



Prevalence of *Toxoplasma gondii* infection in pregnant women those reviewing gynecological centers in Nineveh Governorate

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ABSTRACT

Toxoplasma gondii is a parasite capable of infecting various tissues in many mammals and birds and causes toxoplasmosis. Infection occurs through the consumption of raw or undercooked meat or through contact with infected cats, which are its definitive host. With the spread of the phenomenon of raising domestic cats at home in Iraq in general and in the city of Mosul in particular, interest has arisen in studying the harm this parasite causes to humans, especially women, through its effect on fetuses during pregnancy.

This study was conducted to determine the prevalence of *T. gondii* infections among pregnant women in Nineveh Governorate, particularly among those who had experienced miscarriages.

This study used an ELISA test to detect *T. gondii* antibodies (IgG and IgM). The results showed that the overall infection percentage was 34% of the 200 samples examined, indicating the presence of acute and chronic infections with the parasite.

No significant differences observed between infection rates and some of the epidemiological factors studied, such as age groups, number of pregnancies, number of miscarriages, and pregnancy stage. The highest infection rate was recorded in the 35-39 age group, during the first trimester of pregnancy, and among women having their first or second pregnancy. The study showed that environmental and social factors and public health behaviors, such as soil handling, cat ownership, and meat cooking practices, were influenced parasite infection rates. The results confirmed that early detection using the ELISA test is an effective diagnostic tool for toxoplasmosis infections and can help prevent potential complications of infection during pregnancy, such as miscarriage or birth defects.

Keyword: Toxoplasmosis, IgG antibodies, IgM antibodies, ELISA test

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INTRODUCTION

Toxoplasma gondii belongs to the order of sporophyte sporozoa is an obligate intracellular parasite. It is capable of infecting various tissues in many mammals and birds and causing toxoplasmosis infection (Dubey *et al.*, 2021). The most common way to contract toxoplasmosis is by consuming raw or undercooked meat containing tissue cysts (Wang *et al.*, 2017) or through contact with infected cats, which are the final hosts, as they shed large quantities of oocysts (Moon, 2023). Toxoplasmosis is a global infectious disease especially in hot and humid regions. Studies showed that this disease has negative effects on fetuses the event that women are infected during pregnancy, as infection with this parasite during pregnancy, may leads to congenital infection. That may lead to miscarriage or death of the fetus (Montazeri *et al.*, 2020). Infected placenta is considered to be the main reason for facilitating it is the parasite passage to the fetus, as 30-40% of women were found infected during pregnancy, The rate of parasite crossing over placenta to the fetus differs if either the mother it was getting toxoplasmosis infection before or during pregnancy, as the Accordingly, the crossing rate does not exceed (1%) in the case of infection occurred before pregnancy, to while increase and to reach (90%) only when occurred during pregnancy (Nascimento *et al.*, 2022).

Toxoplasmosis has three evolutionary forms: Tachyzoites, bradyzoites and sporozoites. The life cycle of the parasite includes the asexual stage in intermediate hosts, such as humans, and the coccid stage that inhabit intestine of the felines definitive host (Weiss and Dubey, 2009). Cats have a great role in the spread of the parasite since they are maintaining parasite cycling by discharge the infectious oocyst in their feces, especially stray cats (Teixeira *et al.*, 2019). Toxoplasmosis in immunocompetent individuals is often asymptomatic, however it can accompany with mild symptoms, such as headache, malaise, muscle aches and diarrhea (Lin *et al.*, 2008). In a study by Wyman (2017), a significant association was found between infection with the parasite and Alzheimer's disease. Catchpole *et al.*, (2023) showed that changes in immune functions due to type 1 (DM) increase the risk of developing toxoplasmosis infection acute infection with toxoplasma is usually. Asymptomatic in immunocompetent individuals, in rare cases it may cause a mild flu-like illness, On the other hand toxoplasmosis infection remains active in immunocompromised individuals, causing acute disease (Wang *et al.*, 2017). Infection differs between countries, as they range between 30-60 %, and they change according to customs cultural, social, nutritional, geographic factors, age, nature of housing, climate and modes of transportation. It reached 30% in the United Kingdom, Europe 50-80%. But it is more prevalent in areas with a warm, humid climate (Fridman *et al.*, 2012, Carter, 2013). The aims of the present study were to detect the presence of *T. gondi* antibodies in the blood of pregnant women subjected to miscarriage. using the enzyme-linked immunosorbent assay (ELISA) and to correlate between the parasite prevalence in aborted pregnant women with Some epidemiological factors such as age, month of pregnancy, number of pregnancies, and number of abortions.

