Toxoplasma gondii seroprevalence in women with bad obstetric history

Zainab Khalil Mohamed Aljumaili (1,2)
Abdulghani Mohamed Alsamarai (3,4)
Wesam Suhail Najem (5)

(1) Department of Microbiology, Tikrit University College of Medicine, Tikrit, Iraq
(2) Kirkuk Health Authority;
(3) Departments of Medicine and Microbiology, Tikrit University College of Medicine, Tikrit, Iraq
(4) Asthma, Allergy Centre, Tikrit Teaching Hospital, Tikrit, Iraq;
(5) Department of Dermatology, Tikrit University College of Medicine, Tikrit, Iraq.

Correspondence:
Prof. Abdulghani Alsamarai
Departments of Medicine and Microbiology
Tikrit University College of Medicine
Tikrit
Iraq
Email: galsamarrai@yahoo.com

ABSTRACT

Background: Toxoplasmosis is a well documented cause of bad obstetric history (BOH).

Objective: To determine the seropositivity of toxoplasmosis in women with bad obstetric history and factors that influence seroprevalence.

Study design: Case control descriptive study.

Patients and Methods: The study included 293 women with BOH and 245 women with normal pregnancy outcome. Serological study carried out to determine T.gondii IgG and IgM using ELISA kits.

Results: The overall seroprevalence rate of T. gondii IgG was 29%, with no significant difference between women with BOH (27%) and women with normal pregnancy (31.4%). However, there was a significant difference between pregnant (20.3%) and non pregnant (31.4%) women. The current T. gondii infection overall rate was 0.9%, with significantly higher rate in women with BOH (1.7%). Both T. gondii IgG and IgM were significantly varied with women's age. Odd ratio confirmed the association of T. gondii IgG and women's age, residence, and education.

Conclusion: The seropositivity of Toxoplasma was significantly influenced by age, residence, and education levels.

Key words: TORCH, BOH, Toxoplasma, Pregnancy, Iraq

Introduction

Primary infection with any of the TORCH agents during pregnancy can lead to adverse outcomes, which are initially inapparent or asymptomatic and thus difficult to diagnose on clinical grounds (1). The ultimate consequences of intrauterine infection can be any one of the following (2): no significant problem, asymptomatic chronic infection, spontaneous abortion, intrauterine fetal death, stillbirth or neonatal death, fetal malformation or neonatal infection.

Spontaneous abortion is a new issue in terms of its social and economic impact. Pregnancy loss has been attributed to several factors involved in human reproduction; genetic and uterine abnormalities, endocrine and immunological dysfunctions, environmental pollutants, psycho-genetic factors and endometriosis, infectious agents, are most important causes of spontaneous abortion (3). The rate of spontaneous abortion from foetal infection by the infectious agents like TORCH is believed to range from 10-15% (4).

Toxoplasma gondii is considered one of the most widespread parasites in the world causing abortion. It is a intracellular protozoan that infects humans and other warm-blooded animals (5). The organism is transmitted to humans by accidental ingestion of water, food, or soil contaminated with T. gondii oocysts or consumption of meat containing T. gondii cysts that is eaten raw or undercooked (6). This disease is clinically insignificant in immunocompetent adults. The immunologic response to primary infection is followed by encystment of the parasite (latent toxoplasmosis), providing life-long immunity. Possible reactivation of latent infection in an increasingly immunosuppressed population, however, makes toxoplasmosis an important opportunistic infection. In addition, toxoplasmosis has long been known as a major cause of perinatal morbidity. T. gondii infection in pregnant women can be transmitted to the fetus and cause mental retardation, blindness, epilepsy and death (7).

In Iraq [Baghdad], Abdulmohymen (8) reported that there was a significant difference ($p<0.05$), in the serum level of Toxoplasma gondii specific IgM among the three investigated patients groups (Recurrent spontaneous abortion, non-recurrent spontaneous abortion, and successful pregnancy). A similar result was obtained by Abbas (9), who showed that 21.5% of women with first abortion have positive only IgM. Al-Fertosi (1-) and Salman (11) showed 19.17% of women with single or repeated abortion. In addition, there is more than one T. gondii strain with difference in virulence among isolates in the nature (12). This strains' difference could be a potential explanation regarding the high prevalence of toxoplasmosis.

The relatively high frequency of toxoplasmosis in women with abortion as Abdulmohymen (8) reported could be due to the sample selection. Their samples were collected from Al-Kadhimyia Teaching Hospital which is a reference hospital for the surrounding rural areas where they have habits in favor of acquiring toxoplasmosis by eating unwashed raw vegetables or unpadded fruits. In addition, in the rural cities there is close contact with cats and consequent exposure to sporulated oocysts by ingestion of these oocysts that contaminate soil during gardening, or eating undercooked meat contaminated with cysts (8). Moreover, the low level of education in the women about the risk factors for toxoplasmosis may play an important role in the high rate of infection (13).

Furthermore, Abdulmohymen's (8) study showed a highly significant difference between the women group with recurrent spontaneous abortion and the women group with successful pregnancy in acute infection of T. gondii, but no significant difference in the mean value between recurrent spontaneous abortion and non recurrent spontaneous abortion (non-RSA) and non- RSA and those with successful pregnancy. It has been proposed that during pregnancy, systemic maternal immune response is biased in favor of Th2 cytokine (14,15). Moreover, Th2 cytokines pattern of pregnancy induces the susceptibility to toxoplasmosis infection, together with risk of placental infection and congenital transmission (16). Evidence from murine and human pregnancy showed that since Th1 type cytokine mediated pregnancy loss, a shift towards Th1-type immunity during T. gondii infection may help to explain pregnancy failure (17,18). Thus, a considerable amount of evidence suggests that Th1 cytokine might well be implicated in adversely affecting pregnancy, directly by interfering with trophoblast survival and function, and indirectly by activating cell-mediated immune effecters (19).

