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Toxoplasma gondii Prevalence and Risk Factors among Pregnant Women in Ibb Governorate, Yemen

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ABSTRACT

Background: Pregnant women and their fetuses are especially vulnerable to toxoplasmosis.
Objective: To assess the prevalence of Toxoplasma gondii and related risk factors in pregnant women at Ibb Governorate, Yemen.
Methods: A cross-sectional study with 415 pregnant women was carried out in Yemen's Ibb Governorate between June and October 2024. Anti-T. gondii antibodies were detected in serum samples by the enzyme-linked immunosorbent assay (ELISA). Data on potential infection risk factors linked to the infection were gathered by the administration of a questionnaire.
Results: The research found an overall seroprevalence of anti-T. gondii antibodies (IgG and/or IgM) of 55.9% (232/415; 95% Confidence Interval: 50.9%–60.9%). Among the participants, 45.0% (187/415) tested positive for IgG, 3.4% (14/415) for IgM, and 7.5% (31/415) for both. Binary regression analysis revealed significant risk factors for infection, including increasing age (Adjusted Odds Ratio [AOR] = 1.88; P = 0.006), history of blood transfusions (AOR = 2.03; P = 0.012), cat presence in the household (AOR = 1.86; P = 0.006), history of miscarriage (AOR = 2.76; P = 0.000), and history of giving birth to a baby with defects (AOR = 5.53; P = 0.002).
Conclusion: These findings indicate a high rate of toxoplasmosis in prenatal medical care clinics in Ibb Governorate, Yemen, underscoring the need for routine screening and health education on transmission modes.

Keywords: Toxoplasmosis; Anti-Toxoplasma gondii Antibodies; Pregnant Women; Risk Factors.

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INTRODUCTION

An obligatory intracellular parasite that causes toxoplasmosis in both people and animals. Pregnant women and their fetuses are especially vulnerable to this disease (1). The frequency of toxoplasmosis varies significantly depending on geographical region, dietary habits, and socioeconomic factors (2). The prevalence is significantly higher in developing countries than in developed countries. Nonetheless, the occurrence of toxoplasmosis ranges from 30% to 60% in both developed and developing regions (3).

Several factors contribute to the progression of toxoplasmosis, including the virulence of *Toxoplasma* strains, the size of the inoculum, the host's immune status, and its genetic background (4). An estimated 190,100 incident cases of congenital toxoplasmosis are thought to occur each year due to vertical transmission from mother to child during pregnancy, with a frequency of 1.5 neonatal cases per 1,000 live births worldwide (5).

A random-effects meta-analysis comprising 250 studies with 723,655 pregnant women was used to construct a global and regional estimate. Pregnant women's data were gathered from 1976 to 2017. The overall IgG seroprevalence in these investigations was 32.9%. The Western Pacific region had the lowest IgG seroprevalence at 11.2%, while the Americas had the highest at 45.2% among the WHO regions. On the other hand, 1.9% was the global IgM seroprevalence (6).

The Middle East has one of the highest prevalence rates in the world, with total infection rates ranging from 30% to 50% (2). Prevalence of anti-*T. gondii* IgG and IgM antibody among pregnant women in Saudi Arabia ranged from 8.6% to 51.4% and from 0% to 8.8%, respectively, according to a review of 20 studies (7). The current study aimed to assess the prevalence of *Toxoplasma gondii* and related risk factors in pregnant women at Ibb Governorate, Yemen.

METHODS

Study Design

From June to October 2024, a cross-sectional survey was conducted in three Ibb Governorate districts. A pre-tested questionnaire was first developed in English and then translated into Arabic, the local language. Data was collected by medical professionals from general maternity and pediatric clinics. The prenatal clinics performed a variety of procedures on pregnant mothers, including ultrasound imaging, laboratory testing, physical examinations, and assessments of medical histories. Serological data were obtained from collaborating private laboratories with patient consent in this study.