MATERIALS AND METHODS

Sample collection

200 blood samples were collected from pregnant women reviewing Ibn Sina Hospital and some external laboratories affiliated to Nineveh Governorate during the period from 1/7/2023 to 1/2/2024. Most chosen women had history of suffering from previous abortions. A special information form (questionnaire) was organized that included age, trimester of pregnancy, number of pregnancies, number of abortions

Detection Initial toxoplasmosis

The working method included using Specific IgG/IgM rapid test device, to detect positivity for Toxoplasmosis antigenic. The kit, produced by the Spanish company Biokit-Sa, was used. 50 microliters of collected serum were placed in the designated dish, and one drop of reagent solution was added to one drop of Latex - I reagent, mixed well the two drops. well with a wooden chopstick.

the slide placed then on the device. The results were checked after 5 minutes. Homogeneous, non-clustering samples indicated the negative result of the test. As for the samples in which clear sticking appeared, it indicated the positive result, i.e. the presence of *T. gondii* antibodies in the serum sample.

Detection of *Toxoplasma* Antibodies in serum

Enzyme-linked immunosorbent assay (ELISA) was used to confirm the patient's serologic status using an advanced serological method for detecting *T. gondii* infection, using a kit from the American company Biocheck. This method is used to detect antitoxoplasma IgM and IgG.

Statistical analysis

Chi-square analysis was performed at a probability level of ($P > 0.05$) (Al-Rawi, 2000) to estimate the effect of several factors on the proportion of parasites infected.

RESULTS AND DISCUSSION

To ensure the positivity of toxoplasmosis infections those initially detected using Latex agglutination test, the 200 serum samples of pregnant women (who had suffered from previous abortions or stillbirths or deformed births in Nineveh) were subjected to ELISA Immunological diagnosis test (Table 1). 68 sample showed to be positive for toxoplasmosis (34 %) compared to 132 negative samples (66%). As shown in Table. 1, no statistically significant differences at $P < 0.05$.

Table (1): Percentage of toxoplasmosis infection in pregnant women:

Examination t	n. examined	n. positive s.	%	n. negative s,	%
ELISA	200	68	34	132	66

The ELISA test is characterized by high sensitivity and specificity in the detection of diseases (Liesenfeld *et al.*, 1996) as it is used in the detection of specific antibody IgM (Carroll and Pfaller, 2024) and specific antibody IgG. In acute infection the immunoglobulin IgM appears alone or with the immunoglobulin IgG, while in chronic cases immunoglobulin IgG appears alone without the immunoglobulin IgM (Lin *et al.*, 2008). Among the studies conducted to find out the percentage of infection with *T. gondii* parasite, using the ELISA assaying a study conducted in the Malaysia to determine the incidence of parasite infection among various groups of people, including pregnant women, the incidence rate reached 42.5% (Nasiru *et al.*, 2020). In a study conducted in Egypt, differences were observed in the prevalence of *T. gondii* among pregnant women using PCR or ELIS tests, with the prevalence rate reaching 11.81% (Ibrahim, *et al.*, 2017). Significant associations were found between the prevalence of *T. gondii* and a history of spontaneous abortion, consumption of raw vegetables, and the presence of cats in the household. Multivariate analysis confirmed that a history of spontaneous abortion was a significant predictor of *T. gondii* prevalence among study participants. (Al-Adhroey *et al.*, 2019). The prevalence of seronegative toxoplasmosis among pregnant women in Saudi Arabia was 28% (Moafa, *et al.*, 2024). In a study conducted in Najaf Governorate in Iraq, the results of the ELISA test showed that 27 samples (33.7%) and 4 samples (5%) were positive for IgG and IgM, respectively (Noori, 2021). The results of the ELISA-IgM and ELISA-IgG tests showed that the infection rate in women was 14% and 66%, respectively (Al-Ammash, *et al.*, 2018). in Duhok, Kurdistan Region, Iraq The prevalence of toxoplasmosis among females with infection detected in both IgM and IgG was 0.3% and 20.6%, respectively (Abdullah, *et al.*, 2024). The incidence of *Toxoplasma gondii* among pregnant women was found to be 45.55% by examining 180 samples (Shahatha, 2017). A study was also conducted by Mohammad and Jasim (2017) in the city of Kirkuk, where the total infection rate was 11.6% of the total samples of 250 samples. As a study was conducted in the city of Kirkuk, the percentage was lower than that of the current study, as the infection rate was 19.6% (Barzinij, 2021). In a study conducted in Mosul to detect the parasite using

several tests, it was found that the infection rate using the ELISA test reached 31.6% (Al-Safar *et al.*, 2019).

