



Article

# The Effect of the Parasite *Toxoplasma gondii* on the Mother and Fetus in Samples Taken from Hospitals in Mosul City

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**Abstract:** The study revealed that *Toxoplasma gondii* is one of the most common parasites affecting pregnant women and leading to early or late miscarriage. Tests were conducted on 120 samples from participating women who visited public and private health institutions in Mosul. The study showed that 92 women exhibited symptoms of *T. gondii* infection. After performing serum tests, 74 participants tested positive for the parasite by identifying immunological markers (IgG and IgM). The prevalence of IgG antibodies was found to be 92.5% (IU/mL) in 50 identified samples, indicating latent or chronic infection. The prevalence of IgM antibodies in serum reached 57.1% (IU/mL) in 14 confirmed samples, indicating a recent and acute infection with *T. gondii*. Furthermore, 16 out of 24 samples showed both types of antibodies. Antibodies or immune markers, IgG and IgM, were found in 66.6% of women (IU/mL) with a standard deviation of  $\pm 2.32$  and a p-value of  $< 0.0001$ . The study also showed that contact with cats increases the infection rate, with 78.3% of women who do not live with cats having an infection rate of 21.7%. Furthermore, the number of previous abortions increases the infection and abortion rates by more than 66% compared to other cases, as does the consumption of contaminated food. This study also indicated that the 20-30 age group is 54% more susceptible to infection with the *T. gondii* parasite than other age groups. Additionally, women living in cities were found to be twice as likely to be infected as women living in rural areas. The study also found that women living in cities are more likely to be infected than women living in rural areas.

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**Keywords:** *Toxoplasma gondii*, cat, IgG and IgM, abortion, immunological markers.

## 1. Introduction

The *Toxoplasma gondii* parasite is one of the most widespread parasites in the world. It causes asymptomatic infections in most cases, but it can lead to serious illness in immune compromised individuals. If a pregnant woman is infected during pregnancy, it can significantly affect fetal development and infant growth after birth, potentially leading to adverse outcomes in newborns. The prevalence of this parasite varies from country to country. It is one of the most contagious infectious agents, a protozoan parasite that infects most mammals, including humans [1]. Chronic toxoplasmosis affects approximately 35% of the world's population [2]. Some effects of toxoplasmosis acquired during pregnancy can include birth defects and fetal death in more than 73% of cases. The disease often presents without any obvious symptoms, but when symptoms do appear, they are vague or atypical and may include fever lasting two to four days, headache, enlargement of the liver and spleen, chills, sweating, muscle pain, and inflammation. The pharynx may be affected, and sometimes a widespread, non-itchy rash may appear. Lymphadenopathy is

generally the most common manifestation of the disease [3], affecting 10% of pregnant women with hyperactive or acute toxoplasmosis. Although extensive lymphadenopathy may occur in a small number of cases, it can last for several weeks and may appear symmetrically in the cervical region. It is painless. Complications of the disease can include blindness or visual impairment, as well as chorioretinitis [3]. Congenital toxoplasmosis can also cause serious consequences in the fetus. Despite this, some countries do not recommend toxoplasmosis testing, and toxoplasmosis infection during pregnancy is often overlooked due to the often subtle and nonspecific symptoms. No specific recommendations are provided for at-risk patients, despite the significant risk of transmission [4].

As is scientifically known, the *Toxoplasma gondii* parasite has a complex reproductive cycle and a definitive host, which is cats, and an intermediate host. In the definitive host, *T. gondii* reproduces sexually, while in the intermediate host, it reproduces asexually [5]. The danger lies in the intermediate host, which may be a human, as the active form of *T. gondii* can transform into a latent form, bradyzoites, which can migrate to organs such as the brain and eyes. At this point, this inactive form of *T. gondii* may be difficult to eradicate by the immune system or even by medications that cannot penetrate the blood-brain barrier or the multiple layers of the eyeball [6]. It is quite possible for the bradyzoite infection to be transmitted to vegetables and fruits, and it can also be ingested by intermediate hosts such as sheep, pigs, and cattle [7]. Many studies have reported that *T. gondii* can be transmitted to pregnant women through the consumption of contaminated fruits, vegetables, water, seafood, unpasteurized milk, and undercooked or contaminated meat [8][9].