The aim of the present study is to provide a picture about frequency, distribution, risk and determinants of the seroprevalence of T. gondii infections during pregnancy and their association with high delivery risk factors.

Patients and Methods

Settings:

Kirkuk General Hospital, Primary Health Care Centers in Kirkuk Governorate.

Study Design:

The study design is a Descriptive Case Control Study.

Study area:

This descriptive case-control study was conducted at the antenatal clinic of Kirkuk General Hospital and Primary Health Care Centre in Tessean. Women (pregnant or non pregnant) with bad obstetric history were recruited from those attending outpatient Gynaecology Clinic Kirkuk General Hospital or the outpatient Clinic at Tessean PHC.

Study Population:

The study population is women of childbearing age. Study population was recruited from Primary Health Care Centers located in urban and rural areas in Kirkuk Governorates. In addition, one of the study population group was recruited from pregnant women who were in labor to select the group of pregnant women with risky outcomes.

Group 1: Pregnant women with age range of 17-45 years, and with normal pregnancy.

Group 2: Non pregnant women with age range of 17 - 45 years, and

with normal pregnancy.

Group 3: Pregnant women with Risk factor (BOH) depending on their previous pregnancy and /or delivery outcome which included pregnancy loss, intrauterine deaths, preterm deliveries and intrauterine growth retardation. Their age ranged from 17 t0 45 years.

Group 4: Non-pregnant women with Risk factor depending on their previous pregnancy and /or delivery outcome which included pregnancy loss, intrauterine deaths, preterm deliveries and intrauterine growth retardation. Their age ranged from 17 to 45 years.

The demographic information of these groups is shown in Table 1. The target number recruited for each group was 150 women. However, the total number of women included in the study was 538, of these 293 (54.5%) had BOH, and 245 (45.5%) had normal pregnancy history. In the BOH group, 144 (49.1%) women were pregnant, while in the normal pregnancy group, 117 (47.7%) were pregnant.

Collection of data

The designated investigators visited the outpatient department daily, selected the study subjects, and screened them using a predesigned pretested schedule considering the inclusion and exclusion criteria till the study subjects recruitment could be identified. The next available age-matched multiparous antenatal woman without BOH was included in the control group subjects.

Clinical examination and laboratory investigations were carried out for the study subjects to exclude other causes of foetal wastage, such as hypertension, diabetes mellitus, syphilis, Rh (rhesus) incompatibility, physical causes of abortion, and consanguinity. Subjects with known causes of foetal wastage were excluded from the study. All of them were interviewed to ascertain age, medical and obstetric information.

Sample Collection:

For serological analysis, 5-10 mL of venous blood was collected in a sterile container with strict aseptic precautions from each study subject. The serum was separated and stored in numbered aliquots at -20 oC till assayed. All the serum samples collected from the study and control groups were tested for HSV 2 IgM and IgG antibodies by commercially available (ELISA) kits. The results were read by a Microwell reader and compared in a parallel manner with controls; optical density was read at 450 nm on an ELISA reader.

Ethical approval

The ethical committee of the concerned institute approved the research protocol. The purpose and procedures of the study were explained to all the study subjects, and informed consent was obtained from them. The study design was approved by the ethical committee of TUCOM that is now registered in the USA [U.S. Department of Health and Human Services (HHS)& Registration of an Institutional Review Board (IRB)]. IORG #: IORG0006885. Institution: Tikrit University College of Medicine [TUCOM] OMB No. 0990-0279

Methods:

ELISA was used for determination of IgM and IgG for HSV-2 and the test was performed according to manufacturer instructions. The kit was purchased from BioCheck, Inc, 323 Vintage Park Dr, Foster City, CA 94404.

Analysis of data

Collected data were compiled in Microsoft Excel spreadsheet. The proportion and the mean value were computed in appropriate situations. To find out any association between categorical data, Chi square test was employed using the SPSS (Version 16). If the sample size in BOH group did not reach the targeted number, Power Analysis was performed to determine the accuracy of findings.

The study finding data are presented as frequency ± SD and 95% Confidence Interval. Bivariate Regression Line Analysis calculated Odd Ratio for determination of association between the two variables. The determinants for T.gondii infection was determined by calculation of Odd Ratio using Logistic Regression Line Analysis. Confounding factors such as age, socio-economic status, etc. were standardized when serological determinants were calculated.

Table 1: Study population

Group		Number	Mean age ± SD in years
Women with bad obstetric history	Pregnant	144	27.38 ±7.5
	Non pregnant	149	28.56 ± 6.7
	Total	293	27.97 ± 7.1
Women with normal pregnancy	Pregnant	117	26.00 ± 6.2
	Non pregnant	128	30.16 ± 10.9
	Total	245	28.16 ± 9.2
Grand total		538	28.06 ± 8.1
P value	ANOVA	NS	

Results

The overall seroprevalence rate of T. gondii IgG was 29%, with no significant difference (X2=1.293) between women with BOH (27%) and women with normal pregnancy (31.4%) (Table 2). However, there was a significant difference (X2=18.59,P=0.000) between pregnant (20.3%) and non pregnant (31.4%) women (Table 3). The current T. gondii infection overall rate was 0.9%, with significantly (X2 =4.22, P=0.04) higher rate in women with BOH (1.7%).

