The Effect of Geography on HIV and Sexually Transmitted Infections in Tijuana's Red Light District

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INTRODUCTION

In Tijuana, Mexico, sex work is quasilegal and largely confined to the red light district (*Zona Roja*), a clustering of commercial sex establishments covering approximately 2.9 km² around the city's main tourist area.¹ The majority of the estimated 9,000 female sex workers (FSWs) work in the Zona Roja where they are required to purchase work permits. However, nearly half are believed to work without permits.^{2,3}

Some studies have examined the role of space in shaping epidemics of HIV and sexually transmitted infections (STIs) among FSWs;^{4,5} however, these findings do not generalize to settings where sex work is geographically concentrated within a formalized red light district. In a previous Tijuana study, a small number of bars accounted for a high proportion of HIV/STI prevalence among FSWs but excluded the large number of FSWs soliciting from public spaces, such as street corners.⁶ We extend this study by mapping the primary work location of FSWs in the Zona Roja. We hypothesized a decrease in HIV/STI risk among those working closer to the geographic center of the Zona Roja, where sex work is more commercialized and monitored.

METHODS

Data Collection

Between January 2004 and 2006, Tijuana FSWs enrolled in a behavioral intervention to increase condom use. Trained female counselors administered face-to-face interviews in Spanish as previously described.² Participants provided a blood sample and cervical swabs to detect HIV antibody, syphilis antibody, *Neisseria gonorrhea* and *Chlamydia trachomatis*. The study was approved by the Institutional Review Boards at the University of California San Diego and the General Hospital in Tijuana.

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Data Analysis

Participants identified the primary location where they traded sex and we digitized this in ArcGIS 9.2 (ERSI, Redlands, CA, USA). We calculated the roadway distance, in meters, between workplace and the center of the Zona Roja. Roadway distance was defined as the path distance a pedestrian would actually travel identified by maps from the Tijuana Municipal Planning Institute. The geographic center was defined as the center point of a one-block street where sex work is most concentrated in the Zona Roja.^{7,8}

Associations between proximity to the center of the Zona Roja and the presence of HIV, chlamydia, gonorrhea, or syphilis titers $\geq 1:8$ (e.g., “active” syphilis) were initially examined separately, with several participants testing positive for more than one infection. Large variation in the geographic distribution of work location between FSWs infected with active syphilis compared to those with HIV and other STIs was observed. We therefore combined HIV, chlamydia, and gonorrhea into a single outcome (i.e., HIV/STI) and adjusted for active syphilis in all statistical models.

Analyses compared FSWs that tested positive for at least one HIV/STI to those that tested negative across all infections using Wilcoxon Rank Sum or Fisher’s exact tests. Characteristics associated with HIV/STIs, in addition to geographic proximity, were identified through multivariate logistic regressions. We restricted analysis to baseline data from FSWs reporting work in or near the Zona Roja (excluding pockets of sex work in distant neighborhoods) since this is the most prominent tourist area and includes a variety of venues where sex work is solicited.

RESULTS

Of 474 FSWs, 343 (72.4 %) worked in the Zona Roja and were eligible for this analysis. Median age was 33 years (interquartile range [IQR]: 26, 40), over a quarter spoke English (27.7 %), and one fifth were born in the state of Baja California (22.1 %). Nearly half (43.7 %) worked in the sex trade for more than 4 years and 19 % owned their place of residence compared to living with relatives, friends, or renting (Table 1).

Prevalence was 7 % for HIV, 6.6 % for chlamydia, 9.6 % for gonorrhea, and 14.9 % for active syphilis. Participants primarily reported working in a bar (51 %) or on the street (41 %) with relatively few reporting other primary work venues (8 %). Median distance of work location from the geographic center among FSWs without HIV/STIs ($n=255$) was 174 m (IQR, 120–304) compared to 217 m (IQR, 146–318) among FSWs with HIV/STIs ($n=88$); street-based FSWs reported the furthest median distance (253 m).

Compared to FSWs without HIV/STIs, FSWs with HIV/STIs worked significantly farther away from the geographic center, reported a steady partner who was an injection drug user, and reported knowing fellow FSWs that injected drugs (Table 1). There were no significant differences between groups with respect to venue where sex was traded or amounts earned for protected and unprotected sex. Infected FSWs were significantly more likely to use drugs before or during sex than non-infected FSWs and were more likely to report injecting drugs in the past month.