Research Objectives:

- 1-To diagnose *T. gondii* in samples from pregnant women in Mosul.
- 2 - To identify the side effects and risk factors associated with *T. gondii* infection in both the mother and fetus.

## 2. Methodology

### Sample Collection and Infection Survey:

The study was conducted on 120 participants who had previously experienced miscarriages. Blood samples were taken from each participant who visited Al-Khansaa Maternity Hospital and some private clinics for pregnant and infant care in Nineveh Governorate between January and June 2026. The participants' ages ranged from 20 to 45 years. All necessary health approvals were obtained, and they were selected using a systematic random sampling method. The gestational age was determined to be from the third to the ninth month [10]. All information related to the study samples was recorded, including place of residence, type of housing, and number of miscarriages. Data on disease-related risk factors were collected from all pregnant women through personal interviews using a structured questionnaire. This involved collecting socio-demographic data, including the participant's age, education level, place of residence, and knowledge of infection transmission methods. In addition, behavioral and lifestyle information was collected (such as: consuming raw or undercooked meat, eating raw fruits or vegetables, dining in restaurants, receiving blood transfusions, handling cats, and exposure to garden soil).

All data and questionnaires were recorded for both infected and uninfected samples. The uninfected samples were considered the control group.

Examination and Diagnosis: After diagnosis by healthcare staff at health facilities for pregnant women and newborns seeking care, 92 samples (out of a total of 120) showed symptoms similar to *T. gondii* infection. Blood samples were taken from these samples for laboratory testing. Simultaneously, 20 asymptomatic samples were identified, and blood

samples were also taken from them. These 22 samples were considered the control group [11].

### **Serum Samples and Serological Diagnosis:**

Approximately 5 ml of venous blood was collected from each study participant using sterile methods by drawing blood into a tube and maintaining it at 4°C before transport to the medical and clinical laboratories under suitable conditions. All blood samples were centrifuged at 4000 rpm for 5 minutes. Serum samples were collected and stored at -20°C until analysis. Serum samples were tested using a specific KTI from the commercial ELISA kits of Bioket-SA (Platelia™ Toxo IgG and Platelia™ Toxo Igm). IgG antibodies against *T. gondii* were evaluated quantitatively, while IgM antibodies were detected qualitatively. Sample testing procedures were followed according to the manufacturer's instructions and protocols. Antibody concentrations were expressed in international units per milliliter (IU/mL). A result of 9 IU/mL or higher was considered positive for the parasite. The study indicated a previous or latent chronic infection. IgG antibody concentrations for *T. gondii* below 6 IU/mL were considered negative [9, 10, 11]. IgM antibody levels for *T. gondii* were the indicator. IgM levels greater than or equal to 1 IU/mL were considered positive for toxoplasmosis, indicating a recent infection, while IgM levels less than 0.80 were considered negative. The results were then recorded and statistically analyzed for all samples [10].

### **Side effects and risk factors associated with *T. gondii* infection:**

Ingestion of bradyzoites by the definitive host is followed by several cycles of asexual reproduction, and finally, sexual reproduction, resulting in the formation of non-budding oocysts. When unencapsulated eggs are shed in feces, they become infectious, potentially contaminating soil, fruits, vegetables, water, and pets such as cats. Intermediate hosts include all mammals, with humans being the most susceptible, and birds as well [12]. Toxoplasmosis can be transmitted through the meat of goats and sheep. The disease is transmitted to humans by consuming raw or undercooked meat, ingesting eggs released by cats in the environment, or through congenital infection during pregnancy. When the mother is infected during the first trimester of pregnancy, the risk of congenital infection is lowest (10-25%), but it is more likely to cause serious harm. When the infection begins during the last trimester of pregnancy, the risk of congenital infection is highest, reaching (60-90%) [13].

