Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): July
ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

Immunoglobulin Variations and Risk Factors Linked to Pregnancy Loss

Mohammed A. Ameer Haraj[1*], Mohammed Obaid Al-Mansoori[2], Rajwan Jawad Al-Obaidi[3]
[1,2,3]Department of Biology, College of Education, University of Al-Qadisiyah, Iraq

Email: mohammed.abdulameer@qu.edu.iq

Abstract. Objectives: To investigate the immunological changes, demographic risk factors, and potential correlations between Toxoplasma gondii infection and abortion incidence. Methods: A comprehensive cross-sectional study was conducted on 22 participants, analyzing IgG and IgM antibody levels, demographic characteristics, and histological changes across different age groups. Immunological markers, residence patterns, cat contact, and meat consumption were evaluated using statistical analyses. Results: Significant immunological variations were observed: IgG levels escalated from 51.25 IU/ML (healthy individuals) to 310.25 IU/ML (two abortion history), IgM levels demonstrated complex fluctuations across abortion categories, Undercooked meat consumption emerged as the most critical risk factor (OR: 2.5, p=0.001), Cat contact (OR: 1.6, p=0.016) and rural residence (OR: 1.1, p=0.012) were secondary risk factors, Age group 26-30 years demonstrated the highest pregnancy and abortion variability. Conclusions: Toxoplasma gondii infection demonstrates complex immunological responses correlated with abortion history, with dietary and environmental factors significantly influencing infection risk. The study underscores the need for targeted screening and preventive strategies in high-risk populations.

Highlights:

1. IgG levels increase with abortion history; IgM shows variable patterns.
2. Undercooked meat, cat contact, and rural living raise infection risk.
3. Women aged 26–30 show highest variability in pregnancy outcomes.

Keywords: Toxoplasma gondii, Immunoglobulins, Abortion, Risk Factors, Seroprevalence

Published : 16-06-2025

Introduction

The protozoan parasite Toxoplasma gondii (T. gondii) can infect babies and induce serious diseases if it remains outside host cells [1]. Direct exposure to contaminated cat faeces or consumption of infected meat, beverages, or soil are the primary routes for parasite transmission to humans [2]. The parasite can infect both the

ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

mother and her foetus, resulting in congenital toxoplasmosis. The placenta is crucial for the transfer of Toxoplasma gondii from the mother to the foetus [3]. Research indicates that some placental alterations, including inflammation, calcification, and necrosis, may occur due to a pregnancy-associated infection with Toxoplasma gondii. Adverse pregnancy outcomes such as miscarriage, foetal mortality, or preterm delivery may result from these abnormalities [4]. The histopathological changes in the placenta of pregnant women who experience abortions owing to Toxoplasma gondii infections should primarily be investigated by the analysis of immunoglobulins, specifically IgG and IgM. The protozoan parasite Toxoplasma gondii is a predominant cause of stillbirths, preterm births, and many congenital anomalies. Alterations in the form or function of the placenta during maternal gestation might result in significant repercussions for the developing foetus [5]. Immunoglobulins, or antibodies, are essential for the immune system to combat infections. IgG and IgM are very pertinent due to their function in the immunological response to Toxoplasma gondii. Human immunoglobulin G (IgG) offers enduring protection against infectious illnesses [6]. In contrast, IgM is the primary immunoglobulin produced in response to an infection, indicating that the pathogen was contacted recently [7]. Investigating the function of IgG and IgM in the histopathological anomalies observed in the placentas of pregnant women who have experienced abortions due to toxoplasmosis will enhance comprehension of this subject. This knowledge may facilitate improved diagnosis, prevention strategies, and treatments for this condition [8]. Improved maternal and child health outcomes following Toxoplasma gondii infection can be attained by comprehending the complex interplay among IgG, IgM, and the placenta.

Method

Patients at the Obstetrics and Gynecology Hospital in Al-Diwaniyah City, Iraq had their blood samples drawn between January and April in the year 2024. This research evaluated 22 women who had previously undergone abortions and 22 women who were in the control group and had healthy pregnancies. To compile the data questionnaire, in-person interviews were carried out. Five samples of venous blood were collected from each group and spun at 3000 rpms for five minutes in a centrifuge. Until the test was carried out, the sera were kept at -20°C. All blood samples were tested for the presence

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): July
ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

of IgM and IgG using the Enzyme Linked Immunosorbent Assay (ELISA) from CAUSBIO Company.

