

Seroprevalence and Risk Factors for *Toxoplasma gondii* Infection among Pregnant Women in Northeast Iran

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We report *Toxoplasma* IgG seroprevalence of 34.4% among 419 pregnant women in Mashhad, northeast Iran. Soil contact, living in rural environment, and level of education were associated with infection. The prevalence did not increase with age, suggesting high infection rate during childhood and adolescence.

Toxoplasma gondii infections in humans are acquired mainly by consumption of raw or insufficiently cooked meat containing tissue cysts or by ingestion of water, soil, or vegetables contaminated with oocysts shed by infected cats (1). Congenital infection may occur rarely during primary maternal infection and cause severe sequelae, such as visual or neurological impairment in the newborns. The infection is more prevalent in regions with humid climates and poor water hygiene (2, 3). Uninfected pregnant women living in regions where *T. gondii* is more prevalent are at substantial risk of acquiring the infection. With respect to great health burden, prevalence of *Toxoplasma* infection has been greatly assessed in different parts of the world, and the possible risk factors, such as consumption of undercooked meat, unwashed vegetables, soil contact, direct contact with cats, residency status, and educational level, have been evaluated (4).

The prevalence of *T. gondii* in pregnant women ranges from less than 1% to more than 75% in different parts of the world (2, 5). The lowest prevalence was observed in North America and some parts of Asia. Perhaps, *Toxoplasma* is most prevalent in Latin America; seroprevalence of about 50 to 70% has been reported in pregnant women from Brazil, Colombia, and Cuba (6, 7). Numerous studies assessed seroprevalence and risk factors to *Toxoplasma* in Iran. Due to the great geographical and cultural differences, low, moderate, or high seroprevalence was reported in different parts of Iran. As expected, no unique pattern of risk factors was reported (8–14).

We evaluated, for the first time, the seroprevalence and common risk factors for *Toxoplasma* infection in Mashhad County, the third biggest city of Iran and the capital of Razavi Khorasan Province in the northeast of the country.

The study population was 419 pregnant women who referred to health houses for antenatal checkups from February 2010 to January 2011 and filled out the informed consent. The study was approved by the ethics committee of Pasteur Institute of Iran. A questionnaire was given out to the volunteers to acquire data on sociodemographic/obstetric factors and common risk factors for *Toxoplasma* infection (Tables 1 and 2). Serum samples were tested using Euroimmun enzyme-linked immunosorbent assay (ELISA) kits (Euroimmun, Lübeck, Germany) for the presence of *Toxoplasma* IgG and IgM antibodies and avidity of IgG antibodies. IgG and IgM indexes of <0.8 were regarded as the negative results, between 0.8 to 1.1 as the borderline, and ≥ 1.1 as the positive results. In the avidity kit, an avidity index of <40% indicated low avidity antibodies, between 40 and 60% represented the equivocal range, and >60% represented high-avidity antibodies. Positive

IgG titers and negative IgM titers were considered a latent infection. Sera with concurrent positive IgG and IgM titers were further analyzed by avidity testing. Data were examined with SPSS version 16 using analysis of variance (ANOVA) and chi-squared tests. Differences were considered statistically significant at *P* values of <0.05.

Among 419 women, 144 tested positive for *Toxoplasma* IgG antibodies, indicating a seroprevalence of 34.4% (95% confidence interval [CI], 29.93 to 39.02%). This is consistent with other studies that evaluated seroprevalence of *Toxoplasma* in pregnant women residing in mountainous or dry parts of Iran (10–13). Twenty-seven (18.8%) out of 144 IgG-positive women showed specific IgM antibodies. In IgG avidity testing, two of them had avidity indexes in the equivocal range, and the remaining presented a high avidity index. A high avidity index represents high avidity antibodies which ruled out the occurrence of an infection during the past 3 months. Persistence of *Toxoplasma* IgM antibodies many months or even years after the onset of infection was well documented (15).

It was shown that sociodemographic characteristics were associated with *T. gondii* (Table 1). Soil contact was highly associated with the infection ($P < 0.001$) and considered to be a major risk factor. Soil is often contaminated with the oocysts shed by infected cats, the definite host of *T. gondii*. Consequently, individuals with increased soil contact have more chance to get the infection (4). Living in a rural environment was highly associated with infection ($P < 0.001$). *Toxoplasma* seropositivity in women living in urban and rural areas was 29.1 and 47.5%, respectively. Moreover, level of education was a predictor of *Toxoplasma* infection, and women who spent ≤ 5 years at school were more frequently infected with *Toxoplasma* ($P < 0.05$). It is generally accepted that a higher educational level usually means more knowledge about the infection and its prevention. We observed that women living in rural areas had significantly both more soil contact and lower educational levels ($P < 0.05$). Interestingly, rural residency was still significantly related to *Toxoplasma* after adjusting for soil contact and