Study Setting

Three districts of Ibb Governorate participated in the study: Al-Dhihar, Al-Mashannah, and Jiblah, which are located south of Yemen's capital city, Sana'a (Figure 1). The region has a temperate climate, and its economy is primarily agricultural. According to the most recent census conducted by the Central Statistical System, the total population of Ibb Governorate is approximately 3,118,000 inhabitants, distributed across 20 districts. The study focused on most of the prenatal medical care clinics in these three districts.

Sample Size and Study Population

Using a 95% confidence level and a desired precision of 0.05, the sample size was calculated based on a previous study conducted in Dhamar Governorate (8). Around 415 pregnant women were enrolled, and the Medical Ethics Committee of Ibb University in Ibb, Yemen, approved the study protocol.

Ethical Considerations

The Ethics Committee of Ibb University's Faculty of Medicine and Health Sciences provided ethical approval (EC/24/13). Informed consent was obtained from pregnant women, who were asked to participate voluntarily after explaining to them the objectives of the study. Confidentiality of the study participants' data was assured.

Data Collection

Through face-to-face interviews, a pre-designed questionnaire was used to collect data from the participating women. Information collected from all pregnant participants included age, frequency of pregnancies, history of spontaneous abortions, number of living children, gestational period, place of residence (urban vs. rural), and occupation. Additionally, data were gathered on pet ownership, specifically regarding cats and other domestic animals (e.g., rats), whether participants kept cats as

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pets, and their consumption of animal milk (camel, cow, or goat). Lastly, the questionnaire assessed cooking and eating habits, such as the consumption of raw or undercooked meat. The level of knowledge regarding Toxoplasma infection was also evaluated.

Serological Examinations

Commercial enzyme-linked immunosorbent assay (ELISA) kits (AbiaToxoAbIgG and IgM Fast) were used to test sera for anti-*T. gondii* IgG and IgM. Antibody titers were categorized as either positive or negative based on the manufacturer's defined normal values. Each ELISA test had both positive and negative controls to guarantee the assay's technical performance and the reagents' integrity.

Statistical Analysis

IBM Corp.'s Statistical Package for the Social Sciences (SPSS, version 25) was used to enter and evaluate the data. The descriptive information gathered from the surveys and lab tests was displayed as percentages and frequencies. Using the Pearson chi-square test, differences and relationships between categorical variables were examined. Within the bivariate analysis, 95% CIs and adjusted odds ratios (ORs) were shown. Statistical significance was established at a *P*-value of less than 0.05. In order to determine independent predictors of infection and compute adjusted odds ratios (AORs), all variables that displayed a *P*-value of ≤ 0.05 in the bivariate logistic regression analysis were utilized. A *P*-value of less than 0.05 was deemed statistically significant. A comprehensive explanation of the data was also provided by the corresponding confidence intervals for non-significant comparisons.

