


# Association between *Toxoplasma gondii* IgM Seropositivity and Miscarriage among Yemeni Women in Sana'a, Yemen: A Case-Control Study

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## Abstract

**Background.** *Toxoplasma gondii* is an obligate intracellular protozoan parasite that causes toxoplasmosis worldwide. Primary infection during pregnancy may result in miscarriage, fetal death, or congenital toxoplasmosis with severe fetal complications.

**Objective.** This study aimed to investigate the association between acute *T. gondii* infection and spontaneous abortion among women in Sana'a, Yemen.

**Methods.** A case-control study was conducted from March 2017 to March 2018 in selected hospitals and health centers in Sana'a City. Serum samples were collected from 90 women with spontaneous abortion (cases) and 90 women with normal pregnancy (controls). Acute *T. gondii* infection was assessed by detecting anti-*T. gondii* IgM antibodies using electrochemiluminescence immunoassay (ECLIA). Sociodemographic, obstetrical, and potential risk-factor data were collected using a structured questionnaire and analyzed using SPSS.

**Results.** Anti-*T. gondii* IgM antibodies were detected in 4.4% (4/90) of women with spontaneous abortion and in none of the controls. Although IgM seropositivity was observed exclusively among cases, the difference was not statistically significant ( $P = 0.12$ ). No significant associations were identified between acute *T. gondii* infection and sociodemographic characteristics, reproductive history, or assessed risk factors.

**Conclusion.** Acute *T. gondii* infection was detected only among women with spontaneous abortion; however, no statistically significant association with miscarriage was demonstrated in this study. Larger studies with adequate statistical power are recommended to further evaluate the role of primary toxoplasmosis in pregnancy loss.

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## Introduction

Miscarriage (spontaneous abortion) is one of the most distressing problems affecting pregnant women, particularly those who have not had a successful pregnancy (WHO, 2025). It is more commonly observed in low-income societies and is considered an important family-related problem. The miscarriage rate is 12% to 15% among women who know they are pregnant (Al-Hakami et al., 2020). In the general reproductive population, miscarriage is a common occurrence, affecting approximately 30% to 50% of all conceptions, whereas only 15% to 25% are clinically recognized as spontaneous abortions before the 20th week of gestation or when fetal weight is below 500 g (Bakir et al., 2025). Several factors are associated with spontaneous abortion, including infectious factors, and congenital infections are considered among the most important causes of abortion (Kostova et al., 2023). Recent studies have shown that microbial factors, such as *Toxoplasma gondii* (*T. gondii*), may be associated with spontaneous abortion (Dafallah and Abdallah, 2023).

*T. gondii* is an obligate intracellular protozoan parasite capable of infecting all warm-blooded species, including humans. It is distributed worldwide and is estimated to infect one-third of the world's population, although most infections are asymptomatic (Mehdar et al., 2025). *T. gondii* causes toxoplasmosis, one of the most common parasitic infections, which may result in miscarriage or severe damage to the embryo and fetus, such as stillbirth and congenital abnormalities (Mocanu et al., 2022). Only 10%–20% of patients with toxoplasmosis present with symptoms, which may include lymphadenopathy, persistent myalgia, low-grade fever, malaise, night sweats, sore throat, and retinochoroiditis (Farouk et al., 2020).

Research addressing the association between acute *T. gondii* infection and miscarriage among Yemeni women remains scarce. This study aimed to determine the association between Toxoplasma IgM antibodies and miscarriage and to examine certain risk factors that may play a role in inducing spontaneous abortion.

## Materials and Methods

### Study Design and Samples Size

A descriptive case-control study was conducted between March 2017 and March 2018. A total of 180 samples for both aborted women (case group) and normal pregnancy women (control group), with case-control ratio of 1.1, then the number of cases was 90 women with spontaneous abortion and 90 control, normal pregnancy women.

### Samples and Data Collection

Data were collected directly using a structured questionnaire designed for this study. The questionnaire included all variables required for the analysis, including personal profile, sociodemographic characteristics, obstetrical history, symptoms, selected risk factors, previous diagnosis, and knowledge and health awareness.