Table 2: Toxoplasma seroprevalence in women with bad obstetric history

Group [Number]		Number positive [Percent]	
		IgM	IgG
Bad obstetric history	Pregnant [144]	4 [2.8]	40 [27.8]
	Non- pregnant [149]	1 [0.7]	39 [26.2]
	X^2	1.937	0.096
	P value	NS	NS
	Total [293]	5 [1.7]	79 [27]
Normal pregnancy	Pregnant [117]	0 [0]	13 [11.1]
	Non- pregnant [128]	0 [0]	64 [50]
	X^2	-	42.89
	P value	-	**0.000**
	Total [245]	0 [0]	77 [31.4]
Grand total [538]		5 [0.9]	156 [29]
X^2 BOH versus Normal Pregnancy		4.22	1.293
P value BOH versus Normal Pregnancy		**0.04**	NS

Table 3: Toxoplasma seroprevalence in pregnant compared to non-pregnant women

Group [Number]	Number positive [Percent]	
	IgM	IgG
Pregnant [261]	4 [1.5]	53 [20.3]
Non- pregnant [277]	1 [0.4]	103 [37.2]
X^2	2.003	18.59
P value	NS	**0.000**

Both T. gondii IgG and IgM were significantly varied with women's age (IgG, X2 =54.4, P=0.000; IgM, X2=6.36, P=0.01). Current T.gondii infection was detected in the age group of 20 to 29 (2.1%) years only. T. gondii IgG seroprevalence was 31.1% in women with age of 15-19 years, then declined to reach 17.2% in women with age of 20-29 years. However, IgG seroprevalence increased in women aged 30 and above to the plateau of 66.7% in age group of 40 - 48 years (Table 4). Odd ratio confirmed the association of T, gondii IgG and women age of lower or upper than 30 years (OR=2.66,P<0.0001). Although, T.gondii IgM demonstrated high OR, it did not give significant confirmation of the association and this was due to the small number included in the analysis (Table 5).

Table 4: Frequency of T. gondii in regard to age

Age group in years	Number	T. gondii Number [%]	
		IgM	IgG
15 – 19	74	0 [0]	23 [31.1]
20-29	238	5 [2.1]	41 [17.2]
30-39	172	0 [0]	56 [32.6]
40 -48	54	0 [0]	36 [66.7]
Chi Square		6.36	54.4
P value		**0.01**	**0.000**

Table 5: Odd ratio of T. gondii in regards to age of women lower than 30 years

Variable	Odd ratio [95% Confidence interval]	P value
T. gondii IgM	8.1024 [0.4457-147.2835]	NS
T. gondii IgG	2.66 [1.8157 – 3.8982	<0.0001

T.gondii IgG seroprevalence was significantly higher (X2=7.439, P=0.006) in women living in urban areas (32.2%) as compared to women lining in rural (20%) areas. However, current infection was significantly (X2=7.638, P=0.006) predominant (about 10 times) in rural areas (2.9%) than in urban (0.3%) areas (Table 6). OR confirmed the association between residence and both T.gondii IgM (OR=11.6765,P=0.02) and IgG (OR=1.896, P=0.006) (Table 7 - next page).

Table 6: Frequency of HSV 2 IgG and IgM in regard to sociodemographic characteristics

Variable	[Number]	Number positive [Percent]	
		IgM	IgG
Residence	Rural [140]	4 [2.9]	28 [20]
	Urban [398]	1 [0.3]	128 [32.2]
	X^2	7.638	7.439
	P value	**0.006**	**0.006**
Occupation	House wife [497]	5 [1]	149 [30]
	Working [41]	0 [0]	7 [17.1]
	X^2	0.416	3.065
	P value	NS	NS
Education	Uneducated [34]	0 [0]	11 [32.4]
	Primary [331]	1 [0.3]	109 [32.9]
	Secondary [105]	4 [3.8]	26 [24.8]
	College & above [68]	0 [0]	10 [14.7]
	X^2	11.83	12.53
	P value	**0.019**	**0.014**
Crowding Index	≤ 3 [478]	5 [1.04]	141 [29.5]
	3.1 – 8 [60]	0 [0]	15 [25]
	X^2	0.634	0.524
	P value	NS	NS

T.gondii IgG seroprevalence was higher (about double) in housewives (30%) as compared to working women (17.1%), but the difference not reach a significant level. In addition, all the current T. gondii infections were in housewives. Furthermore, OR did not confirm the association between occupation and both IgG and IgM seropositivity (Tables 6 & 7).

About 96% of women who participated in this study were educated and only 4.1% were uneducated. Relationship between infection with T.gondii and education was significant (P=0.014), also current infection had a significant association with education (P=0.019). OR confirmed T.gondii seropositivity and education for remote (IgG), but not current infection (IgM) (Tables 6 & 7).

T.gondii IgG and IgM seroprevalence was higher in small size families (<3 crowding index). However, OR did not confirm an association between T.gondii infection and family size in women included in our study population (Tables 6 and 7).

Table 7: Association of HSV 2 seropositivity with sociodemographic characteristics using Bivariate analysis.