## **3. Results**

Comparison of infection with IgG and IgM immunological markers (IU/mL):

The results, as shown in Table (1), reveal that 92 samples exhibited symptoms of *Toxoplasma gondii* infection. 74 samples were identified as infected based on internationally recognized immunological marker levels. Studies indicate that a level of 9 IU/mL in each sample is positive for the parasite, suggesting a past or chronic latent infection. Antibody or immunological marker levels for *T. gondii* below 6 IU/mL were considered negative. The prevalence of IgG antibodies was found to be 92.5% (IU/mL) in 50 identified samples, indicating latent or chronic infection. The study also showed that the prevalence of IgM antibodies in the blood serum reached 57.1% (IU/mL) in 14 confirmed samples or cases out of the total number of cases. It indicates a recent and acute infection with the *T. gondii* parasite. It was also shown that 16 out of 24 samples showed the two types of antibodies or immune indicators IgG and IgM at a rate of 66.6% (IU/mL) according to Table (1) with a standard deviation of ( $\pm 2.32$ ), and a P-value ( $P < 0.0001$ ) [12,13].

Table (1) Antibody ratio and immunological markers IgG and IgM (IU/mL) and the number of pregnant women participating in the study:

ELISA	N	Number of women tested				P-value
		Positive		Negative		
Test		NO	%	NO	%	P<0.0001 Test de
IgG	54	50	92.5%	4	7.5%	P<0.0001 Test de
IgM	14	8	57.1%	6	42.9%	P<0.0001 Test de
IgG & IgM	24	16	66.6%	8	33.4%	P<0.0001 Test de
Total	92	74	80.4%	18	19.6%	

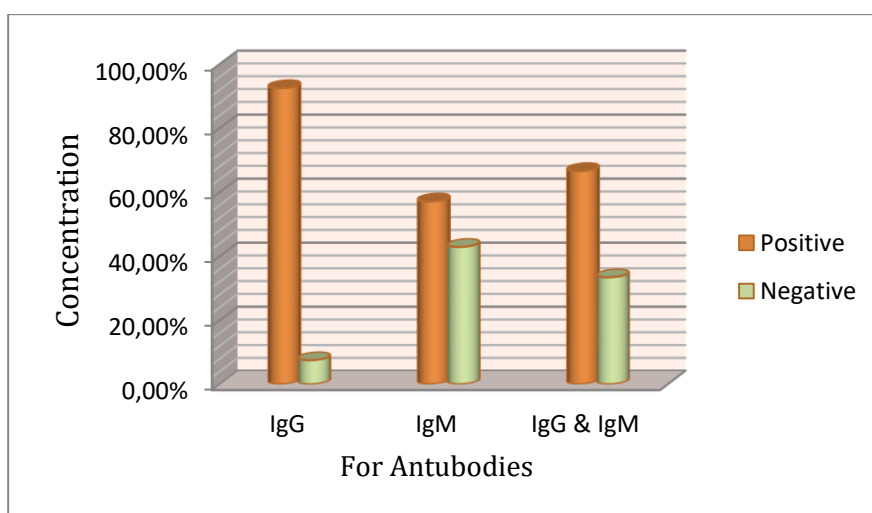


Figure (1) Percentages of appearance of IgG and IgM antibodies (IU/mL) in all their forms in the pregnant women under study.

#### Risk Factors and Causes of Transmission Associated with *Toxoplasma gondii*:

This study identified the most common causes and risk factors associated with the transmission of the *T. gondii* parasite, clarifying the age groups most affected. Table (2) clearly shows a slightly significant difference between the age groups between 20 and 45 years (Figure 3). Those under 30 years of age recorded a higher infection rate than those over 30 ( $P < 0.001$ ), with 54% and 46% respectively. Women who tested negative for the parasite had a similar percentage, but with a potentially large difference: 66.6% and 33.4% respectively.

Comparing women living in urban and rural areas, Table (2) and Figure (3) show a clear and significant difference between urban and rural populations ( $P < 0.001$ ). Urban women were 70.2% infected with the *T. gondii* parasite, while rural women were much less infected, at only 29.8%. Negative infection rates were recorded at almost the same percentage.

On the other hand, abortion had a clear impact on the prevalence and recurrence of the parasite under study. The study revealed that 59.4% of women infected with the parasite had previously experienced an abortion, while 30.6% had not. Negative infection rates were the opposite of positive ones, with a very significant difference: 11.1% had experienced an abortion, while 88.9% had not ( $P = 0.032$ ).