1. Statistical Analysis of Data

The Statistical Package for the Social Sciences, version 17, was utilized for the statistical study. To determine if there were statistically significant differences, we utilized the chi-square test and the Z-test, which is a tool for determining if there is a significant difference between two proportions. In order to assess the strength of the connection between the risk variables and the T. gondii infection, the odds ratio (OR) and its 95% confidence interval (CI) were utilized.

Results and Discussion

A. Results

The present study showed in table (1), the average IgG level in healthy individuals without abortion is 51.25 IU/ML, with a standard deviation of 17.06. This indicates a relatively stable range of IgG levels among healthy subjects.

In the one Abortion following one abortion, there is a significant increase in the average IgG level to 215.33 IU/ML, with a standard deviation of 14.11. This suggests that the immune response may be heightened in the aftermath of a first abortion. Also two Abortions the average IgG level further escalates to 310.25 IU/ML for individuals with a history of two abortions, with a standard deviation of 11.25. This notable increase could indicate a cumulative effect of repeated pregnancy loss on the immune system's responsiveness. And three Abortions**: Interestingly, in individuals with three abortions, the IgG level is recorded at 236.5 IU/ML, with a higher standard deviation of 93.5, implying variability in immune response among this group. This decrease compared to the two-abortion group may suggest a potential threshold effect or adaptation occurring in the immune response following multiple abortions.

Healthy Individuals the IgM level for healthy individuals stands at 2.15 IU/ML, with a standard deviation of 0.32, indicating a stable baseline for this immunoglobulin in the absence of pregnancy complications. In the one Abortion after experiencing one abortion, the IgM level rises to 6.28 IU/ML, with a considerable standard deviation

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): July
ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

of 9.03. This increase may reflect an enhanced immune reaction, possibly as the body attempts to manage the physiological changes occurring post-abortion. Also two abortions the levels of IgM decrease slightly to 4.66 IU/ML for those with two abortions, accompanied by a standard deviation of 2.69. This fluctuation could suggest a complex immune response that warrants further investigation. And three Abortions lastly, individuals who have undergone three abortions show a significant drop in IgM levels to 1.455 IU/ML, with a standard deviation of 0.635. This decrease could indicate a possible downregulation of immune function in response to repeated pregnancy loss, which might merit further clinical exploration.

Table 1. T. gondii IgM and IgG Antibodies (IU/ML) in the Present Study

***T. gondii* antibodies**	**Healthy**	**Without abortion**	**1 abortion**	**2 abortion**	**3 abortion**	**LSD**
IgG (IU/ML)	1-6	51.25±17.06 D	215.33±14.11 C	310.25±11.25 A	236.5±93.5 B	12.631
IgM (IU/ML)	1-6	2.15±0.32 A	6.28±9.03 A	4.66±2.69 A	1.455±0.63 A	5.954

1. Distribution of Healthy and Aborted Pregnancy Cases by Age Group

The present study showed in table (2), the distribution of healthy pregnancies and cases with varying numbers of abortions (0, 1, 2, or 3 abortions) across different age groups. The corresponding p-values for each age group are also provided, indicating the statistical significance of the differences observed. Below is a detailed analysis of the data: In this age group, 2 cases (9.09%) were recorded as healthy pregnancies, while 1 case (4.54%) had no prior abortions. The majority of cases in this group experienced 1 abortion (4 cases, 18.18%). No cases with 2 abortions (0.0%) were observed, while 1 case (4.54%) experienced 3 abortions. A statistically significant association was found in this age group with a p-value of 0.020, indicating a meaningful difference in pregnancy outcomes among the categories.

Age Group: 21–25 Years: Healthy pregnancies were more frequent in this group, with 5 cases (22.72%) recorded. Those without abortions accounted for

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): July
ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

2 cases (9.09%), while women with 1 abortion represented 3 cases (13.63%). No cases of 2 abortions (0.0%) or 3 abortions (0.0%) were observed in this age group. A p-value of 0.005 suggests a statistically significant difference in pregnancy outcomes for this age group.

Age Group: 26–30 Years This group had the highest number of healthy pregnancies, with 8 cases (36.36%). Only 1 case (4.54%) was recorded for women without abortions, while 5 cases (22.72%) were observed for women with 1 abortion. Additionally, 1 case (4.54%) was recorded for women with 2 abortions, and another 1 case (4.54%) for those with 3 abortions. The p-value for this age group was 0.001, indicating a highly significant association between age and pregnancy outcomes.