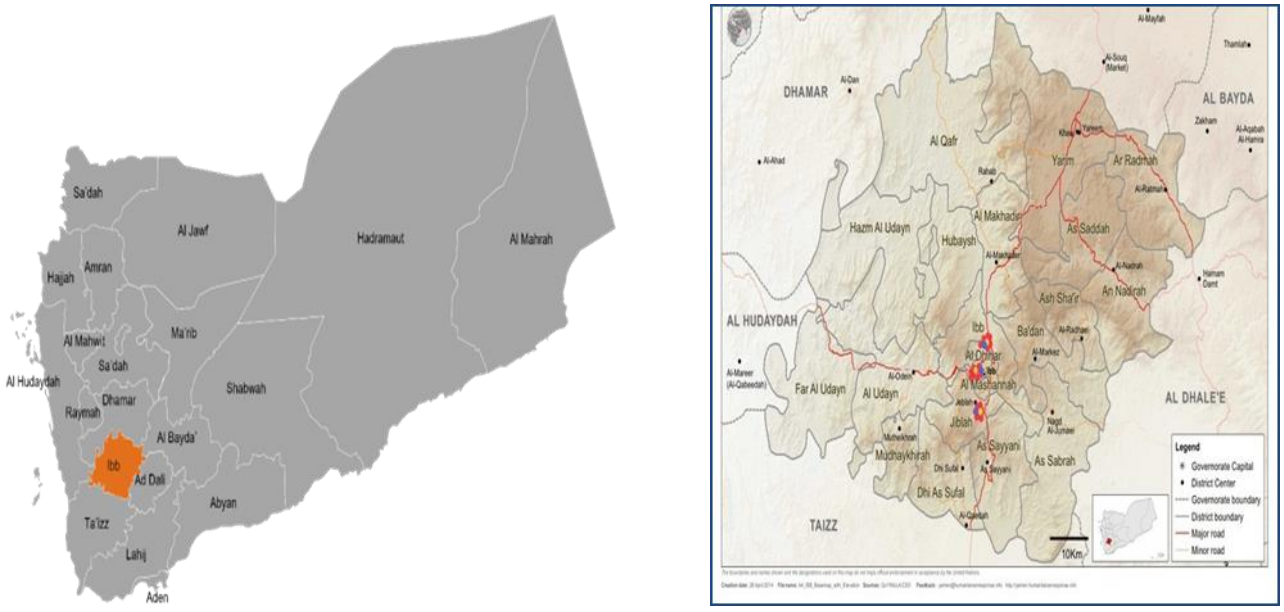

Figure 1: Map of Yemen showing the location of Ibb Governorate and the study area

RESULTS

General Characteristics of the Study Population

A total of 415 pregnant women aged between 17 and 48 years participated in the study, with an average age of 27 ± 6.6 years. In terms of age distribution, 154 women (37.11%) were under 25 years old, while those aged 25 years and older accounted for 261 women (62.89%). Less than half of the participants (195, 46.99%) lived in rural areas, whereas more than half (220, 53.01%) resided in urban areas. Most women (360 out of 415, 86.51%) were unemployed, while 55 (13.49%) were employed.

Regarding the stages of pregnancy, 242 women (58.3%) were in their first trimester, 114 (27.5%) were in the second trimester, and 59 (14.2%) were in their third trimester. In terms of abortion history,

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most pregnant women (229, 55.2%) reported no history of abortion, while 186 women (44.8%) indicated a history of abortion during their pregnancy. The broad demographic, obstetric, and social and economic characteristics of the study population are outlined in Table 1.

Table 1: Socio-demographic, Socioeconomic, and Behavioral Characteristics of Pregnant Women in Ibb Governorate, Yemen (n = 415).

Variable	Frequency	Percentage%
Age		
<25	154	**37.11%**
>=25	261	**62.89%**
Residence		
Urban	220	**53.01%**
Rural	195	**46.99%**
Occupation of women		
Employed	55	**13.25%**
Unemployed	360	**86.75%**
Gestational trimester		
1st trimester	242	**58.3%**
2nd trimester	114	**27.5%**
3rd trimester	59	**14.2%**
History of spontaneous abortion		
Yes	186	**44.8%**
No	229	**55.2%**

Seroprevalence of Anti-*Toxoplasma gondii* Antibodies (IgG & IgM) among Pregnant Women in Ibb Governorate, Yemen

The overall seroprevalence of anti-*T. gondii* antibodies (IgG and/or IgM) among the pregnant women was 55.9% (232/415; 95% Confidence Interval = 50.9%–60.9%). Among the participants, 45.0% (187/415) tested positive for anti-*T. gondii* IgG antibodies alone, 7.5% (31/415) were positive for both IgG and IgM antibodies, and 3.37% (14/415) tested positive for IgM antibodies alone, as shown in Table 2.

Table 2: Seroprevalence of Anti-*Toxoplasma gondii* Antibodies (IgG & IgM) Among Pregnant Women in Ibb Governorate, Yemen (n = 415).

Toxoplasma antibodies	No. tested	No. of positive cases	Percentage %
IgG alone	415	187	45.0%
IgM alone	415	14	3.40%
Both IgG & IgM	415	31	7.50%
Total	**415**	**232**	**55.90%**

Bivariate Analysis of Factors Associated with *T. gondii* Seroprevalence among Pregnant Women in Ibb Governorate, Yemen

The investigation found a strong correlation between the prevalence of *T. gondii* infection and the age of pregnant mothers. Age-related increases in seroprevalence were noted. Compared to those under

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25, pregnant women aged ≥25 years exhibited a significantly greater prevalence of *T. gondii* infection (64.4% [168/261] vs. 41.6% [64/154]; AOR = 1.88, 95% CI = 1.20–2.94, *P* = 0.006).

