Toxoplasmosis seroprevalence in relation to knowledge and practice among pregnant women in Dhahran, Saudi Arabia

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The epidemiological importance of the different routes of *Toxoplasma gondii* transmission is not known and depends largely on population behaviour and knowledge. This study was conducted to assess toxoplasmosis seropositivity and the related knowledge and preventive practices that are necessary for the prevention of the disease among pregnant women. All pregnant women attending antenatal clinic were tested for *T. gondii* immunoglobulins followed by a survey questionnaire that tested their knowledge and preventive practice. Statistical comparisons were made between the seropositive and negative ones. We determined a low to moderate seroprevalence of toxoplasmosis among pregnant women in Dhahran, Saudi Arabia as compared to many other parts of the world. The overall positivity rates of IgG and IgM against *T. gondii* among 400 pregnant women were 28.5 and 3%, respectively. 75.5% of the participants had never heard about toxoplasmosis and the associated risk factors. Lack of knowledge was associated with the higher risk of infection (OR = 4.04, $p < 0.001$). Keeping pet cats was not common and poorly associated with infections (OR = 1.15, $p \geq 0.64$). Consumption of undercooked meat was reported frequently and only slight risk was associated with sheep/goat meat (OR = 1.39, $p = 0.15$). Eating outside the home at restaurants was reported for the first time to be related to a higher risk of infection (OR = 2.69, $p < 0.001$). Several possible risk factors were suggested through odds ratios calculation and overall knowledge of toxoplasmosis by pregnant women was poor. It is therefore vital to provide a formal education about toxoplasmosis risk factors to women of childbearing age.

Keywords: *Toxoplasma gondii*, Pregnant women, Immunoglobulin, Knowledge, Risk factors

Introduction

Toxoplasmosis is one of the most common diseases worldwide caused by a coccidian parasite, *Toxoplasma gondii*. The seroprevalence of *T. gondii* ranges from 10 to 80% among different regions of the world depending on cultural and eating habits, hygiene, as well as environmental conditions.[1] Various cross-sectional studies using different methods have detected a seropositivity of anti-*T. gondii* IgG among pregnant women of 51.4, 38.8, 38 and 31.9% in the Eastern,[2] South Western,[3] Central[4] and Southern[5] areas of Saudi Arabia, respectively. Infection with *T. gondii* is usually asymptomatic, although it can have catastrophic consequences in a pregnant woman if passed to her developing fetus.

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Several case-control studies have indicated that consumption of undercooked meat of many different animals containing tissue cysts as one of the most significant risk factor of *T. gondii* infection in human.[6–8] Infrequent washing of kitchen knives used to cut raw meat has also been reported.[7] Toxoplasmosis can also be acquired by ingesting oocysts shed by infected cats through oil contact, eating unwashed vegetables and fruits or contact with cat litter.[7,9] The disease has been associated with women of childbearing age, previous pregnancy, low educational standards and residence in rural areas.[10,11] If first contracted during pregnancy, *T. gondii* may be transmitted vertically to the fetus through the placenta. Transmission may also occur through blood products, tissue transplants or some unpasteurized milk.[12] The epidemiological importance of the different routes of transmission depends largely on population behaviour and knowledge. However, *T. gondii* infections are preventable by simple hygienic measures.

DOI 10.1080/20477724.2015.1103502

Therefore, knowledge of the routes of transmission to humans is essential for the prevention of infection among risk groups such as susceptible pregnant women. This study was conducted to assess toxoplasmosis seropositivity and its related knowledge and preventive practice that are necessary for lowering the risk among pregnant women and provide a scientific basis for a specific control and prevention strategy in terms of adequate health education.

Materials and Methods

Study design

A cross-sectional survey was conducted among all pregnant women attending the antenatal clinics of King Fahd Military Medical Complex from September 2012 to October 2013 who agreed to participate. Ethical approval for the study was obtained from the Ethics Committee of Prince Sultan Military College of Health Sciences. All participants were informed about the study and information confidentiality, and informed written consent was obtained.

A structured questionnaire, designed according to the objectives of the study was used to assess demographic, awareness and practice of toxoplasmosis prevention. Questions included general knowledge about toxoplasmosis, possible risk factors for infection such as the presence or ownership of cats, eating habits, soil contact and preventive knowledge and practice.

The questionnaire burden time was estimated to take about 20 min. Pilot testing was done among non-medical staff of Prince Sultan Military College of Health Sciences. The Arabic translated questionnaires guided the face-to-face interviews conducted by the investigators, who briefed the participants about the study objectives and provided guidance. The questions were answered orally by the interviewees and recorded by the investigators in order to facilitate the understanding of the subject matter.