Age Group: 31–35 Years Healthy pregnancies in this age group accounted for 7 cases (31.81%). No cases (0.0%) were observed for women without abortions, and 3 cases (13.63%) were recorded for women with 1 abortion. No cases (0.0%) were reported for women with 2 or 3 abortions in this age group. The p-value was 0.007, indicating statistical significance.

A total of 22 cases (99.97%) were recorded as healthy pregnancies across all age groups. Women without abortions accounted for 4 cases (18.17%), while 15 cases (68.16%) were observed for women with 1 abortion. Women with 2 abortions accounted for only 1 case (4.54%), and those with 3 abortions made up 2 cases (9.09%). The p-values across all age groups were statistically significant (all <0.05), indicating a strong association between age and pregnancy outcomes.

Table 2. Seropositive Rate of T. Gondii Igm and Igg Antibodies According to Age Demographic Characterization of Healthy Pregnancies and T. Gondii

Age group	Healthy	Without abortion	1 abortion	2 abortion	3 abortion	*P*- value[a]
18-20	2 (9.09%)	1 (4.54%)	4 (18.18%)	0 (0.0%)	1 (4.54%)	0.020[a]

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): July
ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

21-25	5 (22.72%)	2 (9.09%)	3 (13.63%)	0 (0.0%)	0 (0.0%)	0.005[a]
26-30	8 (36.36%)	1 (4.54%)	5 (22.72%)	1 (4.54%)	1 (4.54%)	0.001[a]
31-35	7 (31.81%)	0 (0.0%)	3 (13.63%)	0 (0.0%)	0 (0.0%)	0.007[a]
Total cases	22 (99.97)	4 (18.17)	15 (68.16)	1 (4.54%)	2 (9.09%)	

2. Antibody Presence in Women with Abortion

The present study showed in table (3), the demographic characteristics of women with healthy pregnancies compared to those with T. gondii antibodies (Abs) and a history of abortion. It analyzes factors such as residence, contact with cats, and consumption of undercooked meat, alongside their respective odds ratios (OR), confidence intervals (CI), and p-values. Among women with healthy pregnancies, the majority (14 cases, 63.63%) resided in rural areas, while 8 cases (36.36%) lived in urban areas. In contrast, women with T. gondii Abs and abortion history were more frequently found in rural areas (17 cases, 77.27%) compared to urban areas (5 cases, 22.72%). The odds ratio (OR) for rural residence was calculated as 1.1 (95% CI: 1.78–3.23), indicating a higher likelihood of T. gondii infection and abortion among rural residents compared to urban residents. The association was statistically significant, with a p-value of 0.012, suggesting that rural residence is a significant risk factor for T. gondii infection in this population. Among women with healthy pregnancies, 10 cases (45.45%) reported contact with cats, while 12 cases (54.54%) had no contact. Among women with T. gondii Abs and abortion history, contact with cats was significantly higher, with 18 cases (81.81%) reporting cat contact compared to only 4 cases (18.18%) who did not have contact. The odds ratio for contact with cats was 1.6 (95% CI: 1.52–4.63), indicating an increased likelihood of T. gondii infection and abortion in women who had contact with cats. This association was statistically significant, with a p-value of 0.016, identifying cat contact as a significant risk factor for T. gondii infection and abortion. Among healthy

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): July
ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

pregnancies, 9 cases (40.90%) reported consuming undercooked meat, while 13 cases (59.09%) did not consume undercooked meat. In contrast, a significantly higher proportion of women with T. gondii Abs and abortion history (17 cases, 77.27%) reported consuming undercooked meat, compared to only 5 cases (22.72%) who did not. The odds ratio for undercooked meat consumption was 2.5 (95% CI: 2.21–5.36), indicating a strong association between undercooked meat consumption and T. gondii infection with abortion. This association was highly statistically significant, with a p-value of 0.001, making undercooked meat consumption the most significant risk factor for T. gondii infection and abortion among the factors analyzed.