Compared to women without a history of spontaneous abortion, pregnant women with a history of abortion had a substantially higher correlation with *T. gondii* infection (69.3% [129/186] vs. 44.9% [103/229]; AOR = 2.76, 95% CI = 1.84–4.15, *P* = 0.000). Furthermore, compared to individuals who had not contracted *T. gondii*, giving birth to a baby with congenital anomalies was substantially associated with infection (AOR = 5.53, 95% CI = 1.85–16.51, *P* = 0.002).

The frequency of *T. gondii* infection was greater in pregnant women with a history of blood transfusion than in those without (75.0% [75/100] vs. 49.8% [157/315]; AOR = 2.03, 95% CI = 1.16–3.56, *P* < 0.001). An increased risk of infection was also linked to the presence of rats and cats in the home. The prevalence of *T. gondii* infection was found to be significantly higher among women who had cats than among those who did not (67.5% [100/148] vs. 49.8% [133/267]; AOR = 1.86, 95% CI = 1.19–2.90, *P* = 0.006).

Table 3: Bivariate Analysis of Factors Associated with *T. gondii* Seroprevalence among Pregnant Women in Ibb Governorate, Yemen (n = 415).

Variable	No	n(%)	OR(95%CI)	AOR(95%CI)	*P* value
Age					
<25	154	64(41.6)	Reference		
≥25	261	168(64.4)	2.54(1.69-3.82)	1.88(1.20-2.94)	**0.006***
Residence					
Urban	220	122(55.4)	Reference		
Rural	195	110(56.4)	0.96(0.65-1.42)	1.12(0.74-1.69)	**0.582**
Occupation of women					
Employed	55	29(52.7)	Reference		
Unemployed	360	203(56.3)	0.83(0.47-1.45)	0.94(0.52-1.71)	**0.941**
Gestational trimester					
1st trimester	242	130(53.7)	Reference		
2nd trimester	114	71(62.2)	1.42(0.90-2.24)	1.13(0.69-1.85)	**0.624**
3rd trimester	59	32 (54.2)	1.02(0.57-1.80)	0.77(0.39-1.51)	**0.778**
History of Spontaneous (abortion)					
No	229	103(44.9)	Reference		
Yes	186	129(69.3)	2.76(1.84-4.15)	2.76(1.84-4.15)	**0.000***
History of giving birth to a baby with congenital anomalies					
No	383	204(53.2)	Reference		
Yes	32	28(87.5)	6.14(2.11-17.84)	5.53(1.85-16.51)	**0.002***
Number of live children					
<3	310	156(50.3)	Reference		
≥3	105	76(72.4)	2.62(1.61-4.25)	0.91(0.43-1.91)	**0.901**
Having cats in the house					
No	267	133(49.8)	Reference		
Yes	148	100(67.5)	2.099(1.38-3.19)	1.86(1.19-2.90)	**0.006***
History of blood transfusions					
No	315	157(49.8)	Reference		
Yes	100	75(75.0)	3.01(1.82-2.62)	2.03(1.16-3.56)	**0.012***
Having cats in the neighbor					
No	158	79(50.0)	Reference		
Yes	257	153(59.5)	1.49(1.00-2.22)	1.36(0.89-2.08)	**0.155**
Having rodents(rats) in the house					
No	214	102(47.7)	Reference		
Yes	201	130(64.7)	2.01(1.35-2.98)	1.51(0.97-2.35)	**0.065**

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Raw meat Consumption					
No	177	95(53.6)	Reference		
Yes	238	137(57.5)	1.17(0.79-1.73)	1.00(0.65-1.55)	**0.976**
Shawarma Consumption					
No	109	65(59.6)	Reference		
Yes	306	167(54.6)	0.81(0.52-1.26)	1.16(0.68-1.98)	**0.574**
Raw milk consumption					
No	186	97(52.1)	Reference		
Yes	229	135(58.9)	1.37(0.92-2.62)	1.12(0.71-1.75)	**0.615**
Awareness of toxoplasmosis transmission of routes					
Yes	117	63(52.5)	Reference		
No	298	169(57.1)	1.12(0.73-1.72)	1.02(0.61-1.69)	**0.928**

