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Toxoplasma gondii infection in pregnant women: a cross-sectional study in Matehuala City, Mexico

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ABSTRACT

Objectives This study aimed to determine the seroprevalence of *Toxoplasma gondii* (*T. gondii*) infection in pregnant women in Matehuala City, Mexico; and the associated risk factors.

Design A cross-sectional study.

Setting Matehuala City, Mexico.

Participants 311 pregnant women.

Primary and secondary outcome measures Sera of women were analysed for anti-*T. gondii* IgG and IgM antibodies by commercially available immunoassays. Bivariate and multivariate analyses were used to assess the association between *T. gondii* seroprevalence and the characteristics of the pregnant women.

Results Thirteen (4.2%) of the 311 pregnant women studied were positive for anti-*T. gondii* IgG antibodies. No anti-*T. gondii* IgM antibodies were found in anti-*T. gondii* IgG seropositive women. No association between seropositivity and history of blood transfusion, transplantation, caesarean sections, deliveries, miscarriages or number of pregnancies was found. Logistic regression analysis of sociodemographic, behavioural and housing variables showed that availability of potable water at street represented a risk factor for *T. gondii* infection (age-adjusted OR=2.18; 95% CI: 1.05 to 4.53; p=0.03), whereas being born in Mexico was a protective factor for infection (age-adjusted OR=0.01; 95% CI: 0.001 to 0.35; p=0.008).

Conclusions In this first study on the seroepidemiology of *T. gondii* infection in pregnant women in Matehuala, we conclude that the seroprevalence of *T. gondii* infection is low and similar to those reported in pregnant women in other Mexican cities. However, the seroprevalence found is lower than those reported in pregnant women in other countries in the Americas and Europe. Two risk factors associated with *T. gondii* infection were identified. Results of the present study may help for the optimal planning of preventive measures against toxoplasmosis in pregnant women.

Strengths and limitations of this study

- This is the first study of *Toxoplasma gondii* (*T. gondii*) infection in pregnant women in the central Mexican city of Matehuala.
- This study provides information about the immunological status against *T. gondii* in pregnant women in a previously unexplored central Mexican city.
- A low seroprevalence of *T. gondii* infection in the studied pregnant women was found.
- The current work shows risk factors for *T. gondii* infection found in pregnant women that may help for the planning of measures against toxoplasmosis and its sequelae.
- The low rate of seropositivity to *T. gondii* did not allow the finding of further associations between the characteristics of pregnant women and *T. gondii* infection.

INTRODUCTION

Toxoplasmosis is a disease caused by the parasite *Toxoplasma gondii* (*T. gondii*).[1] This parasite is a coccidian of the phylum Apicomplexa[2] and causes infections worldwide.[3] Transmission of *T. gondii* occurs mainly by ingestion of parasite oocysts shed by cats or by consumption of tissue cysts in meat from infected animals.[4] The parasite may cross the placenta of an infected woman and may infect the fetus congenitally.[5] Congenital infection with *T. gondii* may have severe consequences as miscarriage, fetal death and neurological, ocular and another organ damage in the fetus.[6] If the infection occurs in an early phase of pregnancy the rate of transmission is low, but the severity is high if the fetus is infected; whereas if the infection occurs in a late phase of pregnancy the transmission rate is higher, and the severity would be low.[5] On the other hand, infections with *T. gondii* that occur after birth are usually asymptomatic, but the parasite may induce severe disease in immunocompromised patients.[7] Toxoplasmosis is

Table 1 A summary of epidemiological data about *Toxoplasma gondii* (*T. gondii*) infection in studies in pregnant women in Mexico

Study population	Year of the publication of the study	Place of the study	Women tested No.	Prevalence of *T. gondii* infection		Risk factors	Reference
				No.	%		
Women with high risk pregnancies	1995	Guadalajara City	350	122	34.9	Older age, low socioeconomic level, housewife occupation, raw or undercooked meat consumption	9
Women in urban area in northern Mexico	2006	Durango City	343	21	6.1	Soil floor at home, residing outside of Durango State, turkey meat consumption	10
Women in rural area in northern Mexico	2009	Durango State	439	36	8.2	Low socioeconomic conditions, soil floor at home	11
Women in urban area in central Mexico	2016	Aguascalientes City	338	21	6.2	White people, no washing hands before eating, use of latrine	13

a life-threatening disease for transplant recipients under immunosuppression.[8]