Variable			Odd ratio [95% Confidence interval]	P value
Occupation [Housewife versus Employed]	IgM		0.9296 [0.0504-17.0558]	NS
	IgG		2.2020 [0.9582-5.0603]	0.06
Crowding Index [< 3 versus >3]	IgM		1.4055 [0.0768-25.7347]	NS
	IgG		1.2552 [0.6776-2.3253]	NS
Education	Uneducated	IgG	2.7740 [1.038-7.415]	**0.04**
	Primary		2.8477 [1.401-5.787]	**0.003**
	Secondary		1.9089 [0.8541-4.2662]	NS
	College & above		2.7739 [1.0378-7.4146]	**0.04**
	Uneducated vs. Educated	IgM	2.9353 [0.3433-26.641]	NS
Residence [Rural versus Urban]	IgM		11.6765 [1.2938 – 105.3785]	**0.02**
	IgG		1.896 [1.1818-3.0174]	**0.006**

Discussion

The result of TORCH testing suggests that 29% of women of 15-48 years in age in Kirkuk , Iraq were seropositive for T. gondii. Thus 71% of studied population were susceptible to infection with Toxoplasmosis. Pregnant women should take appropriate precautions to protect themselves against infections. Such precautions include cooking meat, handling raw meat or working in soil ; and avoiding contact with cat faeces (20).

The result of this study and that reported by others (21,22), based on serological tests, confirmed expectation that Toxoplasmosis is indeed endemic in Kirkuk and that a substantial proportion of the examined patients' sera showed evidence of earlier infection (IgG), whilst fewer had evidence of current infection (IgM). The prevalence and risk factor for transmission of T. gondii varies substantially between countries and geographical regions (23). In this study Toxoplasma gondii IgG antibodies were found to be 32 times more common than IgM antibodies (29% versus 0.9% in the study group). Clearly the overall prevalence of IgG antibodies, reflecting earlier infection with Toxoplasma gondii among the tested samples from the study population indicated that between 1 in 3 and 1 in 4 had experienced earlier infection and these values are broadening in line with reports from other countries (23,24). However, changes of prevalence of IgG seropositivity across the age groups revealed a more complex story. In 82.8% of woman with age group of 20- 29 years (44.2% of study population) were negative for Toxoplasma gondii IgG and these 4/5ths were susceptible for Toxoplasma gondii infection during their pregnancy.

However, the Toxoplasma gondii IgG seropositivity was higher in the 15-19 years age group. This could be attributed to less meat consumption and catabolism of passively transferred antibodies; prevalence then increased markedly with each successive age class as reported previously in other studies (25-31), peaking in the older subjects at over 66%. This rising trend with age, reflects the constituting risk of infection throughout adult life and arises from cumulative infection . However studies reported for Iraq indicated that Toxoplasma gondii IgG seroprevalence reduced with age (32-36). Risk of exposure and infection with age in an environment where transmission is encouraged by the high density of feral cats (23).

Interestingly the age related trend in prevalence of IgG antibodies in the combined study group (A=all tested samples), was also seen in each of the groups (BOH pregnant, BOH not pregnant, normal pregnancy and normal non pregnancy) representing their subdivision in regard to bad obstetric history). The overall Toxoplasma gondii IgG seroprevalence (29%) in woman from Kirkuk governorate was similar to reported studies from Egypt (37-42), Morocco (43,44), Saudi Arabia (45,46), Iraq (29,21,22,36,38,47-54), Libya (55,56), Tunisia

(57). Although our finding for IgG seropositivity was higher than that reported for Iraq (8,28,58,59,60), Bahrain (61) and Palestine (62). These studies performed in Arab countries indicated that seroprevalence of T. gondii varies substantially between geographical regions, and the variation demonstrated between the studies performed in Iraq.

In Kirkuk, 3 studies were reported. Ali (21) reported seroprevalence of 61 % in 100 pregnant woman where Kader et al (22) reported a seroprevalence of 36.6% in 319 pregnant woman and 52% in 121 aborted woman, giving an overall seroprevalence of 44.3%. In addition, Salman (60) reported a very low (4.84 %) seroprevalence of IgG in 184 woman with bad obstetric history. The present study finding indicated that overall seroprevalence was lower than that reported by Ali (21) and Kadir et al (22), but higher than that reported by Salman (60). Furthermore the global T. gondii IgG seroprevalence in pregnant woman was from 0.48 in Brazil (90 %) to (83 .5%)

in Madagascar (63), while the range in woman with BOH was from 19.44 % reported by Natu et al (64) to 55.2% in Nepal (65). The above information collected together indicated that there was a worldwide variability in the prevalence rate of Toxoplasma gondii seropositivity among pregnant and non pregnant woman. The relationship between education and Toxoplasma infection was recorded in this study, thus women who cannot read and write and with primary school level were more infected than educated woman (32.4 % and 32.9 % respectively), with a highly significant difference between the education level groups. In the United States the risk of Toxoplasmosis is associated with low level of education (66). The T. gondii IgG seroprevalence significantly varies (P= 0.014) with the education level. In addition, the OR confirm that uneducated women and those with primary education have a chance to be detected three times more than women with secondary education and above.

Although , 94 % of educated but uneducated woman still are more prone to infection by Toxoplasma gondii . This might be due to fact that uneducated women were of ideal health condition or may not be caring about that. However, uneducated woman may be less likely to wash boards with soap or bleach after cutting raw meat or using the same knife for salad preparation. The present study finding was in agreement with that reported for Basrah (28), Tikrit (36) and Sudan (67), while none of the 9 studies performed in Iraq reported any information on such variables (26,29,30,32,33,34,35,43,68). From the present study, it was speculated that high education linked with good hygiene sanitary practices reduce the transmission of the parasite. This finding confirmed using both Logistic regression and Bivariate analysis, as it indicated that higher education was protective against infection (X2= 0.614 , P = 0.000).