DISCUSSION

This study is among the few in Yemen that investigate the prevalence of *T. gondii* infection among a significant clinical category of toxoplasmosis in immunocompetent hosts—pregnant women in Ibb Governorate. The overall seroprevalence of anti-*T. gondii* antibodies found in this study was 55.9%. The current findings align with previous studies conducted in Yemen, which reported seroprevalence rates ranging from 45.4% among pregnant women in northern Yemen (9) to 46.2% in Taiz (10) and 64.3% in Aden, southern Yemen (11).

Comparing our findings with those from other countries, the seroprevalence reported in this study (55.9%) is consistent with that in Egypt (57.9%) (12). However, higher seroprevalence rates have been reported in several countries, including Brazil (71%) (13), Lebanon (82.6%) (14), Ethiopia (85.3%) (15), and Ghana (92.5%) (16). In contrast, lower seroprevalence rates have been reported in Hodiedah Governorate (14.4%) (17), Sana'a City (18.7%) (18), Dhamar Governorate (21.2%) (8), Palestine (17.6%) (19), Saudi Arabia (24.1%) (20), and Turkey (30.1%) (21).

Globally, the variation in the seroprevalence of *T. gondii* infection can be attributed to 3.4% of the pregnant women tested positive for IgM antibodies alone various factors, such as differences in diagnostic methods with varying sensitivities and the prevalence of consuming raw or undercooked contaminated meat (13, 22, 23).

According to the current study, pregnant women with IgM antibodies alone had detectable levels of 3.37%, those with both anti-*T. gondii* IgM and IgG antibodies had 7.5%, and those with IgG antibodies alone had 45.0%. These findings indicate a lower seroprevalence of anti-*T. gondii* IgM antibodies alone, which may suggest early infection with toxoplasmosis during pregnancy. Early infection has been associated with spontaneous abortion, and it has been suggested that IgM seropositivity is associated with this risk (9, 24, 25).

On the other hand, the higher seroprevalence of anti-*T. gondii* IgG antibodies alone may indicate chronic infection. This higher prevalence has been reported in previous studies among pregnant women in Aden Governorate (11). Similarly, other studies conducted in Saudi Arabia (26), Egypt (27), Sudan (28), and Ethiopia (29) have reported comparable findings.

The current investigation also documented that domestic cats are a major contributing factor to *T. gondii* contamination (9, 11). These findings are consistent with the results reported in our study. Bivariate analysis revealed a statistically significant association between the age of pregnant women and the seroprevalence of *T. gondii* infection, with higher seroprevalence observed in women aged ≥25 years. This evidence is consistent with prior studies conducted in Taiz Governorate (10), Sana'a City (9), and Turkey (21). In Yemen, older women are often more involved in agricultural activities and animal rearing, which may increase their exposure to *T. gondii.* This could help explain the observed association.

The bivariate analysis also revealed a statistically significant association between giving birth to a deformed baby and *T. gondii* infection. However, this finding contrasts with a study conducted in Dhamar Governorate (8). This association may be attributed to fetal death resulting from disruptions in nutrient and oxygen transport due to vascular lesions formed in the placenta as a consequence of *T. gondii* infection, leading to lethal hypoxic damage to the fetus (30).

This association may suggest a potential link, though causality cannot be established.

Additionally, the present study documented a history of abortion as a significant risk factor for human toxoplasmosis, aligning with findings from Dhamar Governorate (8) and Taiz Governorate (25). There is a suggestion that *T. gondii* may be an etiological factor in miscarriage, particularly in cases where fetal losses exceed three (30).

Risk factors discussed in our study highlighted that rearing cats in the home was a significant risk factor for seropositivity. This finding is consistent with studies conducted in Dhamar Governorate (8) and Aden Governorate (11). Additionally, a history of blood transfusion was identified as a significantly associated risk factor for infection. Significant associations between blood transfusions and toxoplasmosis have also been reported in further studies conducted in Myanmar (32) and Mexico (33), which aligns with our findings. However, other studies, including those in Dhamar (8) and Ethiopia (34), reported no significant association between blood transfusions and toxoplasmosis, contradicting our results.