The difference between infection rates in this study and previous studies is attributed to the difference in the socioeconomic conditions like, urbanization level, healthy habits, dealing with soil, contact with cats, climatic conditions, lack of interest in food and drink hygiene, poor cooking of meat, and contact with animals, which is a source of infection (Ismael, 2023). Variation in the incidence of toxoplasmosis has also been observed. The persistence of toxoplasmosis in different regions may be attributed to the large number of stray cats, poor sanitary conditions, and the accumulation of dirt. In addition, there is weak health control over imported food and meat, as well as the number of samples tested in each case, the period of each study, and its location. Studies have also shown that women who have been in contact with soil and those with non-vegetarian dietary habits have higher levels of antibodies. The social and epidemiological aspects of toxoplasmosis are important factors in the spread of the disease (Alwan, 2025).

The effect of age on the incidence of *Toxoplasma gondii*; the results of the current study showed that the highest rate of infection was concentrated among pregnant women whose ages ranged between 35-39 years, reaching 43.3%, with 30 women out of the total number of women under study, of whom 2 samples and 11 samples were seropositive for IgG and IgM, respectively. It is an indication of the presence of chronic and acute infections, as for the positive overlapping cases of the same age group, which included both acute and chronic infection together, the infection percentage was 0%. The lowest incidence of toxoplasmosis for pregnant women was recorded in the age group (25-29) years, reaching 6.25. % of the total positive cases, 3 of which were chronic cases (7%) and 6 were acute cases (15.9%). While the overlapping infection rate reached 2.6% (2 positive cases). The statistical analysis of the results showed that there were no significant differences between the concentrations of specific antibodies *T. gondii* and age groups, as shown in the (Table 2).

Table (2): The Distribution of seropositive cases of toxoplasmosis in pregnant women and according to different age groups

Age groups	Examined(N)	IgG	%	IgM	%	IgG+IgM	%	total	Total%
19-14	30	3	10	5	16.6	1	3.3	9	30
24-20	46	4	8.7	10	20.8	2	4.3	16	34.8
29-25	39	3	7	6	15.9	1	2.6	10	25.6
30-34	35	2	5.7	9	25.7	1	2.9	12	34.3
35-39	30	2	6.6	11	36.6	0	0	13	43.3
40-44	20	0	0	8	40	0	0	8	40
Total	200	14	7	49	24.5	5	2.5	68	34
P value	0.749								

The present study agreed with a study conducted in Mosul city by Al-Saffar *et al.*, (2019) those found no significant differences between the prevalence of toxoplasmosis infections among different age groups of the examined women. In a study conducted in Iraq, the highest incidence of IgM infection was in the age group 25-34, while the highest incidence of IgG infection was found in the age group 17-24 years. (Atiyah and Ubaid, 2024) High IgG antibody titers to toxoplasmosis were also observed, reaching 61.53% (16 of 26) in the 20-24 age group and 85.71% (6 of 7) in the 30-34 age group by Al-jubory (2017). Among the studies conducted on the relationship of the infection rate to the age of pregnant women was a study conducted in Anbar province by Shahatha (2017) those found

that the highest infection rate was 65.62% in the age group 30-26 years, and the lowest infection rate was 25% in the age group 40-36 years, and the statistical analysis showed that there is Significant differences for age ($p < 0.05$). In a study conducted in Egypt, a high prevalence of *T. gondii* serotypes was observed in the age group from 21 to 30 years (El-Shqanqery *et al.* 2017).

The relationship between the incidence of *T. gondii* infection and the trimester stage:

The results of the current study showed the effect of the trimester stage of pregnancy on the rates of infection with *T. gondii* parasite. The highest infection rate was redistricted at the first trimester of pregnancy (1-3) months, reaching 8.38%, of 80 tested samples, of which 7 (8.8%) were safe (had IgG only). Phenomenon genetics, 8.8%, acute injury, and 22 genes serum sample contain IgM only (27.5%), added to 2 seropositive sample with IgG + IgM (2.5%) compared to women who had pregnancy within the third trimester stage (7-9monthes), reaching 22% of the 50 tested samples. Which included (24%) acute infection, and 9(18%) chronic infection and 0% inter current infection. The statistical analysis of the results showed that there were no statistically significant differences between the concentrations of *T. gondii* antibodies and the months in which pregnancy occurs, as shown in (Table 3).