The present study indicated that T. gondii infection was more predominant in housewives (30 %) compared to employed (17.1 %). Thus occupation plays a key role in the transmission of the disease when occupation is related to direct contact with meat, soil and animals. The majority of women (92.2%) in this study were housewives and few of them are working in jobs not related to soil or meat but (?) mostly they are house wives. The predominance of infection in housewives as this study indicated was in agreement to that reported for Kirkuk (22,60), Almothana (69), Al-Najaf (30), and Tikrit (36). However, prevalence rate was much higher than that reported by Salman (3.49 %)(60) for Kirkuk in 2007, while it was about similar to that reported by Kadir (22) for Kirkuk in 2011. Another two studies performed in Iraq , for Najaf (68) and Basrah (34) reported lower predominance rate of Toxoplasma gondii infection. One study reported for Basrah, Iraq (28), did not find a relationship between Toxoplasma gondii infection and occupation. Although the prevalence rate for Toxoplasma gondii infection was higher in housewives but the OR did not confirm the responsibility of such occupation as bivariate as logistic regression analysis demonstrated.

The present study has revealed that the prevalence rate of Toxoplasmosis varies remarkably in relation to residence and it was significantly more predominant in urban areas (32.2 %) than that for rural (20 %) areas. The OR confirmed that women living in urban areas have more of a chance to be infected than those living in rural areas. This finding was in agreement to that reported in Iraq, for Najaf (30), Karbala (33), and Tikrit (36). However, other studies in Iraq reported that prevalence rate was more in rural areas, in AL-Anbar (29), Diyala (32), Tikrit (35) and Kirkuk (22). All the studies reported that high prevalence in rural areas presented their data as frequency and did not perform any statistical test to determine the association. In addition, the study population size of most of the studies (except 22) was smaller than ours, which may influence their findings. Globally, seroprevalence estimates from human population vary greatly among different countries, among different geographical areas within one country, and among different ethnic groups living in the same area (70).

Toxoplasma gondii IgG seroprevalence was higher in families with crowding index of less than 3 (29.5 %). However, OR did not confirm a significant association between family size and Toxoplasma IgG seroprevalence. The presence of IgM antibody in 5 women suggests that 0.9% active infection may be present in the studied population. Four of them are pregnant and thus IgG avidity testing is the preferred method to confirm the recent infection (71), because IgM antibodies can persist for months after initial infection in some individuals (72,73). Alternate testing algorithms use higher IgM serologic titers as good indicators of acute infection; economic considerations prompt additional tests (74,75).

T. gondii IgM seroprevalence in high risk women declined from 1.05 % in the previous 3 years (Retrospective study) to 0.9 % in our prospective study (15 % decline), but this was not the case for IgG seroprevalence. The latter is a measure of individuals infected months or years earlier; therefore, it is unlikely we would detect a decline until incidence decreases significantly for 5 to 10 years. Declining of IgM seroprevalence suggests that knowledge about how to prevent T. gondii infection may have improved, the prevalence of T. gondii cysts in food animals in the region are declining , or the feral cat control is reducing the quality of oocysts entering the environment. The association of T. gondii with abortion, does

act as an impact on society to increase the awareness towards prevention of infection. There is one problem that emerged recently which may affect T. gondii in Iraq, which is the prevalence of T. gondii in meat, most likely sheep and goats, imported into Iraq for human consumption is unknown.

Reports from other countries in the region since 2001 found T. gondii prevalence of 23 % to 25 % in sheep (76-82), suggesting that lamb, if it is under cooked, could be a source of T. gondii infection. Since there is no well designed feral cat control program, thus infected cats may be responsible for parasite spread. T. gondii seroprevalence was significantly higher in non-pregnant (37 %) women as compared to pregnant women (20.3 %). This finding is in agreement with that reported by others (21) for Kirkuk.

In conclusion, the seropositivity of Toxoplasma was significantly influenced by age, residence, and education levels.

References

1. Turbadkar D, Mathur M, Rele M: Seroprevalence of TORCH infection in bad obstetric history. Indian J Med Microbiol 2003;21:108-11, 2003.

2. Johnson P, Barnes R, Hart C, Francis W: Determinants of immunological responsiveness in recurrent spontaneous abortion. Transpl,1994; 38(3):280-4.

3. Denoj S, Zuhara K. F, Sekaran K. Influence of TORCH infections in first trimester miscarriage in the Malabar region of Kerala. African Journal of Microbiology Research 2008;2: 56-59.

4. Shashi C, Usha A, Aruna A. Prevalence of IgM Anti-bodies to Toxoplasma, Rubella and Cytomegalovirus Infections During Pregnancy. J K Science 2004;6:190-192

5. Ippokratis M, Maria D, Maria K, Stavros S, Maria A. Prevalent Geno-types of Toxoplasma gondii in Pregnant Women and Patients from Crete and Cyprus. Am Soci Trop Med Hygi 2008;79: 205-209

6. Fernando R, Jessica LT, Alejandro A, Carlos V, José VA, Gloria TA, Adriana M, et al. Prevalence of Infection with Toxoplasma gondii among Pregnant Women in Cali, Colombia, South America. Am Soci Trop Med Hygi 2008;78: 504-508

7. Jumaian N.F. Seroprevalence and risk factors for Toxoplasma infection in pregnant women in Jordan. Eastern Mediterranean Health Journal: 2005;11:45-51.