Currently, screening for *T. gondii* infection is not routinely performed in blood banks (35). The parasite is present in the blood in the form of tachyzoites, which are the invasive stage and can disseminate to other organs via the bloodstream (36). Therefore, the presence of *T. gondii*-infected blood poses a potential source of infection for pregnant women receiving transfusions, as indicated by our survey.

Blood transfusion is a worthwhile topic that might be improved by taking policy consequences into account, such as the creation and application of uniform screening procedures for *T. gondii* in blood banks. Transfusion safety could be increased by implementing such techniques as leukoreduction or targeted serological testing, especially for high-risk populations like expectant mothers. (37, 38).

In the present study, no significant association was found between seropositivity and the consumption of raw or undercooked meat (including shawarma). This finding is consistent with studies conducted in Dhamar Governorate (8), Khartoum, Sudan (39), and Turkey (21). However, it contrasts with a survey conducted in northern Brazil, where a significant association was observed between seropositivity for anti-*T. gondii* and the consumption of undercooked meat (13). Additionally, residence and gestational age showed no significant association with the seroprevalence of anti-*T. gondii* antibodies, which aligns with similar findings reported in Dhamar Governorate (8).

Limitations

This study has various limitations that should be recognized. First, data on potential risk factors were gathered via self-reported questionnaires, which may have introduced self-reporting bias and impacted the accuracy of the reported exposures. Second, the serological findings were not verified by polymerase chain reaction (PCR) testing, which may have provided a more precise diagnosis of *Toxoplasma gondii* infection and discriminated between active and prior infections. In addition, there was insufficient follow-up to track the progression or potential outcomes of infection during pregnancy, limiting the ability to assess long-term maternal and fetal consequences.

CONCLUSION

The study revealed a high prevalence of *Toxoplasma gondii* infection, indicating a significant public health concern for pregnant women and their offspring in Yemen. The findings highlight the importance of developing standard screening programs for toxoplasmosis during pregnancy in Yemen, and it is suggested that prenatal care services include routine screening and health education.

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Conflict of Interest

The author declares that there is no conflict of interest.

REFERENCES

[1] Chaudhry SA, Gad N, Koren G. Toxoplasmosis and pregnancy. *Can Fam Physician*. 2014;60(4):334–6.

[2] Pappas G, Roussos N, Falagas ME. Toxoplasmosis snapshots: global status of *Toxoplasma gondii* seroprevalence and implications for pregnancy and congenital toxoplasmosis. *Int J Parasitol*. 2009;39(12):1385–94.

[3] Shoukat T, Awan UA, Mahmood T, Afzal MS, Wasif S, Ahmed H, et al. Epidemiology of toxoplasmosis among the Pakistani population: a systematic review and meta-analysis. *Pathogens*. 2022;11(6):675.

[4] Sanchez SG, Besteiro S. The pathogenicity and virulence of *Toxoplasma gondii*. *Virulence*. 2021;12(1):3095–114.

[5] Torgerson PR, Mastroiacovo P. The global burden of congenital toxoplasmosis: a systematic review. *Bull World Health Organ*. 2013;91:501–8.

[6] Bigna JJ, Tochie JN, Tounouga DN, Bekolo AO, Ymele NS, Youda EL, et al. Global, regional, and country seroprevalence of *Toxoplasma gondii* in pregnant women: a systematic review, modelling and meta-analysis. *Sci Rep*. 2020;10(1):12102.

[7] Alzaheb RA. Seroprevalence of *Toxoplasma gondii* and its associated risk factors among women of reproductive age in Saudi Arabia: a systematic review and meta-analysis. *Int J Womens Health*. 2018;10:537–44.

[8] Al-Adhroey AHAKO, Mehrass AAKO, Al-Shammakh AA, Ali AD, Akabat MY, Al-Mekhlafi HM. Prevalence and predictors of *Toxoplasma gondii* infection in pregnant women from Dhamar, Yemen. *BMC Infect Dis*. 2019;19:1–9.