Blood samples were collected from five hospitals and three health centers and clinics in Sana'a city, namely Al-Thawra Modern General Hospital, Al-Sabeen Maternity and Child Hospital, Al Gumhouri Teaching Hospital, The Specialized Mother Hospital, The Woman and Child Hospital, Al-Zahrawi Center, Al-Zahra'a Center, and Dr. Al-Salami Saba Clinic.

A 5 mL blood sample was collected from each consenting woman with miscarriage and each pregnant woman by venipuncture and transferred into a sterile anticoagulant-free bottle. The blood was allowed to clot, then centrifuged at 3000 rpm for 5 minutes, and the serum was transferred into Eppendorf tubes.

### Serological Testes

Serological assays were performed using the electrochemiluminescence immunoassay (ECLIA) technique on the Cobas e411 system (Roche Diagnostics GmbH, Mannheim, Germany). Serum samples of each participating woman were examined in vitro for the qualitative determination of IgM antibodies for *T. gondii*.

### Statistical Analyses

The data obtained from the questionnaires and the laboratory analyses were analyzed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as frequencies and percentages. Associations between categorical variables were assessed using Pearson's chi-square test or Fisher's exact test when expected cell counts were less than 5. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated where applicable. All tests were two-sided, and p-values less than 0.05 were considered statistically significant.

## Results

### Comparative of IgM antibodies of *T. gondii* between participant groups

In the present study, IgM antibodies to *T. gondii* were considered evidence of primary infection. They were detected in 4.4% (4/90) of the study group, whereas no IgM antibodies were detected in the control group. However, the difference between the two groups was not statistically significant ( $p = 0.12$ ), indicating no significant difference between the groups with respect to *T. gondii* infection (Table 1).

Table 1. Comparative percentages of IgM antibodies to *T. gondii* in sera of participants women.

	Study group (90 cases) No. (%)	Control group (90 cases) No. (%)	$\chi^2$	<i>p</i> -value
<i>T. gondii</i> IgM positive	4 (4.4%)	0 (0.0%)	4.09	0.04*
<i>T. gondii</i> IgM negative	86 (95.6%)	90 (100.0%)		
Total	90 (100.0%)	90 (100.0%)		

$\chi^2$ , Chi square ( $\geq 3.9$  significant); *p*-value, Probability value ( $<0.05$  significant); \*, Fisher's exact test.

### **Distribution of *T. gondii* IgM antibodies according to the sociodemographic and obstetrical characteristics of participating women**

Table 2 presents the distribution of *T. gondii* IgM positivity among the 90 participating women according to their sociodemographic and obstetrical backgrounds. Overall, only four women tested positive, giving a total seroprevalence of 4.4%.

By age, the positive cases were distributed as follows: 1 out of 32 women (3.1%) in the 16–25 years group, 2 out of 46 (4.3%) in the 26–35 years group, and 1 out of 12 (8.3%) in the 36–45 years group. Although the oldest group showed the highest percentage, the difference was not statistically significant ( $p = 0.75$ ).

Regarding education, all positive cases were found only among women with lower levels of schooling. The seropositivity rate was 6.1% (2/33) among illiterate women and 6.7% (2/30) among those with primary education, while no positive cases were detected among women with secondary, diploma, or university education. This pattern also lacked statistical significance ( $p = 0.77$ ).

Looking at obstetrical variables, all four positive cases occurred in the missed abortion group, giving a rate of 5.3% (4/76), with no positives among threatened or complete abortion cases. Regarding gestational age, positivity was 4.1% (2/48) in the first trimester and 4.8% (2/42) in the second trimester. Neither of these associations reached statistical significance ( $p = 0.68$  and  $p = 0.89$ , respectively).

For recurrent miscarriage, the seropositivity rate was 8.3% (1/12) among women with RMC compared to 3.8% (3/78) among those without. However, this difference was not statistically significant either ( $p = 0.48$ ). In summary, none of the examined variables showed a significant association with *T. gondii* IgM seropositivity.