Table 3. The Correlation of Demographic Risk Factors and T. Gondii Seropositivity in Pregnant Women

Demographic Characterization	Healthy n (%)	*T. gondii* Abs with abortion n (%)	OR (95% CI)	*P*-value
Residence:				
Rural	14 (63.63)	17 (77.27)	1.1 (1.78-3.23)	0.012
Urban	8 (36.36)	5 (22.72)		
Contact with cats				
Yes	10 (45.45)	18 (81.81)	1.6 (1.52-4.63)	0.016
No	12 (54.54)	4 (18.18)		
Consumption of under-cooked meat				
Yes	9 (40.90)	17 (77.27)	2.5 (2.21-5.36)	0.001
No	13 (59.09)	5 (22.72)		

P-value <0.05. OR, odds ratio; CI, confidence interval.

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): July
ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

3. Histological Changes

The present study showed in Figure (1), Endometrial inflammation scores and vasculitis severity levels as determined by histology. The lamina propria, endometrium, and uterus are the parts that are involved. endometritis caused by lymphohistiocytic cells. Mild lymphohistiocytic endometritis is the diagnosis for this patient. While studying an infected pregnant gilt, researchers looked at the uterus, endometrium, and lamina propria. An very severe instance of lymphohistiocytic endometritis has invaded the uterus, namely the endometrium and lamina propria, of a pregnant gilt.

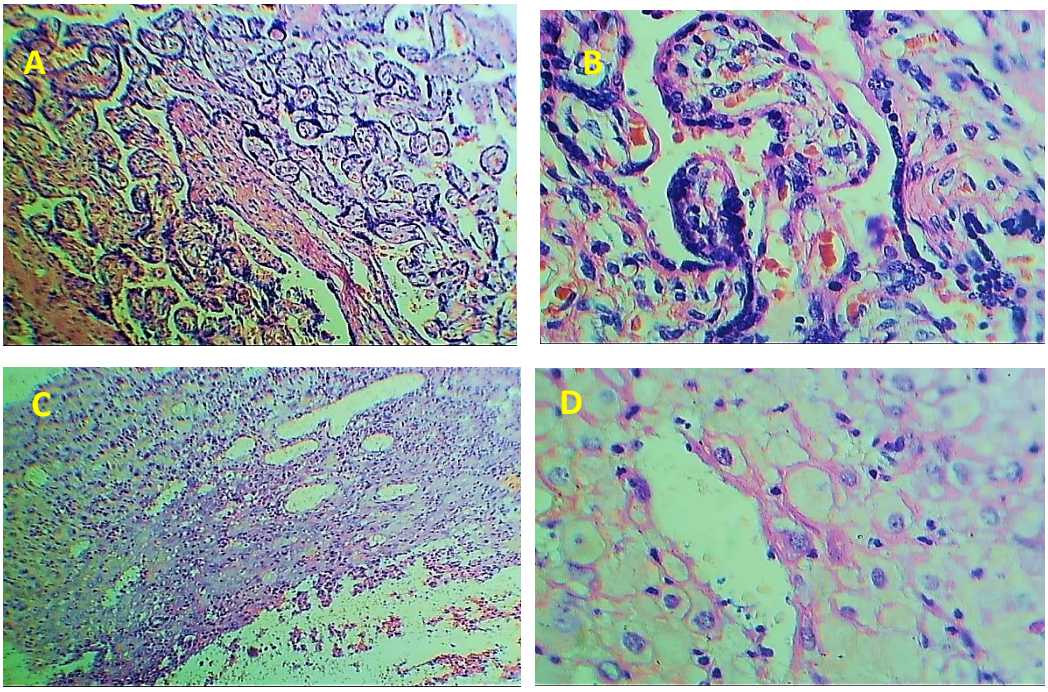

Figure 1. Displays the histologic scores of endometrial inflammation and the degree of vasculitis severity. (a) The components involved include the uterus, endometrium, and lamina propria. The subject of study is a pregnant gilt infected with PRRSV. The staining technique used is Hematoxylin and Eosin (HE). Grade 1 minimal lymphohistiocytic endometritis. (b) The uterus and endometrium of a pregnant gilt infected with PRRSV, seen using a HE staining technique. The patient has grade 2 mild lymphohistiocytic endometritis. (c) The uterus, endometrium, and lamina propria were examined in a pregnant gilt infected with PRRSV using a HE stain

Indonesian Journal on Health Science and Medicine
Vol 2 No 1 (2025): July
ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