The negative infection rates were significantly higher than the positive ones, with 11.1% having experienced an abortion and 88.9% not having ( $P = 0.032$ ). Cat ownership was a clear and significant risk factor ( $P < 0.001$ ), as women who handled or lived with cats showed a significantly higher prevalence of antibodies (Figure 2), with infections recorded at 78.3%, while women who did not live with cats recorded 21.7%. Negative infections were the most common among women who did not live with cats, at 94.5%. Similarly, regarding the consumption of undercooked fruits, vegetables, and meats, it was found that women who may have consumed contaminated or unwashed fruits and vegetables had a higher infection rate of 64.8%, compared to other pregnant women who consumed uncontaminated and well-washed fruits and vegetables ( $P = 0.032$ ), which reached 35.2%. Negative infections were almost the same, with the same significant differences.

Table (2) Results of *Toxoplasma gondii* antibody prevalence according to risk factors and variables for pregnant women under study

Variables	N	Seropositive		Seronegative	
		N	%	N	%
The Age	92	74		18	
< 30 years		40	54%	12	66.6%
≥ 30 years		34	46%	6	33.4%
Residency	92	74		18	
Rural		52	70.2%	13	72.2%
Urban		22	29.8%	5	29.8%
Miscarriage	92	74		18	
Yes		44	59.4%	2	11.1%
No		30	30.6%	16	88.9%
Pet animal (cat)	92	74		18	
Yes		58	78.3%	1	5.5%
No		16	21.7%	17	94.5%
contaminated vegetables and fruits	92	74		18	
Yes		48	64.8%	14	77.7%
No		26	35.2%	4	22.3%

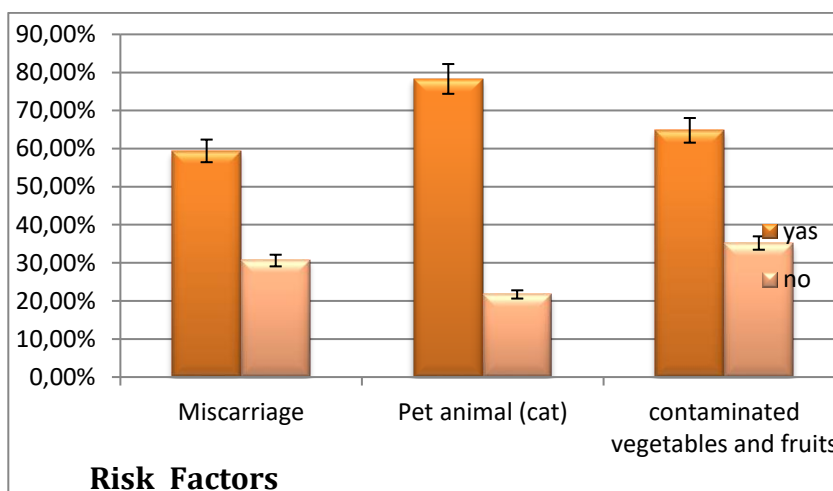


Figure (2): Risk factors related to pregnant women infected with the *Toxoplasma gondii* parasite under study

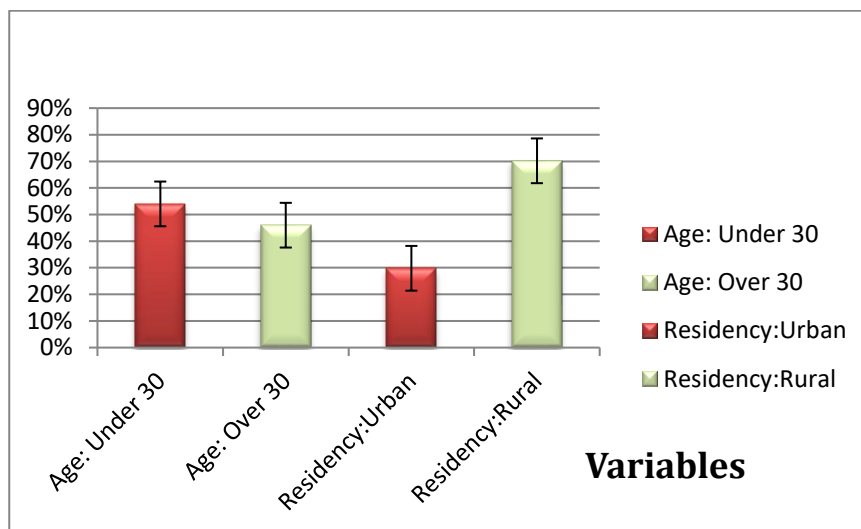


Figure (3): Variables related to pregnant women infected with the *Toxoplasma gondii* parasite under study.