8. Abdul Mohymen N, Hussien A, Hassan FK. Association between TORCH agents and recurrent spontaneous abortion. Iraqi J Med Sci 2009;7:40-46

9. Abbas M M. Seroepidemiological study on toxoplasmosis among women with history of abortion. M.Sc. thesis. College of Medicine, Al-Nahrain University. 2002.

10. Al-Fertosi R B. Possible cellular expression of IFN-? and IFN-? R1 (CD119) in aborted women infected with Toxoplasma gondii. M. Sc. Thesis, Coll. Med., Univ. AL-Nahrain. 2006.

11. Salman LS, Juma SMA. Correlation between Apoptosis and Toxoplasma in Abortion Induction: Relevance of TUNEL Assay. Euro J Sci Res 2009;37:406-425.

12. Bhopale G M. Review, pathogenesis of toxoplasmosis. Comp Immunol Microbiol Infect Dis. 2003; 26: 213-222.

13. Nash J Q, Chissel S, Jones J, Warburton F and Verlander N Q. Risk factors for

toxoplasmosis in pregnant women in Kent, United Kingdom. Epidemiol Infect. 2005; 133: 475-483.

14.Wegmann T G, Lin H, Guilbert L and Mosmann T R. Bidirectional cytokine

interactions in the maternal-fetal relationship :is successful pregnancy a Th2 phenomenon? Immunol Today.1993; 14:353-356.

15. Marzi M, Vigano A, Tabattoni D, Villa M L, Salvaggio A, et al. Characterization of type 1 and type 2 cytokine profile in physiologic and pathologic human pregnancy. Clin Exp Immunol.1996; 106: 127-133.

16. Shirahata T, Muroyo N, Ohta C, Goto H and Nakane A. Correlation between increased susceptibility to primary T.gondii infection and depressed production of gamma interferon in pregnant mice. Microbiol Immunol. 1992; 36:81-91.

17. Roberts C W, Walker W and Alexander J. Sex-associated hormones and immunity to protozoan parasites. Clin Microbiol Rev. 2001;14: 476-488.

18. Denkers E Y and Gazzinelli R T. Regulation and function of T-cell-mediated

immunity during T.gondii infection. Clin Microbiol Rev. 1998; 11: 569-588.

19. Raghupathy R, Makhseed M, Azizieh F, Omu A, Gupta M and Farhat B. Cytokine production by maternal lymphocytes during normal human pregnancy and in unexplained recurrent spontaneous abortion. Hum Reprod. 2000; 15: 3: 713-718.

20.Frenkel JK, Dubey JP. Toxoplasmosis and its prevention in cats and man. J Infect Dis 1972; 126;(6.);664-73.

21. Ali AA. Epidemiological study of Toxoplasma gondii in Al-Tameem government. 2006

22. Kadir MA, Ghalib AK, Othman NF, Ahmed IS. Seroprevalence of Toxoplasma gondii among pregnant women in Kirkuk, Iraq. J Kir Univ- Sci Studies 2011;6:1-11.

23. Abu Madi MA, Al-Molawi N, Behnke JM. Seroprevalence and epidemiological correlations of T.gondii infections among patients referred for hospital based serological testing in Doha, Qatar. Parasit Vectors 2008;1:39.

24. Petersen E. Toxoplasmosis. Seminar in Fetal & Neonatal Medicine 2007;12:214-233.

25. Abu-Madi MA, Behnke JM, Dabritz HA: Toxoplasma gondii seropositivity and co-infection with TORCH pathogens in high-risk patients from Qatar. Am J Trop Med Hyg 2010; 82;(4.);626-33.

26. Al-Ani RT. Study of Toxoplasma infection in women recurrent abortion in First trimester of pregnancy by Indirect immunofluorescent antibody test (IFAT). Diyala J Pure Sci 2012;8:24-34.

27. Al-Seadawy MAH. Prevalence of Toxoplasmosis in pregnant women in Al Muthana province / Iraq. Kufa J Vet Med Sci 2010;1:166-173.

28. Al-Hamdani, M.M. and Mahdi, N.K.(1997). Toxoplasmosis among women with habitual abortion. Eastern Mediterranean Health j., 3(2): 310-315.

29. Almishhadani JI, Aljanabi AU. Toxoplasmosis and Cytomegalovirus Infection among Aborted Women in Al-Anbar Governorate. 2008;6:18-26.

30. Alkalabi R. Seroepidemiological study among different groups of population in Al Najaf city. M Sc Thesis, College of Medicine, Kufa University, 2008.

31. Avelino MM, Campos Jr. D, Parada JCB, and Castro AM. Risk Factors for Toxoplasma gondii Infection in Women of Childbearing Age. Braz J Infect Dis, 2004; 8: 164-174.

32. Khudair MK. Evaluation of infection with Toxoplasmosis for pregnant women

in Diyala province. Diyala J Pure Sci 2012;8:1-8.

33. Hasan SF. Seroprevalence toxoplasmosis among comers to marriage in Kerbala governorate. Kerb J Pharm Sci 2011;2:97-102.

34 . Yousif JJ, Hussein ZA, Naser KM. The detection of Toxoplasmosis infection among married women in Al-Abbasiya -Najaf region. J Kufa Univ Biol Sci 2010;2:2-7.

35 . ADdory AZR. Seroepidemiological study of toxoplasmosis among pregnant women in Salah Adeen governorate. Tik Med J 2011;17:64-73.