In the multivariable model, three factors were independently associated with HIV/STIs: increasing distance away from the Zona Roja’s geographic center (OR, 1.41 per 200 m; 95 % CI, 1.04 and 1.91), owning their place of residence (OR, 0.35; 95 % CI, 0.13 and 0.89), and active syphilis (OR, 2.59; 95 % CI, 1.27 and 5.28).

TABLE 1 Characteristics of FSWs with and without any HIV/STIs in Tijuana

	Yes HIV/STIs (N=88)	No HIV/STIs (N=255)	Univariate OR (95 % CI)	Adjusted OR (95 % CI)
Geographic proximity				
Distance to center of Zona Roja, median (IQR)*	217 (145, 318)	174 (120, 304)	2.37 (1.04, 1.80)	1.41 (1.04, 1.91)
Sex work venue				
Street	43 (48.9 %)	98 (38.4 %)	Ref	
Bar/cantina	38 (43.2 %)	138 (54.1 %)	0.63 (0.38, 1.04)	—
Other	7 (8.0 %)	19 (7.5 %)	0.84 (0.33, 2.14)	—
Demographics				
Median age (IQR)	31 (25, 37)	34 (27, 40)	0.97 (0.94, 1.00)	—
Speaks English	33 (37.9 %)	61 (24.1 %)	1.55 (0.80, 2.99)	—
Born in Baja California	28 (32.2 %)	47 (18.6 %)	2.08 (1.20, 3.61)	—
Highest year of school completed (IQR)	7 (5, 9)	6 (4, 9)	1.06 (0.99, 1.14)	—
Married or common law	11 (12.6 %)	46 (18.1 %)	0.65 (0.32, 1.33)	—
Worked in the sex trade for more than 4 years	36 (51.7 %)	112 (37.2 %)	0.93 (0.57, 1.53)	—
Has children	143 (93.5 %)	175 (93.1 %)	1.25 (0.45, 3.47)	—
Lives in own home	19 (12.3 %)	46 (24.3 %)	0.24 (0.10, 0.59)	0.35 (0.13, 0.89)
Years lived in Tijuana	10 (5, 20)	7 (2, 18)	1.01 (0.99, 1.03)	—
Social influence				
Steady partner was an IDU	13 (14.8 %)	19 (7.5 %)	2.15 (1.02, 4.57)	—
Earned ≤\$30 US on average for vaginal sex with a condom	33 (40.2 %)	84 (33.5 %)	1.34 (0.80, 2.24)	—
Earned ≤\$30 US on average for vaginal sex without a condom	56 (63.6 %)	132 (51.8 %)	1.61 (0.99, 2.69)	—
Fellow FSWs injected drugs	35 (40.2 %)	67 (26.6 %)	1.86 (1.11, 3.10)	—
Risk behaviors				
Total no. clients in the past month	12 (5, 20)	11 (6, 23)	0.99 (0.97, 1.00)	—
No. of nonregular clients	5 (2, 15)	6 (2, 16)	0.99 (0.98, 1.00)	—
Often or always used condoms for vaginal sex with clients	37 (42.1 %)	85 (33.5 %)	1.44 (0.88, 2.37)	—
Median no. unprotected anal sex acts with clients (last month)	4 (1, 7)	3 (1, 5)	0.93 (0.82, 1.05)	—
Often or always used drugs before or during vaginal sex	25 (28.4 %)	36 (14.2 %)	2.40 (1.34, 4.30)	—
Had at least one IDU sex partner last month	18 (20.5 %)	41 (16.7 %)	1.29 (0.69, 2.38)	—
Had male clients who have injected drugs	36 (40.9 %)	82 (32.3 %)	1.45 (0.88, 2.39)	—

TABLE 1 (continued)

	Yes HIV/STIs (N=88)	No HIV/STIs (N=255)	Univariate OR (95 % CI)	Adjusted OR (95 % CI)
Ever injected drugs	25 (28.4 %)	46 (18.0 %)	1.80 (1.03, 3.16)	—
Injected drugs last month	19 (21.6 %)	31 (12.2 %)	1.99 (1.06, 3.74)	—
Injected heroin past month	23 (26.1 %)	40 (15.7 %)	1.99 (1.06, 3.74)	—
Injected cocaine past month	7 (8.0 %)	11 (4.3 %)	1.92 (0.72, 5.11)	—
Injected speedball past month	8 (9.1 %)	16 (6.3 %)	1.49 (0.62, 3.62)	—
Injected methamphetamine past month	11 (12.5 %)	10 (3.9 %)	3.50 (1.43, 8.56)	—
Smoked, inhaled, or snorted methamphetamine past month	61 (69.3 %)	111 (43.7 %)	2.93 (1.74, 4.91)	—
Ever shared needles or injection equipment	17 (19.3 %)	33 (12.9 %)	1.61 (0.85, 3.06)	—
Other STI				
Syphilis titer ≥1:8	24 (27.9 %)	27 (10.8 %)	3.20 (1.73, 5.93)	2.59 (1.27, 5.28)