#### 4. Discussion

This study indicates that serological procedures can aid in the diagnosis and identification of *Toxoplasma gondii* infection by rapidly detecting antibodies, or immunological markers, in blood serum samples. This allows for the determination of whether the infection is chronic or acute.[14] The study also revealed a significant difference in the prevalence of *Toxoplasma gondii* infection among pregnant women. Chronic infection is characterized by the presence of IgG antibodies, while acute infection is characterized by the presence of IgM antibodies. ELISA test results showed the presence of both IgG and IgM antibodies against *T. gondii*. Chronic infection accounted for 92.5% of the study participants, a high percentage. This indicates that the parasite can persist in infected women for years. The risk associated with this parasite is twofold: firstly, chronic infection is often asymptomatic, leading women carrying the parasite to neglect proper hygiene practices to eliminate it; and secondly, if pregnancy occurs, it can lead to miscarriage after the third month, given the high miscarriage rate. The infection rate doubles, as shown in Table (2), in the presence of chronic infection (Figure 2). Regarding acute infection with the *T. gondii* parasite, characterized by the appearance of the IgM antibody, the study revealed that the prevalence of this antibody was 57.1% in eight of the 14 women whose serum samples tested positive for the parasite. This is based on studies stipulating that a level of 9 IU/mL per sample indicates infection [22, 23]. This is a relatively low rate, but it poses a risk to the fetus and may subsequently become chronic. These results may be similar to other studies, such as the 2022 study [15], which indicated a prevalence of 59% for IgG antibodies to toxoplasmosis, a significant difference from the current study. Meanwhile, the prevalence of IgM antibodies was 8% among women in Baghdad with a history of recurrent spontaneous abortion. According to the findings of Khairandesh et al. (2019) [16], women who had their first abortion had a higher percentage of positive IgM antibodies compared to women who had not had an abortion. This overall percentage is similar to that observed in the current study. This study also revealed the presence of both IgG and IgM antibodies in some participants. These antibodies were found in 24 of the 92 women in the study, with 16 samples (66.6%) being positive for both IgG and IgM antibodies (compared to 0% for all antibodies in the healthy women) or the control group. This indicates that chronic infection can lead to simultaneous acute infection, posing a significant risk and potentially leading to miscarriage. This finding is consistent with study [17][18][19][20].

On the other hand, this study clarified that there is a strong correlation between infection with the *Toxoplasma gondii* parasite in all its forms and owning or raising cats at

home. According to Table (2) and Figure (2), the infection rate among pregnant women who have direct contact with cats is significantly higher, reaching 78.3% of positive cases [21][22][23]. This is a substantial difference compared to women who do not have contact with cats, who recorded an infection rate of 21.7%. This result confirms that the main cause of infection transmission from cats to women is humans, as studies indicate that humans are the intermediate host, while cats are the definitive host for the *Toxoplasma gondii* parasite. When linking age groups to contact with cats, although previous studies have shown relatively higher infection rates among older age groups compared to younger age groups [18][24], this study clarified that infection rates were highest among those under 30 years of age, with 54% of infections recorded for this variable. Women over 30 years of age recorded lower infection rates. Infections of 46%, where this high seroprevalence in the age group under 30 years can be attributed to frequent contact and handling of infected cats or vegetables and fruits (Table 2) and Figure (2). This may not be consistent with the results of the study by Nazari et al., but it is consistent with a 2018 study [19] conducted in Iran, where a higher prevalence of antibodies was observed in the 25-30 year age group compared to other age groups.

Finally, the study clearly shows, in comparison between women living in the city and rural areas, a significant difference ( $P < 0.001$ ) was observed, as shown in Table (2) and Figure (3). Urban women were infected with the *T. gondii* parasite at a rate of 70.2%, while rural women were much less infected, not exceeding 29.8%. This may be attributed to several reasons, including that rural women have a stronger immune system due to good nutrition and the absence of cats in their homes. In addition, the reason may be attributed to the small sample size of women living in rural areas participating in the study. This result is consistent with another study, such as [20,21], which confirmed similar reasons to the results of the current study.