### **Distribution of *T. gondii* IgM antibodies according to some risk factors**

Table 3 examines the association between *T. gondii* IgM positivity and selected risk factors. For blood transfusion, none of the nine women with a transfusion history tested positive (0.0%), compared to four positive cases among the 81 without (5.0%), though the difference was not significant ( $p = 0.50$ ). For animal care, two positive cases were found among the 36 women with animal contact (5.6%) and another two among the 54 without (3.7%), with no significant link ( $p = 0.67$ ).

Regarding partner relationship, the seropositivity rate was 4.5% (2 out of 44 women) among those who reported having a regular relationship with their partners, compared to 4.3% (2 out of 46 women) among those who did not. The two percentages were nearly the same, and the statistical test gave a  $p$ -value of 0.96, which clearly indicates that this particular factor had no notable or meaningful influence on IgM positivity within this study group.

Table 2. Distribution of IgM antibodies to *T. gondii* among the study group according to sociodemographic and obstetrical characteristics

Variable	Total No. (%)	<i>T. gondii</i> IgM		$\chi^2$	<i>p</i> -value
		Positive No. (%)	Negative No. (%)		
<b>Age group (Years)</b>					
16-25	32 (35.6)	1 (3.1)	31 (96.9)	0.56	0.75*
26-35	46 (51.1)	2 (4.3)	44 (95.7)		
36-45	12 (13.3)	1 (8.3)	11 (91.7)		
<b>Education level group</b>					
Illiterate	33 (36.7)	2 (6.1)	31 (93.9)	1.80	0.77*
Primary	30 (33.3)	2 (6.7)	28 (93.3)		
Secondary	15 (16.7)	0 (0.0)	15 (100.0)		
Diploma	2 (2.2)	0 (0.0)	2 (100.0)		
University	10 (11.1)	0 (0.0)	10 (100.0)		
<b>Abortion type</b>					
Threatened	4 (4.4)	0 (0.0)	4 (100.0)	0.77	0.68*
Missed	76 (84.5)	4 (5.3)	72 (94.7)		
Complete	10 (11.1)	0 (0.0)	10 (100.0)		
<b>Gestational age (Trimester)</b>					
First	48 (53.3)	2 (4.1)	46 (95.9)	0.01	0.89*
Second	42 (46.7)	2 (4.8)	40 (95.2)		
<b>Recurrent miscarriage (RMC)</b>					
Yes	12 (13.3)	1(8.3)	11(91.7)	0.49	0.48*
No	78 (86.7)	3 (3.8)	75 (96.2)		
<b>Total</b>	<b>90 (100.0%)</b>	<b>4 (4.4)</b>	<b>86 (95.6)</b>		

$\chi^2$  Chi square ( $\geq 3.9$  significant).

*p*- value, Probability value ( $<0.05$  significant)

\* Fisher's exact test

Table 3. Seroprevalence of IgM antibodies to *T. gondii* according to selected risk factors

Variable	<i>T. gondii</i> IgM			$\chi^2$	p-value
	Total No. (%)	Positive No. (%)	Negative No. (%)		
<b>Blood Transfusions</b>					
Yes	9 (10.0)	0 (0.0)	9 (100.0)	0.46	0.50*
No	81 (90.0)	4 (5.0)	77 (95.0)		
<b>Animals care</b>					
Yes	36 (40.0)	2 (5.6)	34 (94.4)	0.17	0.67*
No	54 (60.0)	2 (3.7)	52 (96.3)		
<b>Relationship between pair</b>					
Yes	44 (48.9)	2 (4.5)	42 (95.5)	0.002	0.96*
No	46 (51.1)	2 (4.3)	44 (95.7)		
<b>Total</b>	<b>90(100.0%)</b>	<b>4 (4.4)</b>	<b>86 (95.6)</b>		

$\chi^2$ , Chi square ( $\geq 3.9$  significant).

p- value, Probability value ( $<0.05$  significant)