Table (3): The Distribution of positive cases of toxoplasmosis in pregnant women according to pregnancy stage:

m. pregnancy	Examined (N)	IgG	%	IgM	%	IgG + IgM	%	Total	Total%
1--3	80	7	8.8	22	27.5	2	2.5	31	38.8
4-6	70	5	7.1	18	25.7	3	4.9	26	37.1
7-9	50	2	4	9	18	0	0	11	22
Total	200	14	7	49	24.5	5	2.5	68	34
P value	0.115								

The study showed that the highest rate of abortion during the first trimester of pregnancy among the tested women, and this is consistent with the record of Sołowińska, and Holec(2025).in India, and this is attributed to the fact that the transmission of infection from mother to fetus occurs during the first three months of pregnancy at a large rate, and this leads to an increase in abortion during the first period more than the rest of the subsequent periods (Kadhim,2013) illustrated that infection rates with Toxoplasmosis among pregnant women were (29.64%) Babylon city. The study showed also the variation in infection rates among pregnant women upon the differences of pregnancy stage (Liu *et al.*, 2015). Clarified that the risk of toxoplasmosis infection rising sharply with progression of gestational age stage, approximately 15% in the first trimester, 25% in the second trimester, and 65% or more in the third trimester (Lebech *et al.* 1999).

The relationship between the incidence of *T. gondii*; infection and number of pregnancies result of the current study. Showed that the highest infection rate was recorded among women who had previous pregnancies from (1-2) times, reaching 38% infection rate out of 160 tested samples, including 10 samples with IgM only (6.6 %) 44 (57%) with IgG only and 3 samples (4.9%) with overlapping infection. In women who had pregnancies (3-5) times, the percentage of parasite infection was less, reaching 37.1 out of a total of 40 samples, of which 4(10%) were febrile infections. 10% acute infection, 5 samples (12.5%) had chronic infection, and 2 samples (2.5%) with overlapping infection. The statistical analysis of the results showed no significant differences between the concentrations of *T. gondii* antibodies and the number of pregnancies as shown in (Table 4).

Table (4): The Distribution of positive cases of toxoplasmosis in pregnant women according to the number of pregnancies

n. pregnancies	Examined(N)	IgG	%	IgM	%	IgG + IgM	%	Total	Total%
1--2	160	10	6.6	44	27.5	3	4.9	57	38.8
3-5	40	4	10	5	12,5	2	2.5	11	37.1
Total	200	14	7	49	24.5	5	2.5	68	34
P value	0.433								

To reduce the incidence of *T. gondii* infection during pregnancy, and the resulting congenital toxoplasmosis, some researchers have recommended health education in addition to conducting some prenatal tests. (Milne *et al.*,2020). Educating and providing health care to pregnant women about the symptoms, risks, and consequences of Toxoplasmosis infection during pregnancy is important (Bigna *et al.*,2020).

The relationship between the incidence of *T. gondii* infection and the number of abortions, (Tables 4-5) illustrated the relation between number of abortions and rate of affect the rates of infection with the *T. gondii* parasite for pregnant women, as it was found that there was no significant difference in test between seropositive cases and number of abortions. Anyway, as the highest infection rate for women who had abortions (1-2) times was 39.2% (47 cases) out of, from 120 samples. With a3% chronic infection and 27.5%% acute infections 33 seropositive cases), and3.3% overlapping infections 4 samples. It is found also that women who had miscarriages the percentage of parasite infection was the less 3 infected cases of 15 samples (20%) all of them were acute cases.

There were no statistically significant differences between the infection rate with *T. gondii* and the number of abortions among pregnant women, as shown in (Table 5).

Table (5): The Distribution of positive cases of *T. gondii* in pregnant women according to the number of abortions

m. abortions	Examined(N)	IgG	%	IgM	%	IgG + IgM	%	total	
0	35	2	5.7	8	22.9	0	0	10	28.8
1-2	120	10	8.3	33	27.5	4	3.3	47	39.2
3-4	30	2	5.7	5	16.6	1	2.9	8	26.6
<4	15	0	0	3	20	0	0	3	20
Total	200	14	7	49	24.5	5	2.5	68	34
P value	0.271								

Among the studies conducted on the relationship of the number of miscarriages among pregnant women and the percentage of infection with the *T. gondii* parasite, as the Number of miscarriages in the first period of pregnancy occupied the highest percentage, amounting to 53.12% (Shahatha, 2017). The number of abortions had an effect on the parasite infection rate and is consistent with other reports (Sarkar *et al.*, 2012; Chintapalli and Padmaja, 2013; Amshavathani., 2013).