## 5. Conclusion

This study revealed that *Toxoplasma gondii* is a parasite that infects pregnant women and can lead to miscarriage in over 70% of cases. Diagnosis is based on elevated levels of antibodies or immunological markers (IgG and IgM) in the blood serum (more than 9 IU/mL). Chronic infection can be identified by IgG levels, while acute infection is identified by IgM levels. The study also identified several important factors that can significantly increase infection rates, exceeding 65% above normal levels. These factors include age, previous miscarriages, contact with cats, place of residence, and consumption of food contaminated with the parasite..

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## REFERENCES

- [1] E. Watts, Y. Zhao, A. Dhara, B. Eller, A. Patwardhan, and A. P. Sinai, "Novel Approaches Reveal that *Toxoplasma gondii* Bradyzoites within Tissue Cysts Are Dynamic and Replicating Entities In Vivo," *mBio*, vol. 6, no. 5, Art. no. e01155-15, 2015.
- [2] C. Konradt, N. Ueno, D. A. Christian, J. H. DeLong, G. H. Pritchard, J. Herz, *et al.*, "Endothelial cells are a replicative niche for entry of *Toxoplasma gondii* to the central nervous system," *Nature Microbiology*, vol. 1, Art. no. 16001, 2016.
- [3] J. P. Dubey, "The history of *Toxoplasma gondii*—the first 100 years," *Journal of Eukaryotic Microbiology*, vol. 55, no. 6, pp. 467–475, 2008.