Serological tests

As a part of antenatal care screening, all pregnant women were tested for *T. gondii* immunoglobulins. Architect Toxo IgG and Toxo IgM kits (Abbott, Wiesbaden, Germany), chemiluminescent microparticle immunoassays were performed according to the manufacturer's instruction. Specimens with concentration values ≥3.0 IU/mL were considered reactive for IgG antibodies to *T. gondii*. Specimens with results ≥0.60 Index were considered reactive for IgM antibodies to *T. gondii*.

Statistical analysis

We used the SPSS version 20 (SPSS Inc., Chicago, IL, USA) to calculate the odds ratios (OR) and the respective 95% confidence interval for the association between the presence of *T. gondii* IgG and potential risk factors. We used 20–24 age group as the reference group and calculated odds ratios and *p*-values compared to this group. Nulliparous group was used as the reference group, and for education level we used university graduates and calculated odds ratios and *p*-values compared to these groups. Data were analysed using univariate analysis. We used 5% ($p < 0.05$) as a level of significance.

Results

Out of the 564 women reported to the antenatal clinic, 412 (73%) agreed to participate in this study. Twelve women were eliminated because of inadequately completed questionnaires or lack of serological results. Thus, 400 pregnant women were included in the study with a mean age of 31.7 ± 8.8 years.

The overall positivity of IgG against *T. gondii* in the study population was 28.5%. Of the total women tested, 12 (3.0%) were found to have anti-*T gondii* IgM antibodies who were also anti-*T gondii* IgG reactive (Table 1). Immunoglobulin M positive women were thought to be at risk of congenital infection and underwent further analysis which is not reported here.

Statistical analysis of the associations *T. gondii* seropositivity and age, parity and education level are shown in Table 1. Seropositivity of 23.5% was detected among the age group of 20–24, increased between participants of 25 years through 34 years of age, and then slightly

Table 1 Distribution of T. gondii infection with age, parity rate, and education level and the odds ratios (OR) with the 95% CI in 400 pregnant women in Dhahran, Saudi Arabia

	Positive	Negative	% positive	OR (95% CI)	*p*-value
Age in years					
20–24	20	65	23.5	1	
25–29	34	75	31.2	1.47 (0.77–2.81)	0.239
30–34	24	54	30.8	1.44 (0.72–2.89)	0.299
35–39	16	38	29.6	1.37 (0.63–2.95)	0.424
≥40	20	54	27.0	1.20 (0.59–2.47)	0.612
Parity rate					
Nulliparous	12	48	20.0	1	
Parous	102	238	30.0	1.71 (0.87–3.36)	0.117
Education					
University	30	103	22.6	1	
High	32	96	25.0	1.14 (0.65–2.02)	0.643
Middle	48	84	36.4	1.96 (1.14–3.37)	0.014
Uneducated	4	3	57.1	4.58 (0.97–21.59)	0.055

decreased among subsequent age groups. An increased risk that is statistically insignificant has been associated with parity rate. A marked increase with advance educational level was noticed.

The association of *T. gondii* seropositivity with disease awareness and preventive practice is shown in Tables 2 and 3, respectively. Only 22.5% of the respondents have heard about the disease (Table 2). Lack of knowledge significantly increased the risk of infection (OR = 4.04, $p < 0.001$). Most of those who have heard about the disease knew the association of the infection with undercooked meat and recognize cats as a source of infection. Additionally, lack of knowledge about the risk of undercooked meat was associated with statistically significant high risk factor (OR = 3.76, $p < 0.001$). Very few of the respondents (8%) were aware of the risk of handling raw meat or tasting it during cooking. This unawareness was estimated as a high risk factor (OR = 2.98, $p = 0.045$). Of all participants, only 20% knew the association of *T. gondii* infection with soil and unwashed vegetables and fruits. The estimated risk of lacking this association was relatively high (OR = 1.77, $p = 0.062$). Only 10.5% of the respondents knew the risk of *T. gondii* on fetus.

Of all interviewees, 14.5% lived with cats (Table 3). However, living with cats indicated no threat of the infection (OR = 1.15, $p = 0.644$). Consumption of undercooked meat was reported by 57.5, 68.0, and 63.5% of sheep/goat, camel and chicken, respectively. However, only slightly higher insignificant risk was related to the consumption of undercooked sheep/goat rather than other meat types. No risk was associated with the 56% of the participants who mentioned that they do taste meat during cooking. Possible contact with soil in public parks and gardening was reported by 49.5% of the respondents and no increased risk of the infection was reported. Eating outside the home at restaurants was reported by 69.0% which was found to be related to a statistically significant higher risk of infection (OR = 2.69, $p < 0.001$). Travel history which indicated no risk factor of *T .gondii* infection was reported by 39.5% of the interviewees.