\*, Fisher's exact test

## Discussion

The primary finding of this case-control study was the detection of *Toxoplasma gondii*-specific IgM antibodies in 4.4% (4/90) of women with miscarriage, compared to 0.0% in the control group. Although this indicates a higher prevalence among cases, the difference was not statistically significant (Fisher's exact test,  $p = 0.12$ ). Consequently, our data do not support a significant association between acute toxoplasmosis and spontaneous abortion in this cohort of Yemeni women. This result suggests that, in this specific population, primary *T. gondii* infection may not be the predominant infectious trigger for pregnancy loss, directing attention toward other etiological factors, particularly other members of the TORCH complex. The occurrence of spontaneous abortion, despite the absence of a significant association with acute *T. gondii* infection, may reflect the involvement of other congenital infectious agents, which warrants a broader epidemiological investigation.

The lack of a significant link between acute toxoplasmosis and miscarriage in our study prompts a critical evaluation of the relative contribution of other TORCH infections in the Yemeni context. Recent regional seroepidemiological studies provide compelling evidence to support this notion. For instance, Al-Thobhani et al. (2023) investigated rubella virus among pregnant women in Hodeidah, western Yemen, and reported a high IgG seroprevalence (89.2%), indicative of endemicity, but a low rate of acute/recent infection (IgM positivity, 2.0%). Crucially, their analysis, similar to ours, found no statistically significant association between rubella

seropositivity and various sociodemographic or obstetric characteristics. This parallel suggests that acute rubella infections are also relatively infrequent and may not be the primary driver of acute miscarriage in these communities. Conversely, the study by [Al-Bana et al. \(2021\)](#) on herpes simplex virus type 2 (HSV-2) among pregnant women in Dhamar, Yemen, revealed a markedly different pattern. While the overall seroprevalence was low (6%), HSV-2 infection demonstrated statistically significant associations with adverse obstetric outcomes, including previous abortion ( $P = 0.03$ ) and stillbirth ( $P = 0.001$ ). This stark contrast suggests that HSV-2 might be a more potent and prevalent infectious risk factor for pregnancy loss in Yemen than acute *T. gondii* or rubella. Furthermore, regarding cytomegalovirus (CMV), [Al-Arnoot et al. \(2020\)](#) found that while 96.9% of pregnant women in Hodeidah were CMV-IgG positive (indicating past exposure), the rate of primary infection (IgM positive) was only 1.8%, aligning with the generally low incidence of acute primary TORCH infections observed in our study. Collectively, these local findings highlight the etiological heterogeneity of TORCH infections and strongly suggest that public health strategies in Yemen should prioritize a comprehensive screening approach, with particular emphasis on HSV-2, rather than focusing solely on toxoplasmosis.

Our findings are consistent with several international reports that similarly failed to demonstrate a statistically significant association. For example, [Ghasemi et al. \(2016\)](#) reported IgM seropositivity rates of 2.7% in cases and 0.9% in controls in Tehran, Iran, which were remarkably close to our results and were also non-significant. This similarity across different geographic regions may reflect the generally low incidence of primary toxoplasmosis during pregnancy in populations with moderate seroprevalence. However, our results diverge from those of other studies, even within the same city of Sana'a. [Alsaide et al. \(2019\)](#) reported a significantly higher IgM prevalence among women who had an abortion (11%) than in the control group (1%) in Sana'a ( $P < 0.05$ ). This discrepancy might be attributed to differences in study periods, sampling techniques, or the specific diagnostic platforms used. Moreover, in Sudan, [Mohamed et al. \(2017\)](#) paradoxically observed a higher IgM prevalence in the control group (5.6%) than in the case group (3.9%), although the difference was not significant. Conversely, in Iran, [Kheirandish et al. \(2019\)](#) found a significantly higher IgM prevalence in the study group (3.3%) than in the control group (0.4%), with a substantial odds ratio (OR = 10.266,  $P = 0.019$ ). These conflicting international data underscore the notion that the association between acute toxoplasmosis and miscarriage is highly context-dependent and influenced by local hygiene practices, dietary habits, and circulating parasite genotypes.