- [4] S. Almeria and J. P. Dubey, "Foodborne transmission of *Toxoplasma gondii* infection in the last decade: An overview," *Research in Veterinary Science*, vol. 135, pp. 371–385, 2021.
- [5] J. L. Jones, V. Dargelas, J. Roberts, C. Press, J. S. Remington, and J. G. Montoya, "Risk factors for *Toxoplasma gondii* infection in the United States," *Clinical Infectious Diseases*, vol. 49, no. 6, pp. 878–884, 2009.
- [6] Q. Liu, Z.-D. Wang, S.-Y. Huang, and X.-Q. Zhu, "Diagnosis of toxoplasmosis and typing of *Toxoplasma gondii*," *Parasites & Vectors*, vol. 8, Art. no. 292, 2015.
- [7] T. S. Lima and M. B. Lodoen, "Mechanisms of Human Innate Immune Evasion by *Toxoplasma gondii*," *Frontiers in Cellular and Infection Microbiology*, vol. 9, Art. no. 103, 2019.
- [8] C. Rudin, H. H. Hirsch, R. Spaelti, S. Schaedelin, and T. Klimkait, "Decline of Seroprevalence and Incidence of Congenital Toxoplasmosis Despite Changing Prevention Policy—Three Decades of Cord-Blood Screening in Northwestern Switzerland," *Pediatric Infectious Disease Journal*, vol. 37, no. 11, pp. 1087–1092, 2018.
- [9] Y. Zhang, B. S. Lai, M. Juhas, and Y. Zhang, "*Toxoplasma gondii* secretory proteins and their role in invasion and pathogenesis," *Microbiological Research*, vol. 227, Art. no. 126293, 2019.
- [10] F. Peyron, C. L'ollivier, L. Mandelbrot, M. Wallon, R. Piarroux, F. Kieffer, *et al.*, "Maternal and Congenital Toxoplasmosis: Diagnosis and Treatment Recommendations of a French Multidisciplinary Working Group," *Pathogens*, vol. 8, no. 1, Art. no. 24, 2019.
- [11] A. A. H. Al-Awadi, R. Abdul Ghani, and A. M. Al-Mekhlafi, "*Toxoplasma gondii* Infection Among Institutionalized Children with Down Syndrome in Sana'a City, Yemen: Implications of Low IgG Seroprevalence," *Acta Parasitologica*, vol. 67, no. 1, pp. 530–534, 2022.
- [12] F. Kheirandish, B. Ezatpour, S. Fallahi, M. J. Tarahi, P. Hosseini, A. K. Rouzbahani, *et al.*, "Toxoplasma serology status and risk of miscarriage: A case-control study among women with a history of spontaneous abortion," *International Journal of Fertility & Sterility*, vol. 13, no. 3, pp. 184–189, 2019.
- [13] L. Gras, R. E. Gilbert, M. Wallon, F. Peyron, and M. Cortina-Borja, "Duration of the IgM response in women acquiring *Toxoplasma gondii* during pregnancy: Implications for clinical practice and cross-sectional incidence studies," *Epidemiology and Infection*, vol. 132, no. 3, pp. 541–548, 2004.
- [14] S. Cassaing, *et al.*, "Comparison between Two Amplification Sets for Molecular Diagnosis of Toxoplasmosis by Real-Time PCR," *Journal of Clinical Microbiology*, vol. 44, no. 3, pp. 720–724, 2006.
- [15] H. Yamada, *et al.*, "A cohort study of maternal screening for congenital *Toxoplasma gondii* infection: 12 years' experience," *Journal of Infection and Chemotherapy*, vol. 25, no. 6, pp. 427–430, 2019.
- [16] R. Ahmadi, J. Sadeghinasab, A. Siyadatpanah, F. Mirzaei, B. Aghcheli, and R. Norouzi, "Frequency of *Toxoplasma gondii*, Rubella, and Cytomegalovirus Antibodies in Pregnant Women in Yazd Province, Iran," *Advanced Journal of Clinical Microbiology and Infection*, vol. 10, no. 4, pp. 145–151, 2023.
- [17] M. Teweldemedhin, A. Gebremichael, G. Geberkirstos, H. Hadush, T. Gebrewahid, S. W. Asgedom, *et al.*, "Seroprevalence and Risk Factors of *Toxoplasma gondii* Among Pregnant Women in Adwa District, Northern Ethiopia," *BMC Infectious Diseases*, vol. 19, no. 1, Art. no. 327, 2019.
- [18] M. Marangi, N. Lago, G. Mancinelli, O. L. Antonio, T. Scirocco, M. Sinigaglia, *et al.*, "Occurrence of the protozoan parasites *Toxoplasma gondii* and *Cyclospora cayetanensis* in the invasive Atlantic blue crab *Callinectes sapidus* from the Lesina Lagoon (SE Italy)," *Marine Pollution Bulletin*, vol. 176, Art. no. 113428, 2022.
- [19] N. Nazari, A. Bozorgomid, A. Janbakhsh, and F. Bashiri, "*Toxoplasma gondii* and human immunodeficiency virus co-infection in western Iran: A cross-sectional study," *Asian Pacific Journal of Tropical Medicine*, vol. 11, no. 1, pp. 58–62, 2018.
- [20] Z. Zhou, H. I. A. Lopez, G. E. Pérez, L. M. Burgos, J. M. Farina, C. Saldarriaga, *et al.*, "Toxoplasmosis and the Heart," *Current Problems in Cardiology*, vol. 46, no. 3, Art. no. 100741, 2021.
- [21] P. O. Odeniran, K. F. Omolabi, and I. O. Ademola, "Risk factors associated with seropositivity for *Toxoplasma gondii* in population-based studies among immunocompromised patients in West African countries, Cameroon and Gabon: A meta-analysis," *Acta Tropica*, vol. 209, Art. no. 105544, 2020.

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- [22] B. Achaw, H. Tesfa, A. J. Zeleke, L. Worku, A. Addisu, N. Yigzaw, *et al.*, "Sero-prevalence of *Toxoplasma gondii* and associated risk factors among psychiatric outpatients attending University of Gondar Hospital, Northwest Ethiopia," *BMC Infectious Diseases*, vol. 19, no. 1, pp. 1–8, 2019.
- [23] E. Watts, Y. Zhao, A. Dhara, B. Eller, A. Patwardhan, and A. P. Sinai, "Novel Approaches Reveal that *Toxoplasma gondii* Bradyzoites within Tissue Cysts Are Dynamic and Replicating Entities In Vivo," *mBio*, vol. 6, no. 5, Art. no. e01155-15, 2015.
- [24] S. Shojaee, A. Teimouri, H. Keshavarz, S. J. Azami, and S. Nouri, "The relation of secondary sex ratio and miscarriage history with *Toxoplasma gondii* infection," *BMC Infectious Diseases*, vol. 18, no. 1, Art. no. 307, 2018.