36. Rashid KN. Seroepidemiological study of Toxoplasma gondii antibody among women in Tikrit city. Tikrit Journal of Pharmaceutical Sciences 2007, 3:86 - 90

37 Deorari AK, Broor S, Maitreyi RS, Agarwal D, Kumar H, Paul VK, et al., 2000. Incidence, clinical spectrum, and outcome of intrauterine infections in neonates. J Trop Pediat 2000; 46(3): 155-159.

38. Ibrahim HM, Huang P, Salem TA, Talaat RM, Nasr MI, Xuan X, Nishikawa Y. Short Report: Prevalence of Neospora caninum and Toxoplasma gondii Antibodies in Northern Egypt. Am. J. Trop. Med. Hyg.2009;80(2):263-267

39. Sen MR, Shukla BN, Tuhina B. Prevalence of serum antibodies to TORCH infection in and around Varanasi, Northern India. JCDR 2012;6:1483-1485.

40. Hussein AH, Ali AE, Saleh MH, Nagaty IM, Rezk AY. Prevalence of Toxoplasma infection in Qualyobia governorate. J Egypt Soc Parasitol 2001;31:355-363.

41. El-Deeb HK, Sala-Eldin H, Khodeer S, Allah AA. Prevalence of Toxoplasma gondii in antenatal population in Menoufia governorate, Egypt. Acta Trop 2012;124:185-191.

42. El-Ridi AM, Nada SM, Aly AS, Ramadan ME and Hagar EG .Toxoplasmosis and pregnancy: An analytical study in Zagazic, Egypt. J Egypt Soc Parasitol, (1991) ; 21(1): 81-85.

43.El Mansouri B, Rhajaoui M, Sebti F, Amarir F, Laboudi M, Bchitou R, et al. Seroprevalence of toxoplasmosis in pregnant women in Rabat, Morocco. Bull Soc Pathol Exot. 2007;100:289-290.

44. Barkat A, Kabiri M, Tligui H, Lamdouar Bouazzaoui N. Seroprevalence of toxoplasmosis in Morocco. Poster 976. Pediatric Research 2010; 68:486-487.

45. Mohammad HI, Amin TT, Balaha MH, Moghannum MS. Toxoplasmosis among the pregnant women attending a Saudi maternity hospital: seroprevalence and risk factors. AnnTrop Medi Parasitol 2010;104:493-504.

46. Al-Qahtani J, Hassan MM. Incidence of toxoplasmosis gondii in Najran region, KSA. J Egypt Soc Parasitol 2012;42:253-260.

47. Jasim M, Majeed HA, Ali AI. Performance of Serological Diagnosis of TORCH Agents in Aborted versus non aborted Women of Waset province in Iraq. Tikrit Medical Journal 2011; 17(2): 141-147

48 . Hutto C, Arvin A, Jacobs R, Steele R, Stagno S, Lyrene R, et al.. Intrauterine herpes simplex virus infections. J Pediat 1987; 110(1): 97-101.

49. Aziz FM, Drueish MJ. Toxoplasmosis: serious disease during pregnancy. Baghdad Sci J 2011;8:91-95.

50. Al-Sodany AK, Salih TH. The prevalence of toxoplasmosis among women. Basrah J Vet Res 2007;6:75-80.

51. Alsaeed MS, Muhsen MA, Al-Juburi GJ. Study the role of Toxoplasma gondii, Cytomegalovirus and anti-phospholipids antibodies in cases of abortion among women in Hilla city. Q Med J 2008;4:1-8.

52. Al-Marzoqi AHM, Kadhim RA, Aljanabi DKF, Hussein HJ, Al Tae ZM.

Seroprevalence study of IgG and IgM Antibodies to Toxoplasma, Rubella, Cytomegalovirus, Chlamydia trachomatis and Herpes simplex II in Pregnancy women in Babylon Province. Journal of Biology, Agriculture and Healthcare 2012;2:159-164.

53. Mossa HAL. Toxoplasmosis in Iraqi women: a retrospective study. Karbala J Med 2009;2:697-701.

54. Al-Shimmery MN, Al-Hilaly HA, Al-khafaji AA. Seroprevalence of cytomegalovirus and toxoplasmosis in cases of miscarriages women in Al-Diwaniyah province. Al-Qadysia Med J 2011;7:160-168.

55 Mousa DA, Mohammad MA, Toboli AB. Toxoplasma gondii infection in pregnant women with previous adverse pregnancy outcomes. Medical Journal of Islamic World Academy of Sciences 2011;19: 95-102.

56. Gashout A, Lazreg T, Gashut H, Swedan T. Qualitative assessment of risk for spontaneous abortion associated with toxoplasma and rubella: immunity appraisal. Libyan J Infect Dis 2008;2:52-56.

57. Al-Nahari AM, Altamimi AHS. Seroprevalence of Anti Toxoplasma gondii IgG and IgM Among Pregnant Women in Sana'a Capital and Capital Trusteeship. Scientific Journal of King Faisal University (Basic and applied Sciences) 2010;11:179-188.

58. Alkhafaji AH, Mohsen KI. Seroprevalence of toxoplasmosis among women with habitual abortion in Thi Qar governorate using ELISA test. J Thi-Qar Sci 2009;1:1-8.

59. Hadi NJ. Prevalence of Antibodies to Cytomegalovirus, Rubella Virus and Toxoplasma gondii among aborted women in Thiqar province. J Educ Coll 2011;1:3-9.