B. Discussion

The T. gondii infection was more common in the high-risk pregnancy group, according to the present study. Consistent with previous studies [9] [10], the results were reliable. Pregnant women who had experienced obstetric problems before had a greater seroprevalence of toxoplasmosis than pregnant women who did not. One in thirteen people in the high-risk category had persistent infection because 12.5% of them tested positive for IgM antibodies. A long-term infection was indicated by 32.5% of the cases who tested positive for IgG antibodies alone. A possible infection that occurred within the last year was suggested by 5.8% of the patients who tested positive for both IgM and IgG antibodies. Several earlier studies with comparable designs found results that were in agreement with ours [11] [12]. Also, a previous study women who had abortions also suffered seroprevalence, which is consistent with our results [13]. Our results show that seropositivity was most common in the 21–25year age group, which corresponds to the reproductive age of women, in contrast to other studies [14] that indicated an age-related rise in the risk of T. gondii infection. Studies have shown that between the ages of 20 and 30, there is a significant rise in the frequency of antibodies in the blood of pregnant women [15] [16] [17]. The riskiest of these outcomes was abortion. The results of the meta-analysis by Li et al. [18] supported this. Extensive research has shown that persistently infected uterine toxoplasma cysts can transmit the infection to the developing baby within the first trimester of pregnancy, which in turn can cause many miscarriages [19]. Congenital infection is reduced by around 60% when a pregnant woman who has developed toxoplasmosis receives therapy [7]. It is not always assured that spiramycin will lower the chance of placental transfer [20]. To confirm toxoplasmosis, further polymerase chain reaction (PCR) testing on amniotic fluid should be performed. Important risk factors for Toxoplasma gondii infection were found to include living in rural regions, having a poor socio-economic position, having just a primary level of education, and having frequent contact with dirt, according to our study. Several previous studies found the same thing [10] [12] [17]. Reasons for this phenomenon's importance include the way people live in rural areas, the abundance of domestic animals, and the perfect conditions for oocyst sporulation

ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

[21]. Additionally, women with better socioeconomic position and greater education eliminated disease transmission mechanisms by implementing appropriate hygienic practices linked to food and cooking [22]. Another important factor that presented a serious threat was eating undercooked meat. Possible limited role of these factors in Diwanyah City, Iraq may be suggested by the negative association between Toxoplasma seropositivity and some identified possible risk factors among seropositive cases in this study. This discrepancy might be explained by cultural and climatic variables in terms of eating preferences and cleanliness.

Conclusions

The study reveals significant correlations between Toxoplasma gondii antibody levels, abortion history, age, and demographic risk variables. IgG levels increased after one and two abortions, indicating an enhanced immune response to pregnancy loss. IgM levels declined with successive abortions, possibly due to downregulation of immune function. Age is a crucial determinant in pregnancy outcomes, with the 26-30 year age group having the highest incidence of healthy pregnancies. Rural habitation, interaction with felines, and raw meat consumption are significant risk factors for T. gondii seropositivity in women with abortion history. Histological evidence of lymphohistiocytic endometritis in the uterus, endometrium, and lamina propria reinforces the infection's influence on the reproductive system.

References

[1] J. P. Dubey, Toxoplasmosis of Animals and Humans, 2nd ed. Beltsville, Maryland, USA: CRC Press, 2010.

[2] P. R. Torgerson and P. Mastroiacovo, "Global Burden of Congenital Toxoplasmosis: Systematic Review," Bulletin of the World Health Organization, vol. 91, pp. 501–508, 2013.

[3] H. Fricker-Hidalgo et al., "Toxoplasma Seroconversion With Negative or Transient Immunoglobulin M in Pregnant Women: Myth or Reality? A French Multicenter Retrospective Study," Journal of Clinical Microbiology, vol. 51, no. 6, pp. 2103–2111, 2013.

ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

[4] M. D. Sarkar, B. Anuradha, N. Sharma, and R. N. Roy, "Seropositivity of Toxoplasmosis in Antenatal Women With Bad Obstetric History in a Tertiary-Care Hospital of Andhra Pradesh, India," Journal of Health, Population and Nutrition, vol. 30, no. 1, pp. 87–92, 2012.

[5] N. Kumari, N. Morris, and R. Dutta, "Is Screening of TORCH Worthwhile in Women With Bad Obstetric History: An Observation From Eastern Nepal," Journal of Health, Population and Nutrition, vol. 29, no. 1, pp. 77–80, 2011.

[6] P. Yasodhara, B. A. Ramalakshmi, V. Lakshmi, and T. P. Krishna, "Socioeconomic Status and Prevalence of Toxoplasmosis During Pregnancy," Indian Journal of Medical Microbiology, vol. 22, no. 4, pp. 241–243, 2004.