[9] Al-Eryani SM, Al-Mekhlafi AM, Al-Shibani LA, Mahdy MM, Azazy AA. *Toxoplasma gondii* infection among pregnant women in Yemen: Factors associated with high seroprevalence. *J Infect Dev Ctries*. 2016;10(6):667–72.

[10] Mahdy MA, Alareqi LM, Abdul-Ghani R, Al-Eryani SM, Al-Mikhlafy AA, Al-Mekhlafi AM, et al. A community-based survey of *Toxoplasma gondii* infection among pregnant women in rural areas of Taiz Governorate, Yemen: the risk of waterborne transmission. *Infect Dis Poverty*. 2017;6:1–6.

[11] Muqbil NA, Alqubatii MA. Seroprevalence of toxoplasmosis among women in Aden city, Yemen. *Arch Biomed Sci*. 2014;2(2):42–50.

[12] Bassiony H, Soliman N, El Tawab S, Eissa S, Eossa AS. Sero-prevalence and risk factors associated with *Toxoplasma gondii* infection among pregnant women in Alexandria, Egypt. *Int J Reprod Contracept Obstet Gynecol*. 2016;5(12):4220–8.

[13] Rocha ÉMD, Lopes CWG, Ramos RAN, Alves LC. Risk factors for *Toxoplasma gondii* infection among pregnant women from the State of Tocantins, Northern Brazil. *Rev Soc Bras Med Trop*. 2015;48(6):773–5.

[14] Nahouli H, El Arnaout N, Chalhoub E, Anastadiadis E, El Hajj H. Seroprevalence of anti-*Toxoplasma gondii* antibodies among Lebanese pregnant women. *Vector Borne Zoonotic Dis*. 2017;17(12):785–90.

[15] Abamecha F, Awel H. Seroprevalence and risk factors of *Toxoplasma gondii* infection in pregnant women following antenatal care at Mizan Aman General Hospital, Bench Maji Zone (BMZ), Ethiopia. *BMC Infect Dis*. 2016;16:1–8.

[16] Ayi I, Edu S, Apea-Kubi KA, Boamah D, Bosompem KM, Edoh D. Sero-epidemiology of toxoplasmosis amongst pregnant women in the greater Accra

region of Ghana. *Ghana Med J*. 2009;43(3).

[17] Al-Kadassy AM, Baraheem OH, Bashanfer SA, Ahmed Al-Kadassy CM. Prevalence of *Toxoplasma gondii* infection in women of child-bearing age in faculty of Medicine and health sciences Hodeida City, Yemen. *Pharma Innov J*. 2018;7(9):256–61.

[18] Abdul-Ghani R, Al-Nahari A, Yousef A, Al-Haj AA, Aqlan A, Jaadan E, et al. *Toxoplasma gondii* infection in relation to pregnancy characteristics and bad obstetric history among pregnant women seeking healthcare in Sana'a city, Yemen. *Yemeni J Med Sci*. 2019;13(1):10–22.

[19] Al Amleh S, Nijem KI. Seroprevalence and associated risk factors of toxoplasmosis among pregnant women in Hebron district, Palestine. *East Mediterr Health J*. 2009;15(5):1278–84.

[20] Aqeely H, El-Gayar EK, Perveen Khan D, Najmi A, Alvi A, Bani I, et al. Seroepidemiology of *Toxoplasma gondii* amongst pregnant women in Jazan Province, Saudi Arabia. *J Trop Med*. 2014;2014:913950.

[21] Ertug S, Okyay P, Turkmen M, Yuksel H. Seroprevalence and risk factors for *Toxoplasma* infection among pregnant women in Aydin province, Turkey. *BMC Public Health*. 2005;5:1–6.

[22] Wam EC, Sama LF, Ali IM, Ebile WA, Aghangu LA, Tume CB. Seroprevalence of *Toxoplasma gondii* IgG and IgM antibodies and associated risk factors in women of child-bearing age in Njinikom, NW Cameroon. *BMC Res Notes*. 2016;9:1–8.