Regarding sociodemographic characteristics, our study found no significant association between *T. gondii* IgM seropositivity and age groups ( $P = 0.12$ ), although a slight increase in seroprevalence was observed with advancing age (from 3.1% in the 16–25 age group to 8.3% in the 36–45 age group). This age-related trend likely reflects cumulative lifetime exposure to the parasite and is consistent with previous local studies, such as [Alkhali et al. \(2015\)](#) in Sana'a, and international reports from Iraq by [Bakir et al. \(2025\)](#) and Iran by [Arbabi et al. \(2025\)](#). Conversely, this contrasts with [Al-Eryani et al. \(2016\)](#) in Sana'a, who reported higher seropositivity among younger pregnant women. Similarly, we observed no significant association

between IgM seropositivity and educational level ( $P = 0.77$ ). Although positive cases were exclusively found among illiterate (6.1%) and primary-educated (6.7%) women, with none among secondary, diploma, or university graduates, this trend did not reach statistical significance, likely due to the very low number of IgM-positive cases. This trend aligns with [Alkhali et al. \(2015\)](#) and [Alkadasi et al. \(2016\)](#) in Ibb, Yemen, supporting the hypothesis that lower educational attainment may correlate with reduced health literacy and higher exposure to traditional risk factors, although the small sample size precludes a definitive conclusion.

While our study assessed educational level as a proxy for socioeconomic status, it did not directly measure maternal health awareness. However, the findings of [Al-Arnoot et al. \(2027\)](#) on CMV are highly instructive in this context, as they explicitly reported that all (100%) of the anti-CMV IgG seronegative pregnant women who were thus highly susceptible to primary infection were entirely unaware of CMV or the associated risks during pregnancy. This profound lack of awareness is a critical and often underestimated risk factor for all TORCH infections, including toxoplasmosis. In our study, seropositivity was concentrated among women with lower educational levels, who typically have limited access to health education. It is plausible that inadequate knowledge about transmission routes, such as handling raw meat, gardening without gloves, or contact with cat feces, contributes to exposure, even if acute infection does not always result in abortion. Therefore, the absence of a direct statistical link in our study does not negate the potential value of targeted health awareness campaigns, as public health interventions aimed at educating women about general hygiene and the nature of TORCH infections remain imperative.

In our analysis of obstetric history, all four IgM-positive cases were observed among women with a missed abortion (5.3%), with no seropositivity among those with a threatened or complete abortion. Although this difference was not significant ( $P = 0.68$ ), this finding suggests that *T. gondii* infection might be more associated with silent intrauterine fetal demise rather than active vaginal bleeding or complete expulsion. This pattern is consistent with a study from Nepal by [Acharya et al. \(2014\)](#), which also linked TORCH infections to missed miscarriages. Regarding gestational age, we found comparable IgM positivity in the first (4.1%) and second (4.8%) trimesters, without significant differences ( $P = 0.89$ ). This aligns with [Saif et al. \(2014\)](#) in Taiz, Yemen, but contrasts with [Mohammad and Salman \(2014\)](#) in Iraq, who reported a significant association specifically with first-trimester losses. Regarding recurrent miscarriage (RMC), although the prevalence of IgM was higher in women with RMC (8.3%) than in those without (3.8%), the difference was not significant ( $P = 0.48$ ). This is consistent with the findings of [Alkadasi et al. \(2016\)](#) in Yemen and [Elaadli et al. \(2023\)](#) in Egypt. Some authors have proposed that persistent or chronic toxoplasma infection could contribute to repeated losses; however, our cross-sectional design and reliance on a single IgM measurement preclude the assessment of such chronic reactivation.

Regarding the selected risk factors, our study found no positive IgM cases among the 10% of women with a history of blood transfusion, corroborating the findings of [Farouk et al. \(2020\)](#) in

Nigeria, which suggests that transfusion-acquired toxoplasmosis is not a common route of infection in these settings. Similarly, animal care was not identified as a significant risk factor ( $P = 0.67$ ). This finding aligns with that of [Al-Hindi and Lubbad \(2009\)](#) in Gaza and [Mohamed et al. \(2017\)](#) in Sudan, who also failed to find a significant link between direct animal contact and acute infection. However, it is important to note that the cross-sectional nature of our study and the small number of seropositive cases limit the power to detect subtle associations, and many women may practice animal care but also follow hygienic measures that were not captured in our questionnaire.

