. This type of sampling can introduce bias by omitting unidentified areas and venues, and by excluding FSWs who do not visit these areas and venues, or refuse to be screened.[10] The sample also consisted of volunteers in a sexual risk reduction intervention and thus may not be representative of the broader population of FSWs in each study site. Also, the $30 US compensation for participation in the interview and intervention could have affected the representativeness of the sample; most likely it resulted in greater motivation to participate. Although the low overall HIV prevalence could reflect the success of ongoing HIV/STI surveillance and prevention efforts, our cross-sectional data prevent us from assessing whether overall HIV/STI prevalence is decreasing among FSWs in these cities. Site-specific prevalence estimates may be unstable due to relatively small samples at each site and the fact that entry criteria included reporting high-risk behavior.

This study contributes to our understanding of the HIV epidemic in Mexico by adopting a multi-level approach to identifying correlates of HIV/STI prevalence that includes community-level municipal characteristics that have been largely ignored in previous research. Also, unlike previous work,[23] this multi-site study involved a national sample of FSWs that included both urban and rural regions of Mexico. Our data suggest that interventions are advisable to mitigate the risks associated with FSW lifestyles. Evidence-based behavioral interventions for HIV prevention have been shown to be highly cost-effective and to potentially save public health resources in LMIC such as Mexico.[24]

Declaration of conflict of interests. The authors declare that they have no conflict of interests.

References

1. Baral S, Beyrer C, Muessig K, Poteat T, Wirtz AL, Decker MR, *et al*. Burden of HIV among female sex workers in low-income and middle-income countries: a systematic review and meta-analysis. Lancet Infect Dis. 2012;12:538-49. https://doi.org/10.1016/S1473-3099(12)70066-X
2. del Rio C, Sepulveda J. AIDS in Mexico: lessons learned and implications for developing countries. AIDS. 2002;16:1445-57. https://doi.org/10.1097/00002030-200207260-00001
3. Strathdee SA, Philbin MM, Semple SJ, Pu M, Orozovich P, Martinez G, *et al.* Correlates of injection drug use among female sex workers in two Mexico-U.S. border cities. Drug Alcohol Depend. 2008;92:132-40. https://doi.org/10.1016/j.drugalcdep.2007.07.001
4. Valdespino-Gómez JL, García-García ML, del Río-Zolezzi A, Loo-Méndez E, Magis-Rodríguez C, Salcedo-Alvarez RA. Epidemiología del SIDA/VIH en México; de 1983 a marzo de 1995. Salud Publica Mex. 1995;37:520-4.
5. Uribe-Salas F, Hernández-Avila M, Juárez-Figueroa L, Conde-Glez CJ, Uribe-Zúñiga P. Risk factors for herpes simplex virus type 2 infection among female commercial sex workers in Mexico City. Int J Std AIDS. 1999;10:105-11. https://doi.org/10.1177/095646249901000206
6. McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. Health Educ Q. 1988;14:351-77. https://doi.org/10.1177/109019818801500401
7. Rhodes T. The 'risk environment': a framework for understanding and reducing drug-related harm. Int J Drug Policy. 2002;13:85-94. https://doi.org/10.1016/S0955-3959(02)00007-5
8. Patterson TL, Semple SJ, Chavarin CV, Mendoza DV, Santos LE, Chaffin M, *et al*. Implementation of an efficacious intervention for high risk women in Mexico: protocol for a multi-site randomized trial with a parallel study of organizational factors. Implement Sci. 2012;7:105. https://doi.org/10.1186/1748-5908-7-105
9. Orfaly RA, Frances JC, Campbell P, Whittemore B, Joly B, Koh H. Train-the-trainer as an educational model in public health preparedness. J Public Health Manag Pract. 2005;Suppl:S123-7. https://doi.org/10.1097/00124784-200511001-00021
10. Magnani R, Sabin K, Saidel T, Heckathorn D. Review of sampling hard-to-reach and hidden populations for HIV surveillance. AIDS. 2005;19(suppl 2):S67-72. https://doi.org/10.1097/01.aids.0000172879.20628.e1
11. Bush K, Kivlahan DR, McDonell MB, Fihn SD, Bradley KA. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Ambulatory Care Quality Improvement Project (ACQUIP). Alcohol Use Disorders Identification Test. Arch Intern Med. 1998;158:1789-95. https://doi.org/10.1001/archinte.158.16.1789
12. Sistema Nacional de Información Municipal [Internet]. Ciudad de México: Inafed. c2018 - [cited 2015 Mar 28]. Available from: www.snim.rami.gob.mx
13. Patterson TL, Mausbach B, Lozada R, Staines-Orozco H, Semple SJ, Fraga-Vallejo M, *et al*. Efficacy of a brief behavioral intervention to promote condom use among female sex workers in Tijuana and Ciudad Juarez, Mexico. Am J Public Health. 2008;98:2051-7. https://doi.org/10.2105/AJPH.2007.130096
14. Gutiérrez JP, Sucilla-Pérez H, Conde-Gonzalez CJ, Izazola JA, Romero-Martínez M, Hernández-Ávila M. Seroprevalencia de VIH en poblacion mexicana de entre 15 y 49 años: resultados de la Ensanut 2012. Salud Publica Mex. 2014;56:323-32. https://doi.org/10.21149/spm.v56i4.7352
15. Gaines TL, Rudolph AE, Brouwer KC, Strathdee SA, Lozada R, Martínez G, *et al*. The longitudinal association of venue stability with consistent condom use among female sex workers in two Mexico-USA border cities. Int J Std Aids. 2013;24:523-9. https://doi.org/10.1177/0956462412473890
16. Instituto Nacional de Estadística y Geografía. Mujeres y hombres en México 2007. México: INEGI, 2007 [cited Mat 26, 2015]. Available from: http://www.inegi.org.mx/prod_serv/contenidos/espanol/bvinegi/productos/integracion/sociodemografico/mujeresyhombres/2007/MyH_2007_1.pdf
17. Patterson TL, Semple SJ, Staines H, Lozada R, Orozovich P, Bucardo J, *et al*. Prevalence and correlates of HIV infection among female sex workers in 2 Mexico-US border cities. J Infect Dis. 2008;197:728-32. https://doi.org/10.1086/527379
18. Kennedy CE, Fonner VA, O'Reilly KR, Sweat MD. A systematic review of income generation interventions, including microfinance and vocational skills training, for HIV prevention AIDS Care. 2014;26:659-73. https://doi.org/10.1080/09540121.2013.845287
19. de Walque D, Dow WH, Nathan R, Abdul R, Abilahi F, Gong E. Incentivising safe sex: a randomised trial of conditional cash transfers for HIV and sexually transmitted infection prevention in rural Tanzania. BMJ Open. 2012;2:e000747. https://doi.org/10.1136/bmjopen-2011-000747