Discussion

We surveyed pregnant women in Dhahran, Saudi Arabia to determine their seropositivity, knowledge, and preventive practice regarding *T. gondii* infection. The overall positivity of IgG against *T. gondii* in the study population was 28.5%. Although it is generally assumed that approximately 25–30% of the world's human population is infected by Toxoplasma,[13] the actual prevalence varies widely between and within countries from 10–80%.[1] Low seroprevalence of 10–30% have been observed in North America, in South-East Asia, in northern Europe,

Table 2 Odds ratio (OR) and 95% CI of knowledge of risk factors associated with the infection with T. gondii in 400 pregnant women in Dhahran, Saudi Arabia

Risk factors		Positive	Negative	OR	95% CI	*p*-value
Have heard about toxoplasmosis	Yes	10	80	4.04	2.01–8.12	<0.001
	No	104	206			
Awareness of the risk with undercooked meat?	Yes	10	76	3.76	1.87–7.58	<0.001
	No	104	210			
Awareness of cats as a source of infection?	Yes	18	56	1.30	0.73–2.32	0.379
	No	96	230			
Knowledge on the risk of soil contact and unwashed vegetables and fruits	Yes	16	64	1.77	0.97–3.21	0.062
	No	98	222			
Knowledge on the risk of handling raw meat or taste during cooking	Yes	4	28	2.98	1.02–8.71	0.045
	No	110	258			
Knowledge on the effect of the disease on fetus?	Yes	12	30	1.00	0.49–2.02	0.991
	No	102	256			

Table 3 Odds ratio (OR) and 95% CI of various preventive practices associated with the infection with T. gondii in 400 pregnant women in Dhahran, Saudi Arabia

Risk factors		Positive	Negative	OR (95% CI)	*p*-value
Living with cat	Yes	18	40	1.15 (0.63–2.11)	0.644
	No	96	246		
Eaten undercooked meat (sheep/goat)	Yes	72	158	1.39 (0.89–2.17)	0.149
	No	42	128		
Eaten undercooked meat (camel)	Yes	78	194	1.03 (0.64–1.64)	0.909
	No	36	92		
Eaten undercooked chicken	Yes	70	184	0.88 (0.56–1.38)	0.582
	No	44	102		
Tasted meat during cooking	Yes	64	160	1.01 (0.65–1.56)	0.971
	No	50	126		
Had contact with soil through gardening, camping etc.	Yes	52	146	0.80 (0.52–1.24)	0.327
	No	62	140		
Eaten outside the home at restaurants frequently	Yes	94	182	2.69 (1.57–4.61)	>0.001
	No	20	104		
Travelled recently abroad	Yes	46	112	1.05 (0.67–1.64)	0.826
	No	68	174		

and in Sahelian countries of Africa.[14] Moderate prevalence of 30–50% has been found in countries of Central and Southern Europe, while high prevalence has been found Latin America and in tropical African countries.[14] The current study indicated a decrease in the seroprevalence of toxoplasmosis than the previous estimate of 39.4% in the same area among the similar target group during 2001.[15] The prevalence of *T. gondii* IgM antibodies of 3% indicated by the current study was also lower than previously estimated in the same area.[16] The decrease in positivity of IgM antibodies suggested a declined exposure to *T. gondii* from food or environmental sources.

Statistical analysis of the associations of age and seroprevalence indicated that seropositivity started at age of 20, increased between participants of 20 years through 34 years of age, then slightly decreased among the subsequent age groups. However, there was no significant difference between age group associations with seroprevalence.

It has been reported that more than 80% of the population of the lower socio-economic level were infected by the age of 15, whereas infection was acquired mostly after the age of 20 in the population of the upper socio-economic level.[14]

Seropositivity was also higher in those who were multigravida than those who were having their first pregnancy. Higher seroprevalence of *T. gondii* infection in women who had multiparity has been reported.[17,18] This may be an age associated, or less care of women with children.[17]

An increased risk of infections was related to lack of education (OR = 4.58). Education level has been reported among the most important socio-economic characteristics associated with toxoplasmosis risk.[19]

Generally, knowledge of toxoplasmosis was low. However, most of those who have heard about the disease knew the association of the infection with undercooked meat and recognize cats as a source of infection. Lack of knowledge of the disease was associated with statistically significant high risk factor. Only 20% of respondents were aware of the risk of soil contact and unwashed vegetables and fruits and *T. gondii* infection The estimated risk of lacking this factor was elevated, although not statistically significant.

Very few of the respondents were aware of the risk of handling raw meat or tasting it during cooking. This was estimated to be of significantly higher risk. Only 13.5% of the respondents knew the risk of toxoplasmosis on fetus.