### Study limitations

This study has several limitations that must be considered. First, the reliance on IgM antibodies alone, without confirmatory IgG avidity testing, may overestimate or misclassify recent infections, as IgM can persist for months or even years after the initial infection. Second, the relatively small sample size and the low number of IgM-positive cases (only four) drastically reduced the statistical power to detect significant associations or to perform multivariate logistic regression adjusting for confounders. Third, we did not screen for other TORCH agents within the same cohort, which would have allowed for a comparative risk assessment. Fourth, the case-control design cannot establish a temporal causal relationship; it only provides a snapshot of serological status at the time of miscarriage.

### Conclusions

According to the results of the present study, acute *T. gondii* infection may not be the only possible etiology of spontaneous abortion. In this study, *T. gondii* was not significantly associated with abortion. In addition, no significant association was found between primary *T. gondii* infection and any sociodemographic, reproductive, or possible risk factor.

### Abbreviations

CT	Congenital Toxoplasmosis
ECLIA	Electro-chemiluminescence immunoassay
p- value	Probability value
RMC	Recurrent Miscarriage
rpm	Round per minute
SSPS	Statistical Package for the Social Sciences
<i>T. gondii</i>	<i>Toxoplasma gondii</i>
TORCH	Toxoplasmosis, Rubella, Cytomegalovirus, and Herpes
WHO	World Health Organization
$\chi^2$	Chi square

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## Declarations

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This research received no external funding.

### Author Contributions

Conceptualization, N.Q.A. and S.H.A.; methodology, A.A.A. and N.Q.A.; investigation and data curation N.Q.A. and A.A.E.; writing-original draft preparation, N.Q.A.; writing-review and editing, S.H.A. and S.A.; supervision, S.H.A. and A.A.A. All authors have read and agreed to the published version of the manuscript.

### Competing Interests

The authors declare no competing interests.

### Ethics Statement

Ethical approval for this study was obtained from the Faculty of Science, Sana'a University (3\ 14-3-2017). Permission to collect clinical samples was granted by the administrations of Al-Thawra General Hospital, Al-Sabeen Maternity and Child Hospital, Al Gumhouri Teaching Hospital, The Specialized Mother Hospital, The Woman and Child Hospital, Al-Zahrawi Center, and Al-Zahra'a Center. This study was conducted in accordance with the Declaration of Helsinki and prepared following the CARE guidelines for case reporting. Written informed consent was waived as no identifiable patient data were included.

### Data Availability Statement

All data generated or analyzed during this study are included in this published article.

### AI disclosure

The authors used ChatGPT and Paperpal solely to improve the English language and readability of the manuscript. All scientific content was developed, verified, and approved by the authors, who take full responsibility for the manuscript.

## References

Acharya, D., Shrestha, A., Bogati, B., Khanal, K., Shrestha, S., & Gyawali, P. (2014). Serological screening of TORCH agents as an etiology of spontaneous abortion in Dhulikhel hospital, Nepal. *American Journal of Biomedical and Life Sciences*, 2(2), 34–39. <http://www.sciencepublishinggroup.com/j/ajbls>