60. Salman YG. Serological Cross Reaction among Some Causative Agents of Women Abortions (Toxoplasma gondii & Cytomegalovirus & Rubella Virus), with the Incidence of

Hepatitis Virus (B &C). Tik J Pharm Sci 2007;3:102-111.

61. Tabbara KS, Saleh F. Serodiagnosis of toxoplasmosis in Bahrain. Saudi Med J 2005;26:1383-1387.

62. Al-Hindi AI, Lubbad MH. Seroprevalence of toxoplasmosis among Palestinian aborted women in Gaza. Ann Alquds Med 2009;5:39-47.

63.Lelong B, Rahelimino B, Candolfi E, Ravelojaona BJ, Villard O, Rasamindrakotroka AJ, et al. Prevalence of toxoplasmosis in a population of pregnant women in Antananarivo (Madagascar). Bull Soc Pathol Exot. 1995;88:46-49.

64.Abdi J, Shojaee S, Mirzaee A, Keshavarz H. Seroprevalence of toxoplasmosis in pregnant women in Ilam province, Iran. IJP. 2008;3:34-37.

65. Rai SK, Shibata H, Sumi K, Rai G, Rai N, Manandhar R, et al. Toxoplasma antibody prevalence in Nepalese pregnant women and women with bad obstetric history. Southeast Asian J Trop Med Public Health. 1998;29:739-743.

66. Jones JL, Kruszon-Moran D, Wilson M, McQuillan G, Navin T, et al. Toxoplasma gondii in the plasma : seroprevalence and risk factors. Am J Epidemiol 2001;154:357-365.

67. Mohamad K, Kodym P, Maly M, Elrayah I. Assessment of Screening Tests Used to Detect Toxoplasma gondii in Women in Sudan. J Med Diagnost Meth 2012; 1:102. doi:10.4172/2168-9784.1000102

68. Salih HA. Prevalence of toxoplasmosis among pregnant women in Najaf city. Kufa J Vet Med Sci 2010;1:101-108.

69. Al-Qahtani J, Hassan MM. Incidence of toxoplasmosis gondii in Najran region, KSA. J Egypt Soc Parasitol 2012;42:253-260.

70. Tenter AM, Heckeroth AR, Weiss LM. Toxoplasma gondii : from animals to humans. Int J Parasitol 2000;30:1217-1258.

71. Sickinger E, Gay-Andrieu F, Jonas G, Schultess J, Stieler M, Smith D, Hausmann M, Stricker R, Stricker R, Dhein J, Braun HB. Performance characteristics of the new ARCHITECT Toxo IgG and Toxo IgG avidity assays. Diagn Microbiol Infect Dis 2008;62: 235 - 244 .

72. Gras L, Gilbert RE, Wallon M, Peyron F, Cortina-Borja M. Duration of the IgM response in women acquiring Toxoplasma gondii during pregnancy: implications for clinical practice and cross-sectional incidence studies . Epidemiol Infect 2004;132: 541- 548.

73 Bobic B, Djurkoviv-Djakovic O. High levels of IgM antibodies specific to Toxoplasma gondii in pregnancy 12 years after primary Toxoplasma infection. Gynecol Obstet Invest 1991;31: 182- 184.

74 Leite M, Sciciliano S, Rocha LS, Justa MT, César KR, Granato CF. Correlation between specific IgM levels and percentage IgG-class antibody avidity to Toxoplasma gondii . Rev Inst Med Trop Sao Paulo 2008;50: 237 - 242 .

75 De Paschale M, Agrappi C, Belvisi L, Cagnin D, Cerulli T, Clerici P, Mirri P, Manco MT, Cavallari S Viganò EF. Revision of the positive predictive value of IgM anti- Toxoplasma antibodies as an index of recent infection New Microbiol 2008;31: 105 - 111 .

76. Ghazaei C. Serological survey of antibodies to Toxoplasma gondii. Afr J Health Sci 2006;13: 131 - 134 .

77. el-Moukdad AR. Serological studies on prevalence of Toxoplasma gondii in Awassi sheep in Syria [German]. Berl Munch Tierarztl Wochenschr 2002;115: 186 - 188 .

78. Bonyadian M, Hematzade F, Manuchehri K. Seroprevalence of antibodies to Toxoplasma gondii in sheep in the center of Iran . Pak J Biol Sci 2007;10: 3228 - 3230 .

79. Sanad MM, Al-Ghabban AJ. Serological survey on toxoplasmosis among slaughtered sheep and goats in Tabouk, Saudi Arabia. J Egypt Soc Parasitol 2007; 37: 329 - 340 .

80. Sharif M, Gholami S, Ziaei H, Daryani A, Laktarashi B, Ziapour SP, Rafiei A, Vahedi M. Seroprevalence of Toxoplasma gondii in cattle, sheep and goats slaughtered for food in Mazandaran province, Iran, during 2005. Vet J 2007;174: 422 - 424 .

81. Zia-Ali N, Fazaeli A, Khoramizadeh M, Ajzenberg D, Dardé M, Keshavarz-Valian H. Isolation and molecular characteristics of Toxoplasma gondii strains from different hosts in Iran . Parasitol Res 2007;101: 111 - 115 .

82. Acici M, Babuir C, Kilic S, Hokelek M, Kurt M. Prevalence of antibodies to Toxoplasma gondii infection in humans and domestic animals in Samsun province, Turkey. Trop Anim Health Prod 2008;40: 311 - 315