Prevalence of *Chlamydia trachomatis* Infection Diagnosed by Polymerase Chain Reaction in Female Sex Workers in a Northern Mexican City

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Purpose: We aimed to determine the association between *Chlamydia trachomatis* infection and female sex work, and the association between sociodemographic, obstetric, and behavioral characteristics of female sex workers and *C. trachomatis* infection.
Methods: Through a case–control study design, we studied 201 female sex workers and 201 age-matched women without sex work in Durango City, Mexico. *C. trachomatis* DNA was detected in cervical swab samples using polymerase chain reaction.
Results: *C. trachomatis* DNA was detected in 32 (15.9%) of the 201 cases and in 6 (3.0%) of the 201 controls (odds ratio [OR] = 6.15; 95% confidence interval [CI]: 2.5–15.0; $P < 0.001$). The frequency of infection with *C. trachomatis* in female sex workers did not vary ($P > 0.05$) regardless of the history of pregnancies, deliveries, cesarean sections, or miscarriages. Regression analysis of the behavioral characteristics showed that infection with *C. trachomatis* was associated only with consumption of alcohol (OR = 2.39; 95% CI: 1.0–5.71; $P = 0.04$).
Conclusions: We conclude that *C. trachomatis* infection is associated with female sex work in Durango City, Mexico. This is the first age-matched case–control study on the prevalence of *C. trachomatis* infection in female sex workers in Mexico using detection of *C. trachomatis* DNA in cervical samples.

Keywords: *Chlamydia trachomatis*, prevalence, female sex workers, case–control study

Introduction

Chlamydia trachomatis (*C. trachomatis*) is a ubiquitous, obligate, intracellular Gram-negative bacterial pathogen [1]. Humans are the only natural host of *C. trachomatis* [2]. This bacterium remains a significant public health burden worldwide [3]. It is estimated that 100 million cases of *C. trachomatis* infection occur annually [4]. *C. trachomatis* is the pathogen that is most often transmitted by sexual contact [5]. The clinical spectrum of infection with *C. trachomatis* varies from asymptomatic to several acute or chronic, local, and systemic diseases such as trachoma, oculo-genital, and neonatal diseases [6–7]. Infections with *C. trachomatis* of the lower female genital tract are frequently asymptomatic, undiagnosed, and untreated [4]. Pelvic inflammatory disease attributed to ascending genital *C. trachomatis* infections can result in ectopic pregnancies and infertility in women [4–5]. In addition, a recent meta-analysis demonstrated that individuals infected with *C. trachomatis* have a higher risk of cervical cancer [8]. *C. trachomatis* causes inclusion conjunctivitis of the newborn,

with the female birth canal being the reservoir [9]. In addition, infection with *C. trachomatis* causes pneumonia and sepsis [10]. In men, *C. trachomatis* causes urethritis and epididymitis [11].

Little is known about the epidemiology of *C. trachomatis* infection in Mexico. The prevalence of *C. trachomatis* in women in Mexico has been determined in several population groups; for instance, 4% prevalence was reported in women in Cuernavaca City [12], 3.3% prevalence was found in women with leucorrhea in Mexico City [13], and 7.3% prevalence was reported in women in rural and suburban Oaxaca State [14]. However, female sex workers have shown higher prevalence of *C. trachomatis* infection. Uribe-Salas et al. [15] reported 11.1% prevalence of *C. trachomatis* in female sex workers in Mexico City. Whereas in 3 northern Mexican states, prevalence between 12.4% and 16.6% were found in female sex workers [16–17]. In the present study, by using a different study design (case–control) and laboratory method (polymerase chain reaction [PCR]) compared to those used in previous studies in female sex workers in Mexico, we aimed to determine the following: (1) the association between *C. trachomatis* infection and female sex work and (2) the sociodemographic, obstetric, and behavioral characteristics of female sex workers associated with *C. trachomatis* infection.

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Materials and Methods

Study Design and Women Studied. Through a case–control study design, we studied female sex workers (cases) and women with occupations other than sex work (controls) in Durango City from November 2014 to May 2016. Female sex workers were enrolled at the Sanitary Inspection Clinic of the Municipal Government in Durango City, Mexico. The inclusion criteria for enrollment of female sex workers were female sex workers (1) registered in the Sanitary Inspection Clinic, (2) worked in the sex industry for at least one year, and (3) aged ≥18 years old. Control subjects were women without sex work. Controls were sexually active women and enrolled at the Clinic for Family Planning in the Institute for Scientific Research. This public clinic is in Durango City, Mexico, and is part of Juárez University of Durango State.

Sociodemographic, Obstetric, and Behavioral Characteristics of Cases. We recorded the sociodemographic, obstetric, and behavioral data of cases with the aid of a questionnaire. Data about age, residence, birthplace, education, socioeconomic status, history of pregnancies, cesarean sections, miscarriages, and deliveries from all sex workers were obtained. Behavioral factors included duration (years) in the sex industry, area of work (urban, suburban, or rural), sex work in Mexican states other than Durango or abroad, contact with semen during vaginal intercourse, condom use, practice of oral or anal sex, injuries at sex work, and consumption of alcohol, tobacco or drugs.