- Al-Arnoot, S., Alghalibi, S. M., Abdullah, Q. Y. M., & Al-Thobhani, A. (2017). Seroprevalence, risk factors and awareness of cytomegalovirus infection among pregnant women in Hodeidah city, Western Yemen. *Scientific Conference for Medical Labs*, Sana'a University, Sana'a, Yemen.
- Al-Arnoot, S., Alghalibi, S. M., Abdullah, Q. Y. M., & Al-Thobhani, A. (2020). Screening for susceptibility to cytomegalovirus infection among pregnant women in Yemen. *Journal of Gynecology and Women's Health*, 18(3), 4. <https://doi.org/10.19080/JGWH.2020.18.5559890>
- Al-Bana, M. N. Q., Abdullah, Q. Y. M., Al-Arnoot, S., Homid, A., Alsayaghi, R., & AlNowihi, M. (2021). Seroprevalence and risk factors of herpes simplex virus type 2 among pregnant women in Dhamar city, Yemen. *MOJ Biology and Medicine*, 6(3), 108–114. <https://doi.org/10.15406/mojbm.2021.06.00141>
- Al-Eryani, S. M., Al-Mekhlafi, A. M., Al-Shibani, L. A., Mahdy, M. M., & Azazy, A. A. (2016). *Toxoplasma gondii* infection among pregnant women in Yemen: Factors associated with high seroprevalence. *The Journal of Infection in Developing Countries*, 10(6), 667–672. <https://doi.org/10.3855/jidc.7608>
- Al-Hakami, A. M., Paul, E., Al-Abed, F., Alzoani, A. A., Shati, A. A., Assiri, M. I., et al. (2020). Prevalence of toxoplasmosis, rubella, cytomegalovirus, and herpes (TORCH) infections among women attending the antenatal care clinic, maternity hospital in Abha, Southwestern Saudi Arabia. *Saudi Medical Journal*, 41(7), 757–762. <https://doi.org/10.15537/smj.2020.7.25124>
- Al-Hindi, A. I., & Lubbad, A. M. M. (2009). Seroprevalence of toxoplasmosis among Palestinian aborted women in Gaza. *Annals of Alquds Medicine*, 5, 39–47. <https://annalqudsmed.com/aqm/ar/article/view/50>
- Alkadasi, M. N., Putaiah, E. T., Olyoa, K., Alameri, A., & A-Ameri, G. A. (2016). Prevalence of toxoplasmosis among pregnant women and risk factors in Al-K Aeda province, Ibb, Yemen. *International Journal of Innovation and Scientific Research*, 3(8), 892–899. <https://doi.org/10.5958/2231-5659.2016.00034.5>
- Alkhali, A., Hmamouch, A., Amayour, A., Marc, I., El Kharrim, K., & Belghyti, D. (2015). Epidemiology of toxoplasmosis among married women at birth age in Sana'a City (Yemen). *International Journal of Innovation and Scientific Research*, 19(1), 40–48. <http://www.ijisr.issr-journals.org/>
- Alsaide, F. M., Elagib, A. A., El-Rayah, I. E., & Hamad, M. N. M. (2019). Immunological and molecular diagnosis of *T. gondii* infection among aborted women in Sana'a Capital and Capital Trusteeship, Yemen. *International Journal of Medical Research & Health Sciences*, 8(7), 122–133. <http://www.ijmrhs.com>
- Al-Thobhani, A., Abdullah, Q. Y., Alghalibi, S. M., & Al-Arnoot, S. (2023). Seroprevalence of rubella virus antibodies among pregnant women in Hodeidah city, Western Yemen. *Journal of Human Virology & Retrovirology*, 10(1), 7–10. <https://doi.org/10.15406/jhvrv.2023.10.00256>
- Arbabi, N., Firouzeh, N., Azizi, S. G., Mehravaran, A., Etemadi, S., Shafiei, R., et al. (2025). Unraveling the link: Serological and molecular insights into *Toxoplasma gondii* infection in women with spontaneous abortion history. *Tropical Diseases, Travel Medicine and Vaccines*, 11(22), 2–9. <https://doi.org/10.1186/s40794-025-00245-6>
- Bakir, S. A. K., Obaid, H. M., & Jassim, W. M. (2025). Epidemiological aspects of abortion in pregnant women due to *Toxoplasma* and some viral infections. *NTU Journal of Pure Sciences*, 4(4), 56–63. <https://doi.org/10.56286/yhzn3064>
- Dafallah, S. E., & Abdallah, A. M. (2023). The most common infections in pregnancy and their linked to miscarriage. *World Journal of Advanced Research and Reviews*, 18(1), 600–603. <https://doi.org/10.30574/wjarr.2023.18.1.0678>
- Elaadli, H., El-Makarem, H. A., Elrahma, A. H. A., Shaapan, R. M., & Bessat, M. (2023). Prevalence and associated risk factors of *Toxoplasma gondii* infection in sheep and aborted women in Egypt. *Iraqi Journal of Veterinary Sciences*, 37(2), 437–445. <https://doi.org/10.33899/ijvs.2022.133905.2319>