[7] R. McLeod and J. S. Remington, "Toxoplasmosis (Toxoplasma Gondii)," in Nelson Textbook of Pediatrics, R. E. Behrman, R. M. Kliegman, and H. B. Jenson, Eds., 16th ed., Philadelphia, PA: WB Saunders, 2000, pp. 1054–1062.

[8] H. K. El Deeb, H. Salah-Eldin, and S. Khodeer, "Prevalence of Toxoplasma Gondii Infection in Antenatal Population in Menoufia Governorate, Egypt," Acta Tropica, vol. 124, no. 3, pp. 185–191, 2012.

[9] J. J. Schiesselman, Case-Control Studies: Design, Conduct, Analysis, New York, NY: Oxford University Press, 1982.

[10] A. E. Tammam et al., "Seroepidemiology of Toxoplasma Gondii Infection in Women With First Trimester Spontaneous Miscarriage in Qena Governorate, Egypt," Journal of Clinical and Diagnostic Research, vol. 7, no. 12, pp. 2870–2873, 2013.

[11] S. Chintapally, "Seroprevalence of Toxoplasmosis in Antenatal Women With Bad Obstetric History," Tropical Parasitology, vol. 3, no. 1, pp. 62–66, 2013.

[12] S. Senthamarai et al., "Seroprevalence of Toxoplasmosis in Pregnant Women With Bad Obstetric History in a Tertiary Care Hospital, Kanchipuram—A Pilot Study," Disease, vol. 3, no. 1, pp. 29–32, 2013.

[13] A. H. Hussein, A. E. Ali, M. H. Saleh, I. M. Nagaty, and A. Y. Rezk, "Seroprevalence of Toxoplasma Infection in Qualyobia Governorate, Egypt," Journal of the Egyptian Society of Parasitology, vol. 31, no. 2, pp. 355–363, 2001.

[14] E. Zemene et al., "Seroprevalence of Toxoplasma Gondii and Associated Risk Factors Among Pregnant Women in Jimma Town, South Western Ethiopia," BMC Infectious Diseases, vol. 12, p. 337, 2012.

ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo

https://doi.org/10.21070/ijhsm.v2i1.166

[15] S. M. Spalding, M. R. Amendoeira, C. H. Klein, and L. C. Ribeiro, "Serological Screening and Toxoplasmosis Exposure Factors Among Pregnant Women in South of Brazil," Revista da Sociedade Brasileira de Medicina Tropical, vol. 38, no. 3, pp. 173–177, 2005.

[16] A. Malarvizhi et al., "Seroprevalence of Toxoplasma Gondii in Pregnant Women," Journal of Public Health and Epidemiology, vol. 4, no. 7, pp. 170–177, 2012.

[17] N. Siddiqui, F. Shujatullah, H. M. Khan, T. Rabbani, and P. A. Khan, "Socioeconomic Status and Prevalence of Toxoplasmosis in Pregnant Women With Bad Obstetric History," Journal of Immunology and Vaccine Technology, vol. 1, no. 1, pp. 101–103, 2014.

[18] X. L. Li et al., "A Meta-Analysis on Risks of Adverse Pregnancy Outcomes in Toxoplasma Gondii Infection," PLoS One, vol. 9, no. 5, e97775, 2014.

[19] G. O. Ajayi and S. A. Omilabu, "Prenatal Diagnosis of Cytomegalovirus (CMV), Rubella, Toxoplasmosis, Varicella, Parvovirus, Herpes Simplex and Syphilis: The Lagos Programme Experience," Clinical and Experimental Obstetrics & Gynecology, vol. 37, no. 1, pp. 37–38, 2010.

[20] M. Cortina-Borja et al., "Prenatal Treatment for Serious Neurological Sequelae of Congenital Toxoplasmosis: An Observational Prospective Cohort Study," PLoS Medicine, vol. 7, no. 10, e1000351, 2010.

[21] Q. Liu et al., "Toxoplasma Gondii Infection in Pregnant Women in China," Transactions of the Royal Society of Tropical Medicine and Hygiene, vol. 103, no. 2, pp. 162–166, 2009.

[22] T. K. Mohammed, "Seroprevalence of Toxoplasma Gondii Among Pregnant Women in Baghdad City," Iraqi Academic Scientific Journal, vol. 24, pp. 21–28, 2011.