20. Wechsberg WM, El-Bassel N, Carney T, Browne FA, Myers B, Zule WA. Adapting an evidence-based HIV behavioral intervention for South African couples. Subst Abuse Treat Prev Policy. 2015;10:6. https://doi.org/10.1186/s13011-015-0005-6
21. Strathdee SA, Lozada R, Semple SJ, Orozovich P, Pu M, Staines-Orozco H. Characteristics of female sex workers with US clients in two Mexico-US border cities. Sex Transm Dis. 2008;35:263-8. https://doi.org/10.1097/OLQ.0b013e31815b0
22. Weine SM, Kashuba AB. Labor migration and HIV risk: a systematic review of the literature. AIDS Behav. 2012;16:1605-21. https://doi.org/10.1007/s10461-012-0183-4
23. Larios SE, Lozada R, Strathdee SA, Semple SJ, Roesch S, Staines H, *et al.* An exploration of contextual factors that influence HIV risk in female sex workers in Mexico: the social ecological model applied to HIV risk behaviors. AIDS Care. 2009;21:1335-42. https://doi.org/10.1080/09540120902803190
24. Burgos JL, Gaebler JA, Strathdee SA, Lozada R, Staines H, Patterson TL. Cost-effectiveness of an intervention to reduce HIV/STI incidence and promote condom use among female sex workers in the Mexico-US border region. PLoS One. 2010;5:e11413. https://doi.org/10.1371/journal.pone.0011413