- Farouk, H. U., Manga, M. M., Yahaya, U. R., Laima, C. H., Lawan, A. I., Ballah, F. M., et al. (2020). Prevalence and determinants of *Toxoplasma* seropositivity among women who had spontaneous abortion in Gombe, North-Eastern Nigeria. *Journal of Advances in Medicine and Medical Research*, 32(10), 1–10. <https://doi.org/10.9734/jammr/2020/v32i1030556>
- Ghasemi, S., Rasti, S., Piroozmand, A., Bandehpour, M., Kazemi, B., Mousavi, A., et al. (2016). Toxoplasmosis-associated abortion and stillbirth in Tehran, Iran. *The Journal of Maternal-Fetal & Neonatal Medicine*, 29(2), 248–251. <https://doi.org/10.3109/14767058.2014.993604>
- Kheirandish, F., Ezatpour, B., Fallahi, S., Tarahi, M. J., Hosseini, P., Rouzbahani, A. K., et al. (2019). *Toxoplasma* serology status and risk of miscarriage, a case-control study among women with a history of spontaneous abortion. *International Journal of Fertility & Sterility*, 13(3), 184–189. <https://doi.org/10.22074/ijfs.2019.5581>
- Kostova, E. B., Prins, J. R., & van Wely, M. (2023). Role of infections in miscarriage. *Fertility and Sterility*, 120(5), 948–950. <https://doi.org/10.1016/j.fertnstert.2023.09.009>
- Mehdar, E. A., Rizk, H., Tarabulsi, M. K., Salah, A. N., Meinah, S. M., Abdulmohsen, E. T., et al. (2025). Awareness of the effect of *Toxoplasma gondii* on pregnant women among Jeddah University female students in Saudi Arabia: A cross-sectional study. *International Journal of Medicine in Developing Countries*, 9(2), 1–10. <https://creativecommons.org/licenses/by/4.0/>
- Mocanu, A. G., Stoian, D. L., Craciunescu, E. L., Ciohat, I. M., Motofeala, A. C., Navolan, D. B., et al. (2022). The impact of latent *Toxoplasma gondii* infection on spontaneous abortion history and pregnancy outcomes: A large-scale study. *Microorganisms*, 10(10), 1–12. <https://doi.org/10.3390/microorganisms10101936>
- Mohamed, M. Y., Abakar, A. D., Talha, B. A., & Nour, B. Y. M. (2017). Screening of *Toxoplasma gondii* antibodies in pregnant and aborted women attending Wad Medani Maternity Teaching Hospital and Um Algura Hospital using Toxo-Latex agglutination and electro-chemiluminescence immunoassay (ECLIA). *Arch Parasitol*, 1(1), 1–5.
- Mohammad, E. A. K., & Salman, Y. J. (2014). Study of TORCH infections in women with bad obstetric history (BOH) in Kirkuk city. *International Journal of Current Microbiology and Applied Science*, 3(10), 700–709. <http://www.ijcmas.com>
- Saif, N., Al Ameer, G., Alhweesh, M., Alkadasi, M., & Zaid, A. A. (2014). Seroprevalence of toxoplasmosis in pregnant women in Taiz-Yemen. *International Journal of Research in Medical Sciences*, 3(7), 680–690.
- World Health Organization. (2025). *Why we need to talk about losing a baby*. World Health Organization. [https://www.who.int/news-room/spotlight/why-we-need-to-talk-about-losing-a-baby?utm\\_source=chatgpt.com](https://www.who.int/news-room/spotlight/why-we-need-to-talk-about-losing-a-baby?utm_source=chatgpt.com)