[23] Boughattas S, Ayari K, Sa T, Aoun K, Bouratbine A. Survey of the parasite *Toxoplasma gondii* in human consumed ovine meat in Tunis City. *PLoS One*. 2014;9(1):e85044.

[24] Dubey JP. Oocyst shedding by cats fed isolated bradyzoites and comparison of infectivity of bradyzoites of the VEG strain *Toxoplasma gondii* to cats and mice. *J Parasitol*. 2001;87(1):215–9.

[25] Saif N, Al-Ameeri G, Alhweesh M, Alkadasi M, Zaid AA. Sero prevalence of toxoplasmosis in pregnant women in Taiz-Yemen. 2014;680–90.

[26] Al-Harthi SA, Jamjoom MB, Ghazi HO. Seroprevalence of *Toxoplasma gondii* among pregnant women in Makkah, Saudi Arabia. *Umm Al-Qura Univ J Sci Med Eng*. 2006;18(2):217–27.

[27] Tammam AE, Haridy MA, Abdellah AH, Ahmed SR, Fayed HM, Alsammani MA. Seroepidemiology of *Toxoplasma gondii* infection in women with first trimester spontaneous miscarriage in Qena Governorate, Egypt. *J Clin Diagn Res*. 2013;7(12):2870.

[28] Elnahas A, Gerais AS, Elbashir MI, Eldien ES, Adam I. Toxoplasmosis in pregnant Sudanese women. *Saudi Med J*. 2003;24(8):868–70.

[29] Gebremedhin EZ, Abebe AH, Tessema TS, Tullu KD, Medhin G, Vitale M, et al. Seroepidemiology of *Toxoplasma gondii* infection in women of child-bearing age in central Ethiopia. *BMC Infect Dis*. 2013;13:1–9.

[30] Hingorani V, Prakash O, Chowdhry P, Kamalam TS. Toxoplasmosis: abortions and stillbirths. 1970;58(7):967–74.

[31] Arranz-Solís D, Mukhopadhyay D, Saeij JJ. *Toxoplasma* effectors that affect pregnancy outcome. *Trends Parasitol*. 2021;37(4):283–95.

[32] Sint NH, Htun YM, Win TT, Mon AS, Lwin TZ, Maung LO, et al. Seroprevalence and associated risk factors of *Toxoplasma gondii* infection among slaughterhouse workers in Yangon Region, Myanmar: A

cross-sectional study. *PLoS One*. 2023;18(4):e0284352.

[33] Alvarado-Esquivel C, Sánchez-Anguiano LF, Hernández-Tinoco J, Ramos-Nevarez A, Estrada-Martínez S, Cerrillo-Soto SM, et al. Association between *Toxoplasma gondii* infection and history of blood transfusion: a case-control seroprevalence study. *J Int Med Res*. 2018;46(4):1626–33.

[34] Tarekegn ZS, Dejene H, Addisu A, Dagnachew S. Potential risk factors associated with seropositivity for *Toxoplasma gondii* among pregnant women and HIV infected individuals in Ethiopia: A systematic review and meta-analysis. *PLoS Negl Trop Dis*. 2020;14(12):e0008944.

[35] Arnold SJ, Kinney MC, McCormick MS, Dummer S, Scott MA. Disseminated toxoplasmosis. *Arch Pathol Lab Med*. 1997;121(8):869.

[36] Basavaraju A. Toxoplasmosis in HIV infection: An overview. *Trop Parasitol*. 2016;6(2):129–35.

[37] Wang T, Han Y, Pan Z, Wang H, Yuan M, Lin H. Seroprevalence of *Toxoplasma gondii* infection in blood donors in mainland China: a systematic review and meta-analysis. *Parasite*. 2018;25:36.

[38] Mardani A. *Parasite Epidemiol Control*. 2020.

[39] Ibrahim AM, Angara TE, Ismail AA. Seroprevalence of *Toxoplasma gondii* and *Brucella abortus* in dairy animals from the Sudan: Special emphasis to their serological co-existence. *J Appl Vet Sci*. 2016;1(1):37–42.