Toxoplasmosis is an infectious disease that affects many vulnerable populations, among recent studies on toxoplasmosis, a study by Al-Ardi (2021) showed that infection can result in a range of symptoms, from miscarriage to severe illness. The mechanism of behavioral stimulation includes stimulation of a specific immune response and an imbalance in the concentrations of neurotransmitters, hormones, and genes.

Current treatments for toxoplasmosis rely on outdated and ineffective therapies. Antimalarials have been shown to be useful in treating other parasitic-borne diseases, including toxoplasmosis. Antimalarials, such as quinolones, endoplasmic peroxides, pyrazolopyrimidines, and naturally derived peptide-based parasitizing agents, provide the most effective therapeutic solutions against toxoplasmosis. These treatments have been used to control or eliminate toxoplasmosis (Secieru *et al.*, 2020). Among the measures that must be followed are a regular and healthy program during pregnancy, as well as conducting serological tests and avoiding factors that increase the risk of infection (Ismael, 2023).

CONCLUSIONS

The ELISA test has shown high efficacy in early detection of *Toxoplasma gondii* infection in pregnant women to the prevention of serious complications such as miscarriage or congenital malformations the overall infection rate was approximately 34%, including recent and chronic infections. The highest infection rate was recorded among the 35–39 age group and during the first trimester of pregnancy, particularly among women at the first or second pregnancy. Contact with soil, keeping cats, and meat cooking methods showed to be the most important risk factors those persist toxoplasmosis infection in Nineveh different regions.

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انتشار الإصابة بطفيلي *Toxoplasma gondii* لدى النساء الحوامل المراجعات لمراكز أمراض النساء في محافظة نينوى

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الملخص

Toxoplasma gondii طفيلي قادر على إصابة أنسجة مختلفة في العديد من الثدييات والطيور، ويسبب داء المقوسات. تحدث العدوى من خلال تناول اللحوم النيئة أو غير المطهورة جيداً، أو من خلال ملامسة القطط المصابة، والتي تُعتبر العائل النهائي لها. أُجريت هذه الدراسة لتحديد انتشار *T. gondii* بين النساء الحوامل في محافظة نينوى، وخاصةً بين من تعرضن للإجهاض. ومع انتشار ظاهرة تربية القطط بالمنزل في العراق عموماً وفي مدينة الموصل خصوصاً جاء الاهتمام بالدراسة لما يسببه هذا الطفيلي من اذى على الانسان وخاصة النساء حيث يؤثر على الاجنة خلال فترة الحمل استخدمت هذه الدراسة اختبار ELISA للكشف عن الأجسام المضادة (IgM و IgG). أظهرت النتائج أن معدل الإصابة الإجمالي بلغ 34% من بين 200 عينة فُحصت، مما يشير إلى وجود إصابات حديثة ومزمنة بالطفيلي. أشارت التحليلات الإحصائية إلى عدم وجود فروق ذات دلالة إحصائية بين معدلات الإصابة وبعض العوامل الوبائية المدروسة، مثل العمر، وعدد حالات الحمل، وعدد حالات الإجهاض، ومرحلة الحمل. سُجّل أعلى معدل إصابة في الفئة العمرية 35-39 عاماً، خلال الأشهر الثلاثة الأولى من الحمل، وبين النساء في حملهن الأول أو الثاني. أظهرت الدراسة أن العوامل البيئية والاجتماعية وسلوكيات الصحة العامة، مثل التعامل مع التربة، وامتلاك القطط، وأساليب طهي اللحوم، تؤثر على معدلات الإصابة بالطفيليات. وأكدت النتائج أن الكشف المبكر باستخدام اختبار ELISA يُعد أداة تشخيصية فعالة، ويمكن أن يساعد في الوقاية من المضاعفات المحتملة للعدوى أثناء الحمل، مثل الإجهاض أو العيوب الخلقية.

الكلمات الدالة: داء المقوسات، اجسام مضادة IgM ، اجسام مضادة IgG ، اختبار ELISA