Very little is known about the seroepidemiology of *T. gondii* infection in pregnant women in Mexico. A 34.9% seroprevalence of *T. gondii* infection was found in pregnant women with high risk pregnancies in the central Mexican city of Guadalajara.[9] Whereas seroprevalences of 6.1% and 8.2% were found in pregnant women in the northern Mexican city of Durango,[10] and rural Durango,[11] respectively. Seroprevalences of 3.6% and 6.2% were found in women of reproductive age in the northwestern Mexican city of Hermosillo,[12] and in pregnant women in the central Mexican city of Aguascalientes,[13] respectively. A summary of epidemiological data of previous studies of *T. gondii* infection in pregnant women in Mexico is shown in table 1. The seroepidemiology of *T. gondii* infection in pregnant women in the central Mexican city of Matehuala is unknown. This study aimed to determine the seroprevalence of *T. gondii* infection and the factors associated with this infection in pregnant women in Matehuala. The original protocol for the study is shown in online supplementary file 1.

MATERIALS AND METHODS

Study design and pregnant women studied

Through a cross-sectional study design, we studied 311 pregnant women in Matehuala City, Mexico. This city is located in the central Mexican state of San Luis Potosí (figure 1)[https://www.google.es/maps/place/Matehualahttps://www.google.es/maps/place/Matehuala,+S.L.P./@23.6543156,-100.6464011,14z/data=!4m5!3m4!1s0×867e1d-86694082f9:0×4016978679cc460!8m2!3d23.6448029!4d-100.64279].

Inclusion criteria were: (1) pregnant women attended in the General Hospital of the Health Services in Matehuala City, Mexico; and (2) aged 18 years and older. This study was performed from January to April 2018. For calculation of the sample size we used a reference seroprevalence of 6.2%[13] as expected frequency of *T. gondii* seropositivity, 15 000 as the population size, 3.0% of confidence limits and a confidence level of 97%. The result of the calculation was 298 subjects.

Sociodemographic, clinical, behavioural and housing data of pregnant women

Sociodemographic, clinical, housing and behavioural characteristics of the pregnant women were obtained using a standardised questionnaire. Sociodemographic

Figure 1 Geographical location of Matehuala City. This City is located at the North of San Luis Potosí state, Mexico.

data included birthplace, residence, age, gender, socioeconomic status, education and occupation. Clinical data included history of transplant or blood transfusion, number of pregnancies, deliveries, caesarean sections and miscarriages. Behavioural data included consumption of untreated water or unpasteurised milk, unwashed raw vegetables or fruits, contact with animals, contact with cat faeces, type of meat consumed, degree of meat cooking, consumption of dried or cured meat, frequency of eating out of home, contact with soil and travelling. Housing data included type of flooring, water supply, form of elimination of excretes, crowding at home and education of the head of the family.

Sample collection and processing

Each pregnant woman provided a blood sample. After centrifugation of blood, sera were obtained and frozen at –20°C until analysed.

Detection of anti-*T. gondii* IgM and IgG antibodies

Detection of anti-*T. gondii* IgG antibodies was performed using a commercially available enzyme immunoassay '*Toxoplasma gondii* IgG' kit (Diagnostic Automation/Cortez Diagnostics, Inc, Woodland Hills, California. USA). Samples positive for anti-*T. gondii* IgG were additionally analysed for anti-*T. gondii* IgM antibodies by a commercially available enzyme immunoassay '*Toxoplasma gondii* IgM' kit (Diagnostic Automation/Cortez Diagnostics, Inc). IgG and IgM tests were performed following the instructions of the manufacturer.

Statistical analysis

The statistical analysis was performed with the aid of the software Epi Info V.7, and SPSS V.20 (SPSS Inc, Chicago, Illinois, USA). We compared the frequencies of seropositivity among groups using the Fisher's exact test. Logistic regression analysis with the Enter method was used to determine the association between the characteristics of the pregnant women and the seropositivity to *T. gondii*. To avoid bias, clinical characteristics were analysed separately from other characteristics of pregnant women. Subjects with missing values were excluded. Variables with a p value ≤0.15 obtained in the bivariate analysis were included in the regression analysis. We calculated the age-adjusted OR and 95% CI, and a p value <0.05 was considered as statistically significant.

Participation in the study was voluntary. Information about the objectives and procedures of the study was provided to participants, and a written informed consent was obtained from all of them.

Patients and public involvement

This research was done without patient involvement. Patients were not invited to comment on the study design and were not consulted to develop patient-relevant outcomes or interpret the results. Patients were not invited to contribute to the writing or editing of this document for readability or accuracy.

