

Risk factors for *Toxoplasma gondii* infection among pregnant women from the State of Tocantins, Northern Brazil

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ABSTRACT

Introduction: The prevalence of infection by *Toxoplasma gondii* and associated risk factors in pregnant women in Tocantins, Northern Brazil were assessed. **Methods:** Serological analysis was performed in 338 serum samples and an oral questionnaire was utilized to identify potential risk factors. **Results:** Anti-IgG antibodies against *T. gondii* were detected in 71% (240/338) of the pregnant women. Prior contact with cats and meat handling were found to be associated with *T. gondii* infection. **Conclusions:** A considerable percentage (29%) of women living in the Tocantins area remain susceptible to infection by the *T. gondii* protozoon, representing a serious public health risk.

Keywords: *Toxoplasma gondii*. Pregnant women. Risk factors.

Toxoplasmosis is an important parasitic disease caused by the obligate intracellular protozoan *Toxoplasma gondii*, which is distributed worldwide⁽¹⁾. This protozoon can potentially affect several species of animals including humans, but only those belonging to the Felidae family may act as definitive hosts⁽²⁾. Infections in humans occur after the ingestion of raw or uncooked meat containing tissue cysts or by the ingestion of water, soil, or vegetables contaminated with oocysts released by infected cats⁽³⁾. In most cases, the infected humans do not present clinical signs; however, when infection occurs in pregnant women several health problems can affect the fetuses. The transmission of *T. gondii* to the fetus might result in mental retardation, seizures, blindness, hydrocephalus, cerebral calcification, chorioretinitis, and ultimately death⁽⁴⁾. However, in some cases the health problems remain unapparent until the second or third decade of life⁽⁵⁾.

In pregnant women, the prevalence of infection might vary widely with levels ranging from less than 1% to 92%^{(6) (7) (8)}. Recently, a study conducted in Tanzania reported a seroprevalence of 30.9% in pregnant women⁽⁹⁾. In general, the lowest prevalence has been reported in North America, whereas in Latin America,

and particularly in countries such as Brazil, Colombia, and Cuba the prevalence of infection might reach 70%^{(10) (11)}. The wide prevalence range is due to the different risk factors, which might influence the likelihood of infection by *T. gondii* in a given population (e.g., ingestion of undercooked meat, unpasteurized milk, or educational level)^{(5) (12)}.

Several studies have assessed the seroprevalence and risk factors of *T. gondii* in humans from Iran. In this country, different prevalences have been reported because of the marked geographical and cultural differences; in addition, distinct patterns of risk factors have been described^{(13) (14)}. A similar situation is observed in Brazil, which is a large country with different social and environmental profiles. For example, it has been demonstrated that contact with the soil constitutes the most important risk factor associated with *T. gondii* infection in the Southern region of Brazil⁽¹⁵⁾. In contrast, the direct contact with cats was shown to be highly associated with *T. gondii* infection in humans residing in the northeast region⁽¹⁰⁾. Considering the importance of this zoonotic infection and the lack of data in some regions, the aim of this study was to assess the seroprevalence and the risk factors associated with *T. gondii* infection in pregnant women living in the State of Tocantins, Northern Brazil.

A cross-sectional study was conducted using serum samples of 338 pregnant women who were attended through the public healthcare system in the municipalities of Araguaína (7°11'31"S and 48°12'28"W) and Colinas do Tocantins (8°3'23"S and 48°28'38"W) in the State of Tocantins, Northern Brazil.

Blood samples were collected from the cephalic veins of the subjects using sterile tubes without anticoagulant and the

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sera obtained were stored at -20°C until serological analysis. This was subsequently performed using a microparticle immunoenzymatic assay [(MEIA), AxSYM® System kit, Abbott Laboratories], following the manufacturer’s instructions.

To identify the risk factors associated with infection by *T. gondii*, questionnaire data were assessed using Epi Info software (CDC Epi Info™) and analyzed by Pearson’s chi square and Fisher’s exact tests. The significance level was set at 5% and the confidence interval (CI) at 95%.

In this study, samples of 338 pregnant women were analyzed. Of these, 4.7% (16/338) were below 19 years of age, 63% (213/338) were between 20 and 29, and 23.4% (79/338) were over 30 years old.

Anti-immunoglobulin G (IgG) antibodies against *T. gondii* were detected in 71% (240/338) of the pregnant women analyzed in this study, whereas anti-immunoglobulin M (IgM) antibodies

were not observed. Among the patients with positive titer, 4.1% (10/240) were illiterate, 48.7% (117/240) had spent less than five years in school, 38.7% (93/240) had spent more than five years in the school, and 8.3% (20/240) were graduated from faculty. No difference was observed between the level of education and positive detection of *T. gondii* (p = 0.598). Of the positive samples, 11.2% (27/240) and 88.7% (213/240) were obtained from pregnant patients originating from rural and urban areas, respectively (p = 0.78). In addition, no differences were observed between patients from the two municipalities screened. Overall, results of the risk factor analysis are shown in **Table 1**.