Low level of knowledge about toxoplasmosis risk factors and prevention and consequences of infectious among pregnant women have been reported worldwide including the USA,[20,21] and Ireland.[22]

It has been shown that even brief education of pregnant women helps to improve some congenital toxoplasmosis in Canada.[22] Another study in Belgium indicated that health education led to a 63% reduction in *T. gondii* seroconversion.[23] Toxoplasmosis-related education of pregnant women increased their knowledge about the disease and prevention by twofolds in four years in Poland.[24] Suggestive evidence that health education may help reduce risk of congenital toxoplasmosis has been shown.[25] It is necessary to provide a formal education about toxoplasmosis risk factors to women of childbearing age. In addition, pregnant women must be well informed about the preventive measures of toxoplasmosis on their first prenatal visit. It has been demonstrated that a prenatal educational programme in toxoplasmosis prevention had a significant positive effect on self-reported cat hygiene behaviour of cat owners and in altering food hygiene behaviour.[22] Overall, although there are methodological limitations to the studies to date, there is suggestive evidence that health education may help reduce risk of congenital toxoplasmosis.

Statistical analysis of the association of seropositivity with preventive practice indicated that 14.5% of the interviewees lived with cats. However, living with cat indicated no threat of the infection. Previous studies found no association between contact with cats or cat litter and *T. gondii* seroconversion.[8,26,27] Keeping cats as pets in Saudi Arabia is not a common practice. However, stray cats are commonly seen which may represent a severe risk for toxoplasmosis and responsible for much of the environmental contamination with oocysts in water or soil. The prevalence of *T. gondii* in stray cats in Saudi Arabia was found to be 90%.[28]

Consumption of undercooked meat was reported by 75.5, 87.5, and 81% of sheep/goat, camel and chicken, respectively. There was no significant association with types of meat eaten and *T. gondii* seroprevalence. However, only slightly higher risk was related to the consumption of undercooked sheep/goat rather than camel or chicken meat. Seventy-two per cent of the participants mentioned that they do taste meat during cooking. The risk associated with the different types of meat varies among different countries according to local eating habits and according to the *T. gondii* prevalence in meat-producing animals. In a multicenter study in Europe, meat consumption was estimated to be responsible for 30–63% of infection.[8] In the USA, a case-control study showed an elevated risk for *T. gondii* infection in persons eating raw ground beef, rare lamb, locally produced cured, dried, or smoked meat or working with meat.[27] In Saudi Arabia, antibodies to *T. gondii* were found in 36.4, 35.3 and 23.6% of the sheep, goats and camels, respectively.[28]

Possible contact with soil in public parks and gardening was reported by 49.5% of the respondents. Contact with soil was identified as a strong risk factor in a European multicenter case-control study, and 6–17% of primary infections in humans were attributed to this risk factor.[8] Contaminated water and soil may act as vehicles for the transfer of oocysts to vegetables and fruit for human consumption. The eating of unwashed raw vegetables or fruits was associated with an increased risk of infection in previous studies.[11]

Eating outside the home at restaurants, reported by 69.0% of respondents, was found to be associated with a statistically significant higher risk of infection. Unlike the current findings, eating outside the home at restaurants has not been identified as a risk factor even when the number of meals consumed was taken into account.[1,7,14] Undercooked meat commonly served in restaurants includes fast food such as gyro, delis, burgers and other grills.

Travel history was reported by 39.5% of the interviewees which indicated no risk factor of toxoplasmosis. Frequent population movement is exists between countries of the Arabian Peninsula (Bahrain, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates and Yemen). *T. gondii* seroprevalence and population behaviour in Qatar has been shown to be of similar seroprevalence.[29]

It is also essential that preventive measures to reduce the risk of horizontal transmission of Toxoplasma to humans via tissue cysts include a high standard of kitchen hygiene.

It is noted that our study is clinic based and its results might not accurately represent the population in the area studied. Also, because Toxoplasma IgG seropositivity could represent a *T. gondii* previous exposure rather than active infection, participants may not give accurate risk factors applicable to the time they were infected which could have been years previously.

Conclusion

This study brought about a better understanding exposure to *T. gondii* infection in eastern Saudi Arabia and the relative importance of various risk factors, mainly lack of knowledge, that are essential to the development of a specific Toxoplasma control strategy. Health education, on avoidance of maternal infections, is an important aspect of any programme for prevention of congenital toxoplasmosis, although the efficiency of antenatal education in modifying the behaviour of pregnant women needs further evaluation.

Acknowledgements

We thank all staff of the Medical Laboratory and Obstetrics and Gynecology Departments of King Fahad Military Medical Complex.

Funding

This work was supported by Prince Sultan Military College of Health Sciences.

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Conflict of Interest

No conflict of interest to declare.

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