Data are number (percent) of women, unless otherwise indicated. Certain percentages may reflect denominators smaller than the *n* value given in the column head. These discrepancies are due to missing data. Odds ratios (OR) for continuous variables are based on a per-unit increase
IQR interquartile range, *IDU* injection drug user

DISCUSSION

There is increasing public health attention on the identification of areas at increased risk of HIV/STI through the mapping of health data. We found that distance from the center of Tijuana's Zona Roja was independently associated with HIV/STIs among FSWs. For every 200 m a FSW worked away from the geographic center (e.g., equivalent to one block), we observed a 41 % increase in the odds of HIV, chlamydia, and/or gonorrhea infection. These findings support qualitative work in Tijuana where FSWs with higher risk profiles (e.g., decreased condom use, drug addiction, less access to STI prevention services) are more likely to work in the perimeter of the Zona Roja.⁷ This implies that traveling a short distance from where sex work is most visible in Tijuana's red light district poses a higher exposure to HIV/STI risk.

In this study, standard tools to detect geographic areas or clusters with elevated HIV/STIs were limited since FSWs in the Zona Roja often work within a very short distance from one another. Our approach to modeling the effect of distance to the center of Tijuana's Zona Roja captured more variation and allowed us to identify geography as an independent correlate of HIV/STI risk. Through mapping primary work location, we found that more street-based FSWs were located in the perimeter of the Zona Roja, which has important implications on the role of space within less formal sex work sectors. In Tijuana, street-based workers are marginalized to a greater extent and are more likely to experience police harassment, exploitation, and abuse, placing them at increased risk for unsafe sex and increased drug activity.^{9,10}

The effect of geography on HIV/STI risk likely reflects macrolevel factors that hinder working in safer sex work environments. For example, one study concluded that Canadian FSWs spatially displaced to side streets experienced decreased access to preventive services and harm reduction resources.⁴ In Brazil, increased participation in community networks (e.g., neighborhood associations or activist organizations) and increased perceptions of social cohesion (e.g., mutual aid and connectedness) was associated with protective sexual behaviors among FSWs.¹¹ Therefore, the mechanisms underlying the role of space on FSW sexual health may be attributable to social and political contexts that can affect individual risk profiles.

Although several drug use behaviors were significantly associated with HIV/STIs, they were not independently associated with HIV/STI risk after controlling for roadway distance. However, these variables were also spatially dependent, since reports of substance use occurred more frequently in women reporting their work location further away from the geographical center. This highlights the interdependencies between multiple factors increasing the likelihood of HIV/STIs, such as geography and substance use, which not only affect one another but jointly influence sexual health.

Several limitations that should be noted. First, we aggregated STIs, including HIV, into a single outcome. Although separate analyses of each infection would have been preferred, nearly one third of FSWs tested positive for multiple infections. Second, we excluded active syphilis as part of our outcome because we found that FSWs with active syphilis but no other infection worked closer, on average, to the center of the Zona Roja. The differential effect of geography may depend on epidemiologic characteristics specific to syphilis and merit further attention. Third, we mapped prevalent instead of incident HIV/STI cases and therefore cannot infer which areas were associated with greatest risk for acquiring HIV/STIs. However, our analysis identified areas where others are at increased risk for HIV/STI acquisition from

FSWs with these infections and where outreach efforts may be needed. Lastly, this study targeted a higher risk sample of FSWs which does not reflect the general FSW population in Tijuana.

In summary, Tijuana's red light district is circumscribed to specific neighborhoods with FSWs operating in highly concentrated areas. Applying novel geographic methods can alleviate challenges of analyzing the role of space on epidemics in urban settings and helps to inform spatially relevant prevention and support services. After this study concluded, Tijuana implemented a mobile HIV prevention program in high-risk neighborhoods including the Zona Roja to deliver condoms, rapid HIV testing, educational materials, and syringe exchange. Future research on the impact of this mobile outreach is warranted given that HIV/STIs are not uniformly distributed, even within this concentrated locale.

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