DNA Extraction and Amplification. Cervical swab samples were obtained from participants and stored in a home-made 2SP (sucrose–phosphate) medium at −70 °C until analysis. DNA was extracted from cervical samples by proteinase K digestion and phenol–chloroform extraction. *C. trachomatis* DNA was detected by PCR using primers of the *omp* A gen of *C. trachomatis* [18]. These primers generate the amplification of a 129-base pair fragment. The amplification mixture contained 1.5 mM $MgCl_2$, 0.3 μM primers, 1 unit of Taq polymerase (Promega, Madison WI, EUA), 0.16 mM dNTPs, 2 ng DNA, and buffer in a 50-μL reaction volume. This amplification mixture was denatured at 95 °C for 10 min. Then, samples were amplified in 34 cycles. Each cycle consisted of the following: denaturation at 95 °C for 1 min, annealing at 61 °C for 2 min, and extension at 70 °C for 1 min. Samples underwent a final extension at 70 °C for 10 min. Amplification products were analyzed by electrophoresis in 2% agarose gel and stained with 0.1% ethidium bromide.

Statistical Analysis. Data were analyzed with the software SPSS version 15.0 (SPSS Inc. Chicago, Illinois). We calculated the odds ratio (OR) with 95% confidence interval (CI) to assess the association between *C. trachomatis* infection and sex work occupation. In addition, the association between *C. trachomatis* infection and the sociodemographic, obstetric, and behavioral characteristics of the female sex work were analyzed by the Pearson's chi-squared test and the Fisher exact test (when values were 5 or less). Variables of sex workers with a *P* value ≤0.20 obtained by bivariate analysis were further analyzed by multivariate analysis. We calculated the ORs and 95% CIs by regression analysis with the Enter method. Statistical significance was set at *P* value <0.05.

Ethics. The Ethics Committee of the Institute for Scientific Research of the Juarez University of Durango State, Mexico, approved this project. Participation in the study was voluntary. Written informed consent was obtained from all cases and controls before enrollment.

Results

Four hundred and two women were enrolled in this study. Half (*n* = 201) of them were cases (female sex workers), and 201 were controls (age-matched women). Mean ages in cases

Table 1. Sociodemographic characteristics of female sex workers and prevalence of *C. trachomatis* infection

Characteristic	Women tested No.	Prevalence of *C. trachomatis* infection No.	%	*P* value
Age groups (years)				
≤20	10	0	0.0	
21–30	82	14	17.1	0.56
31–40	64	11	17.2	
≥41	45	7	15.6	
Birth place				
Durango State	163	24	14.7	
Other Mexican state	38	8	21.1	0.33
Residence place				
Durango State	200	32	16.0	
Other Mexican state	1	0	0.0	1.00
Education (years)				
No education	4	0	0.0	
1 to 6	58	11	19.0	0.38
7–12	129	21	16.3	
>12	10	0	0.0	
Socio-economic status				
Low	39	8	20.5	
Medium	160	24	15.0	0.4

Table 2. Correlation between behavioral characteristics of female sex workers and *C. trachomatis* infection

Characteristic	Women tested No.	Prevalence of *C. trachomatis* infection No.	%	*P* value
Duration in the sex industry (years)				
1 to 5	20	1	5.0	0.14
6 to 11	47	11	23.4	
≥11	134	20	14.9	
Area of work				
Urban	196	32	16.3	0.74
Suburban	2	0	0.0	
Rural	1	0	0.0	
Sex activity in Mexican states other than Durango				
Yes	58	9	15.5	1.0
No	142	23	16.2	
Sex activity abroad				
Yes	3	1	33.3	0.4
No	198	31	15.7	
Condom use				
Yes	115	19	16.5	0.77
No	80	12	15.0	
Contact with semen during vaginal intercourse				
Yes	86	13	15.1	0.74
No	113	19	16.8	
Practice of oral sex				
Yes	121	16	13.2	0.18
No	79	16	20.3	
Practice of anal sex				
Yes	17	1	5.9	0.31
No	182	31	17.0	
Injuries during sex activity				
Yes	12	2	16.7	1.0
No	187	30	16.0	
Alcohol consumption				
Yes	36	10	27.8	0.03
No	165	22	13.3	
Tobacco consumption				
Yes	41	5	12.2	0.63
No	160	27	16.9	
Drug use				
Yes	13	3	23.1	0.43
No	188	29	15.4	

Table 3. Results of the regression analysis of selected behavioral characteristics of female sex workers and infection with *C. trachomatis*