This study demonstrates that contact with cats and the handling of meat are associated with infection by *T. gondii* in pregnant women from the State of Tocantins, Brazil. The seroprevalence (71%) detected herein was within the range of positivity previously reported in pregnant Brazilian women (from 31% to 91.6%)⁽¹²⁾. It is known that seroprevalence might

TABLE 1 - Risk factors associated with infection by *Toxoplasma gondii* in pregnant women living in the State of Tocantins, Northern Brazil.

Variable	Total number (n)	Positive		Univariate analysis	
		n	%	odds ratio (CI 95%)	p
Ingestion of eggs					
no	78	55	70.5	1	0.535
yes	260	174	66.9	0.84 (0.46–1.49)	
Ingestion of raw vegetables					
no	62	36	58.1	1	0.112
yes	276	189	68.4	1.58 (0.86–2.87)	
Ingestion of raw meat					
no	256	171	66.7	1	0.384
yes	82	59	72.0	1.28 (0.72–2.32)	
Handling of meat					
no	154	95	61.7	1	0.041*
yes	184	132	72.1	1.61 (0.99–2.61)	
Contact with dogs					
no	240	155	64.6	1	0.282
yes	98	73	74.5	1.59 (0.92–2.81)	
Contact with cats					
no	215	123	57.2	1	0.001*
yes	123	108	87.8	5.35 (2.87–10.46)	
Contact with kittens					
no	270	180	66.6	1	0.555
yes	68	48	70.6	1.19 (0.65–2.24)	
Contact with soil					
no	240	167	69.6	1	0.495
yes	98	61	62.2	5.43 (3.27–9.05)	
Origin of water					
treated	86	60	69.8	1	0.594
not treated	252	168	66.7	0.87 (0.49–1.51)	

CI 95%: confidence interval 95%. *Risk factors associated with the infection by *Toxoplasma gondii*.

vary widely in different parts of the world and may be influenced by various environmental and cultural factors⁽¹⁾.

In contrast, this study did not find any correlation between *T. gondii* infection and age, level of educational, or origin of the pregnant women. Considering the lack of age association, the data obtained in this study suggests that in this area the infection probably occurred during childhood. The high infection rate during this period is likely due to the presence of stray cats and the play habits of children. In addition, although, it has previously been demonstrated that the educational level is an important risk factor for the occurrence of *T. gondii* infection, no association was detected in this study. In general, people with a higher educational level have more knowledge about this infection and the methods of its prevention⁽¹¹⁾. As a similar lack of association was observed regarding the origin of samples (i.e., rural or urban areas), it is probable that the number of samples analyzed was small and lacked power to detect differences in infection rates across these parameters. However, in contrast to our results, the results of a previous study conducted in the municipality of Gurupi in the State of Tocantins indicated that a high prevalence of *T. gondii* infection in pregnant women was found to be related to age, as well as contact with raw meat, *in natura* milk intake, education level, working outside the home, and poor hygienic habits during meal preparation⁽¹²⁾.

In this study, certain evaluated feeding behaviors did not exhibit correlation with *T. gondii* infection. For example, a previous study suggested that the consumption of raw vegetables should be considered as a risk factor for infection⁽¹⁵⁾, but this was not relevant in our study. Additionally, toxoplasmosis has been associated with the ingestion of untreated water⁽¹⁴⁾, but this was also not observed here. It was suggested that toxoplasmosis might be transmitted to humans by the ingestion of sporulated oocysts in water and food⁽²⁾.

Instead, only the factors of contact with cats [odds ratio (OR) = 5.35, $p = 0.01$] and meat handling (OR = 1.61, $p = 0.04$) were associated with infection by *T. gondii* in the pregnant women living in the area assessed. Many studies demonstrated the importance of the presence of cats to the occurrence of infection by *T. gondii*. In fact, from an epidemiological point of view, the presence of cats acquires even more importance when these animals share the same environment with potential susceptible reservoirs, especially livestock animals and humans. In this context, the presence of a higher number of cats on a farm can increase the chances of infection of production animals, and in this case, the handling of (their) meat is considerably important in the epidemiology of this parasite. To date, in some Brazilian regions, domestic cats are fed with organs and parts of slaughtered animals; in addition, cats, albeit definitive *T. gondii* hosts, are maintained in the residences to control rats. Both behaviors might contribute to these animals becoming infected with *T. gondii*, and thus increasing the risk of infection in pregnant women.

In conclusion, in the population of pregnant women studied, 71% were anti-*T. gondii* IgG positive. These data indicate that a considerable percentage (29%) of women living in this area remain susceptible to infection by this protozoon, which representing a serious risk for public health. Furthermore, our results demonstrate that contact with cats and the handling of meat are the main risk factors associated with infection by *T. gondii* in pregnant women from the State of Tocantins, Brazil.

Ethical considerations

All patients filled out a free and informed consent statement. In addition, an oral questionnaire was administered to collect information regarding lifestyle and pre-natal data. The present study was approved by the Ethics Committee of the *Fundação de Medicina Tropical de Tocantins* (protocol number 634127129/2009).

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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