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TABLE 1 Toxoplasmosis and sociodemographic/obstetric factors in the study population

Sociodemographic factor	No. of subjects (%)		P value
	IgG negative	IgG positive	
Age (yrs) (<i>n</i> = 408 subjects)			
16–21	67 (63.8)	38 (36.2)	>0.05
22–26	89 (67.9)	42 (32.1)	
27–31	71 (64.5)	39 (35.5)	
32–47	40 (64.5)	22 (35.5)	
No. of yrs in school (<i>n</i> = 418 subjects)			
≤5	86 (56.2)	67 (43.8)	<0.05
5–8	75 (70.8)	31 (29.2)	
8–11	18 (78.3)	5 (21.7)	
≥12	95 (69.9)	41 (30.1)	
Residence (<i>n</i> = 400 subjects)			
Rural	64 (52.5)	58 (47.5)	<0.001
Urban	197 (70.9)	81 (29.1)	
Abortion history (<i>n</i> = 419 subjects)			
None	224 (66.5)	113 (33.5)	>0.05
Once	46 (63.0)	27 (37.0)	
More than once	5 (55.6)	4 (44.4)	
No. of pregnancies (<i>n</i> = 386 subjects)			
1	122 (69.3)	54 (30.7)	>0.05
>1	130 (61.9)	80 (38.1)	
Monthly income (IRR ^a) (<i>n</i> = 407 subjects)			
Below 2,000,000	156 (65.5)	82 (34.5)	>0.05
2,000,000–4,000,000	98 (63.2)	57 (36.8)	
Above 4,000,000	11 (78.6)	3 (21.4)	

^a IRR, Iranian rial.

level of education ($P = 0.021$, odds ratio = 1.76, 95% confidence interval = 1.09 to 2.84).

Similar to many studies (4, 10, 13, 16), our study didn't find a correlation between *Toxoplasma* infection and age, which probably means high infection rate during childhood and adolescence in Mashhad County, as it has been reported in some parts of Iran as well as other developing countries (17–19). Salahi-Moghaddam and Hafizi reported the highest infection rate was in adolescents, and about 60% of women were seropositive by the time they reached the reproductive age (19). The high infection rate in childhood is probably due to the presence of a large number of stray cats and the playing habits of children (i.e., soil contact) (17).

Contact with cats was not associated with *Toxoplasma* in our study, as reported by some studies (20). Few Iranians keep cats at home, and they have less contact with cat feces. In the present study, about 7% of the population study had contacts with cat, and no association was detected.

The prevalence of *T. gondii* infection was not associated with gestational age, number of pregnancies, abortion, and monthly income (Tables 1 and 2). Income might be misrepresented by participants as higher because of shame or other factors. Regardless, educational level might better represent the socioeconomic level.

No relation was observed between consuming undercooked meat or kebab and *Toxoplasma* infection. Though eating raw or

TABLE 2 Toxoplasmosis and risk factors

Risk factor	No. of subjects (%)		P value
	IgG negative	IgG positive	
Soil contact (<i>n</i> = 416 subjects)			
Yes	18 (42.9)	24 (57.1)	<0.001
No	254 (67.9)	120 (32.1)	
Contact with cat (<i>n</i> = 415 subjects)			
Yes	18 (62.1)	11 (37.9)	>0.05
No	254 (65.8)	132 (34.2)	
Undercooked meat intake (<i>n</i> = 419 subjects)			
Once a week or more	149 (63.1)	86 (36.5)	>0.05
Once a month or less	126 (67.5)	58 (31.5)	

undercooked meat is known as an important risk factor for toxoplasmosis, many studies found no association (4, 7). The difference observed among different studies is probably due to different meat-eating habits.

Despite the moderate to high prevalence of *Toxoplasma* (20 to 70%) in different parts of Iran (8, 21, 22), no information is available regarding the burden of the infection, as *Toxoplasma*, in any clinical setting, is not considered a reportable infectious disease by the ministry of health. Our results showed rural residency remained the predisposing factor after adjustment for the two other risk factors, i.e., soil contact and level of education. Moreover, the present study suggests high infection during childhood and adolescence in Mashhad. We therefore emphasize the requirement for enhancement of preventive measures against *Toxoplasma*, i.e., public education regarding the means of infection and how to prevent it, e.g., prevention of soil contact by children and those who perform gardening and farming, especially in rural environments.

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