Characteristic	Odds ratio	95% Confidence interval	*P* value
Duration in the sex industry (≥5 years)	0.31	0.03–2.43	0.26
Practice of oral sex	0.59	0.27–1.28	0.59
Alcohol consumption	2.39	1.0–5.71	0.04

and controls were 33.06 ± 9.76 (range: 18–67) years old and 33.08 ± 9.79 (range: 17–67) years old, respectively ($P = 0.98$). *C. trachomatis* DNA was detected in 32 (15.9%) of the 201 cases and in 6 (3.0%) of the 201 controls. The difference in the prevalence of *C. trachomatis* infection found in cases and controls was statistically significant (OR = 6.15; 95% CI: 2.5–15.0; $P < 0.001$). Bivariate analysis of socioeconomic characteristics of female sex workers showed no association ($P > 0.05$) between *C. trachomatis* infection and age, birthplace, residence, educational level, or socioeconomic status (Table 1). The frequency of infection with *C. trachomatis* in female sex workers did not vary ($P > 0.05$) regardless of the history of pregnancies, deliveries, cesarean sections, or miscarriages. With respect to behavioral characteristics, the variables, namely, duration in the sex industry, practice of oral sex, and alcohol consumption, showed *P* values ≤0.20 by bivariate analysis (Table 2), whereas other behavioral characteristics including area of work, sex work in Mexican states other than Durango or abroad, contact with semen during vaginal intercourse, condom use, practice of anal sex, injuries at sex work, consumption of tobacco, or drugs showed *P* values >0.20 by bivariate analysis. Regression analysis of the 3 behavioral characteristics with *P* values ≤0.20 obtained by bivariate analysis showed that the infection with *C. trachomatis* was associated only with consumption of alcohol (OR = 2.39; 95% CI: 1.0–5.71; $P = 0.04$) (Table 3).

Discussion

The epidemiology of *C. trachomatis* infection in female sex workers in Mexico has been scantly studied. We therefore aimed to determine the association between *C. trachomatis* infection and the occupation of female sex worker in Durango City, Mexico. We found a significantly higher frequency of *C. trachomatis* DNA in cervical samples from female sex workers than in those from control women without sex work occupation. This finding indicates that *C. trachomatis* infection is associated with the occupation of female sex worker. This age- and gender-matched case–control study thus demonstrates that female sex workers in Durango City have an increased risk of *C. trachomatis* infection. Comparison of our results with those reported in studies of female sex workers in Mexico is limited and should be interpreted with care because differences in the study design and in laboratory methods among the studies exist. There are few reports on the prevalence of *C. trachomatis* in female sex workers in Mexico. In a study performed in 3 cities (Durango, Zacatecas, and Torreón) in the north of Mexico, prevalence values between 5.2% and 16.2% of *C. trachomatis* infection were found [17]. However, in such study, a cross-sectional design and an enzyme immunoassay which detects *C. trachomatis* antigen in endocervix were used [17]. In the present study, we used a case–control study design, and diagnoses of *C. trachomatis* infection were based on *C. trachomatis* DNA detection using PCR. In a study of female commercial sex workers in Mexico City, researchers found a prevalence of 11.1% of *C. trachomatis* infection obtained by cultures of the bacterium in McCoy cells and identification with fluoresceinated monoclonal antibodies

[15]. In an additional study, the same research group found 14.4% prevalence of *C. trachomatis* infection in female sex workers at the Mexico–Guatemalan border by analyzing cervical swab samples using a nonradioactive nucleic acid hybridization assay [19]. In a further study, 25.0% of female commercial sex workers in Mexico City had anti-*C. trachomatis* IgG antibodies [20]. However, our results obtained by detection of *C. trachomatis* DNA cannot be compared with those of seroprevalence of *C. trachomatis* infection. We compared our results with those obtained in studies of female sex workers in other countries using PCR methodology. The prevalence (15.9%) of *C. trachomatis* infection found in our study is higher than the 6.6% prevalence of *C. trachomatis* endocervical infection reported in female sex workers in Hungary using plasmid PCR [21]. In contrast, the prevalence found in our study is lower than a 28.5% prevalence of *C. trachomatis* cervical infection found in female sex workers in Dakar, Senegal, using PCR [22]. The association between *C. trachomatis* infection and female sex workers found in our study agrees with the same association found in a study in Bangladesh, where researchers found a significantly higher prevalence value of *C. trachomatis* infection in 40 female sex workers (58%) than in 110 sexually active women (27%) using immunochromatography test and/or plasmid PCR [23].

We found an association between *C. trachomatis* infection and alcohol consumption in female sex workers. In a search of this association in the biomedical literature, we did not find any report. It is possible that alcohol consumption in female sex workers might be linked to risky behavioral factors for *C. trachomatis* infection. Further research about this association should be conducted.

Conclusions

We conclude that *C. trachomatis* infection is associated with female sex work in Durango City, Mexico. This is the first age- and gender-matched case–control study on the prevalence of *C. trachomatis* infection in female sex workers in Mexico using detection of *C. trachomatis* DNA in cervical samples. The association between *C. trachomatis* and consumption of alcohol deserves further investigation.

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Authors' Contributions

LFSA and NVH conceived the study protocol, performed the data analysis, and wrote the manuscript. FMGI and JHT performed data analysis and wrote the manuscript. JANF obtained the samples and clinical data. MAD, ARPA, AASC, and EIAS performed laboratory tests and data analysis. SEM performed statistical analysis. CAE participated in the design of the protocol, performed data analysis and wrote the manuscript. All authors read and approved the final version of the manuscript.

Conflict of Interest

The authors declare that no conflict of interest exists.

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