Table 2 Sociodemographic characteristics of pregnant women and seroprevalence of *Toxoplasma gondii* (*T. gondii*) infection

Characteristic	Subjects tested No.	Prevalence of *T. gondii* infection		P *value*
		No.	%	
Age groups (years)				
18–30	231	8	3.9	0.74
31–44	80	4	5.0	
Birthplace				
Mexico	309	12	3.9	0.08
Abroad	2	1	50.0	
Residence area				
Urban	227	9	4.0	0.38
Suburban	23	0	0.0	
Rural	61	4	6.6	
Educational level				
No education	8	1	12.5	0.28
1 to 6 years	253	12	4.7	
7–12 years	49	0	0.0	
>12 years	1	0	0.0	
Occupation				
Housewife	190	11	5.8	0.75
Business	2	0	0.0	
Employee	89	2	2.2	
Student	15	0	0.0	
Professional in biomedical area	4	0	0.0	
Professional in non-biomedical area	5	0	0.0	
None	6	0	0.0	
Socioeconomic level				
Low	181	9	5.0	0.41
Medium	130	4	3.1	

RESULTS

Pregnant women were 18 to 44 (mean: 26.14±5.97) years old and were studied during their 1 to 9 (median: 7) month of pregnancy. Thirteen (4.2%) of the 311 pregnant women studied were positive for anti-*T. gondii* IgG antibodies. None of these anti-*T. gondii* seropositive women were positive for anti-*T. gondii* IgM antibodies. Table 2 shows the association between the sociodemographic characteristics of the pregnant women and the seroprevalence of *T. gondii* infection.

As to clinical characteristics, no association (p>0.05) between seropositivity to *T. gondii* and history of blood transfusion, transplantation, caesarean sections, deliveries, miscarriages or number of pregnancies was found.

With respect to behavioural and housing characteristics, only the variables availability of potable water and education of the head of the family showed p values lower than 0.15 by bivariate analysis. Table 3 shows results of the bivariate analysis of a selection of behavioural and housing characteristics and seroreactivity to *T. gondii*. Logistic regression analysis of sociodemographic, behavioural and housing characteristics with p<0.15 obtained by bivariate analysis showed that *T. gondii* infection was positively associated with availability of potable water at street (age-adjusted OR=2.18; 95% CI: 1.05 to 4.53; p=0.03), and negatively associated with being born in Mexico (age-adjusted OR=0.01; 95% CI: 0.001 to 0.35; p=0.008). Results of the regression analysis are shown in table 4.

Table 3 Bivariate analysis of a selection of behavioural and housing characteristics and infection with *Toxoplasma gondii* (*T. gondii*) in pregnant women

Characteristic	Subjects tested No.	Prevalence of *T. gondii* infection		P *value*
		No.	%	
Cats at home				
Yes	100	2	2.0	0.23
No	211	11	5.2	
Raising farm animals				
Yes	184	7	3.8	0.77
No	127	6	4.7	
National trips				
Yes	231	11	4.8	0.52
No	80	2	2.5	
Beef consumption				
Yes	291	12	4.1	0.58
No	20	1	5.0	
Sheep meat consumption				
Yes	78	2	2.6	0.52
No	233	11	4.7	
Venison consumption				
Yes	20	1	5.0	0.58
No	291	12	4.1	
Horse meat consumption				
Yes	5	1	20.0	0.19
No	306	12	3.9	
Snake meat consumption				
Yes	14	1	7.1	0.45
No	297	12	4.0	
Rat meat consumption				
Yes	30	2	6.7	0.36
No	281	11	3.9	
Sausages consumption				
Yes	275	13	4.7	0.37
No	36	0	0.0	
Soil contact				
Yes	150	7	4.7	0.78
No	161	6	3.7	
Floor at home				
Ceramic or wood	150	4	2.7	0.37
Concrete	157	9	5.7	
Soil	4	0	0.0	
Availability of potable water				
In the home	271	9	3.3	0.06
In the land	18	1	5.6	

Continued

DISCUSSION

Very little is known about the seroepidemiology of *T. gondii* infection in pregnant women in Mexico. This study aimed to determine the magnitude of the infection with *T. gondii* in a sample of pregnant women in the northern Mexican city of Matehuala. The seroprevalence found in the present study is similar to *T. gondii* seroprevalences reported in pregnant women in other northern Mexican cities including Durango (6.1%),[10] and Aguascalientes (6.2%)[13] and women at reproductive age in the northwestern Mexican city of Hermosillo, Sonora (3.6%).[12] On the other hand, the seroprevalence of *T. gondii* infection found in the present study is lower than the 8.2% seroprevalence of this infection found in pregnant women in rural Durango State.[11] These studies used the same immunoassay to detect anti-*T. gondii* IgG antibodies. In the Americas context, the seroprevalence found in this study is lower than the 39.8% to 51% seroprevalence of *T. gondii* infection reported in pregnant women in Cali City, Colombia;[14] Bahia State, Brazil;[15] and 10 English-speaking Caribbean countries.[16] In addition, the seroprevalence found in pregnant women in Matehuala City is lower than the 11.1% to 21.9% seroprevalences of *T. gondii* infection reported in European countries including Spain,[17] Portugal,[18] Turkey[19] and Sweden.[20] It is not clear why the seroprevalence found in the current study is lower than those reported in pregnant women in other countries. Differences in the characteristics of the pregnant women and type of environment among the compared countries might explain the differences in the *T. gondii* seroprevalences. In general, it is likely that the parasite circulates in a low rate in Mexico. In fact, a study performed in the northern Mexican state of Durango showed a low rate of *T. gondii* infection in cats and other animals.[21] However, there are specific population groups in Mexico with a high seroprevalence of *T. gondii* infection; for instance, miners in Durango State who had a seroprevalence of 60%.[22] We looked for sociodemographic, behavioural and housing characteristics associated with *T. gondii* seropositivity. Logistic regression analysis showed that *T. gondii* infection was positively associated with availability

Table 3 Continued

Characteristic	Subjects tested No.	Prevalence of *T. gondii* infection No.	%	P *value*
In the street	22	3	13.6	
Crowding at home				
No	160	10	6.2	0.16
Semi-crowded	118	2	1.7	
Overcrowded	33	1	3.0	
Education of the head of family				
7 years or more	189	7	3.7	0.11
4 to 6 years	109	4	3.7	
Up to 3 years	13	2	15.4	

of potable water at street, and negatively associated with being born in Mexico. The association of *T. gondii* exposure and availability of potable water at the street suggests poor sanitary environment and socioeconomic status. It is possible that water can be contaminated with *T. gondii* when transported from the street sources to the houses. The use of unclean containers or contamination of water with soil during transport might contribute for *T. gondii* infection. There is poor knowledge about toxoplasmosis in Mexico. A recent study in housewives showed that this population group had a low knowledge about preventive measures against *T. gondii* infection.[23] For its part, the negative association between *T. gondii* seropositivity and being born in Mexico suggests that *T. gondii* infection might have been acquired abroad.

The present study has some limitations, pregnant women were from a low or medium socioeconomic status, and participants were obtained from only one hospital. Therefore, further studies including also pregnant women of high socioeconomic status and obtained in several hospitals for a better understanding of the epidemiology of *T. gondii* infection should be conducted. Results of this study cannot be generalised to other pregnant women in Mexico. Anti-*T. gondii* IgM antibodies were determined only in sera of women with anti-*T. gondii* IgG antibodies. Anti-*T. gondii* IgM appears early during primary infection; however, detection of this marker alone without anti-*T. gondii* IgG cannot provide a reliable diagnosis of infection since a considerable number of false-positive results has been reported in anti-*T. gondii* IgM immunoassays.[24]

Table 4 Multivariate analysis of selected characteristics of pregnant women and their association with *Toxoplasma gondii* infection

Characteristic	Age-adjusted OR	95% CI	P *value*
Birthplace (Mexico)	0.01	0.001 to 0.35	0.008
Availability of potable water	2.18	1.05 to 4.53	0.03
Education of the head of family	1.67	0.65 to 4.33	0.28

CONCLUSIONS

In this first study on the seroepidemiology of *T. gondii* infection in pregnant women in the northern Mexican city of Matehuala, we conclude that the seroprevalence of *T. gondii* infection is low and similar to those reported in pregnant women in other Mexican cities. However, the seroprevalence found is lower than those reported in pregnant women in other countries in the Americas and Europe. Risk factors associated with *T. gondii* infection identified in the present study should be considered for the optimal planning of measures to avoid *T. gondii* infection during pregnancy.

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Contributors CA-E, AAV-H, JH-T and J-MS-P designed the study protocol, performed the data analysis. CA-E wrote the manuscript. AAV-H, OLLL, LFSA and OEG-L obtained blood samples, submitted the questionnaires and performed the data analysis. A-AS-C, SMS-P, FXC-J, EMM-H and E-IA-S performed the laboratory tests. All authors read and approved the final version of the manuscript.

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Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The Institutional Ethical Committee of the General Hospital of the Health Services in Matehuala City, Mexico, approved this study.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. All data relevant to the study are included in the article or uploaded as supplementary information. The data set analysed is available from the corresponding author on reasonable request.

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