Journal of Amran University 05 (2025) p. 351-362

مجلة جامعة عمران

journal homepage: www.auy.edu.ye

Toxoplasma gondii Prevalence and Risk Factors Among Pregnant Women in Public Hospitals in Sana'a City, Yemen

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Received 1 Nov. 2025; accepted in final form 16 Dec. 2025.

Abstract

Background: Toxoplasmosis is caused by the intracellular protozoan organism Toxoplasma *gondii* and is a widespread disease that can progress to a serious systemic disease (congenital disease). Therefore, this study aimed to determine the prevalence of *T. gondii* infection and its risk factors among pregnant women in public hospitals in Sana'a City, Yemen. **Methods:** Two hundred and twenty pregnant women were selected for this study and screened for *T. gondii* antibodies (IgG and IgM) using enzyme-linked immunosorbent assay (ELISA). Demographic data, risk factors, complications, blood grouping, and behavioral data were collected using a pretested questionnaire via face-to-face interviews. **Results**: The total positivity rates for IgG and IgM antibodies were 15.9% and 5.9%, respectively. The highest prevalence was in the < 25 years (65.9%) for IgG and ≥ 25 years (53.9%) for IgM. A high rate of T. gondii was observed among pregnant women residing in urban areas: 25 (71.4%) for IgG and 9 (69.2%) for IgM. The high prevalence of *T. gondii* among pregnant women with O blood was 21 (60.0%) for IgG and 8 (61.5%) for IgM, and high-risk factors included rearing cats in the house (OR= 6.76; Cl= 3.30-13.4). **Conclusion:** This study reported a high seroprevalence among pregnant women in public hospitals in Sana'a City, Yemen. The identified risk factors included proximity to cats and domestic animals. Sanitation, health education, and personal hygiene are all required for promotion to avoid *T. gondii* infection among pregnant women.

Keywords: Seroprevalence, Pregnant women, Risk factors, Toxoplasmosis, Yemen.

الخلفية: داء المقوسات مرضٌ يُسببه طفيل المقوسة الغوندية، وهو مرضٌ واسع الانتشار قد يتطور إلى مرضٍ جهازي خطير (مرضٌ خلقي). لذلك، هدفت هذه الدراسة إلى تحديد مدى انتشار عدوى المقوسة الغوندية وعوامل الخطر المرتبطة بها بين النساء الحوامل في المستشفيات الحكومية بصنعاء، اليمن. **المنهجية:** تم اختيار 220 امرأة حامل لهذه الدراسة، وخضعن لفحص الأجسام المضادة للمقوسة الغوندية (IgG وIgM) باستخدام اختبار المقايسة المناعية الإنزيمية المرتبطة (ELISA). جُمعت البيانات الديموغرافية، وعوامل الخطر، والمضاعفات، وفصائل الدم، والبيانات السلوكية باستخدام استبيان من خلال مقابلات شخصية. **النتائج:** بلغت نسبة إيجابية الأجسام المضادة IgG و IgM 15.9% و5.9% على التوالي. وسُجل أعلى معدل انتشار في الفئة العمرية الأقل من 25 عامًا (65.9%) للأجسام المضادة IgG، وفي الفئة العمرية من 18 إلى 23 عامًا (46.2%) للأجسام المضادة IgM. لوحظ ارتفاع معدل الإصابة بداء المقوسات بين النساء الحوامل المقيمات في المناطق الحضرية: 25 حالة (71.4%) للأجسام المضادة IgG و9 حالات (69.2%) للأجسام المضادة IgM. وبلغ معدل انتشار داء المقوسات بين النساء الحوامل ذوات فصيلة الدم +O، 20 حالة (57.1%) للأجسام المضادة IgG و8 حالات (61.5%) للأجسام المضادة IgM، وشملت عوامل الخطر العالية تربية القطط في المنزل (نسبة الأرجحية = 6.76؛ فاصل الثقة = 3.30-13.4). **الخلاصة:** أظهرت هذه الدراسة ارتفاعًا في معدل انتشار الأجسام المضادة بين النساء الحوامل في المستشفيات الحكومية بمدينة صنعاء، اليمن. وشملت عوامل الخطر المحددة القرب من القطط والحيوانات الأليفة. وتُعد النظافة العامة والتثقيف الصحي والنظافة الشخصية من العوامل الضرورية للوقاية من عدوى داء المقوسات بين النساء الحوامل.

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Introduction

Toxoplasma gondii is an intracellular protozoan parasite with various intermediate hosts that infects mammals and birds [1]. There are two stages in the life cycle of this parasite: the intestinal stage in the final host and the extraintestinal stage in intermediate hosts, such as humans and other warm-blooded animals [2]. *T. gondi*i is mainly transmitted by ingestion of oocysts excreted by cats or by consuming raw or undercooked meat of infected animals containing tissue cysts. Tachyzoites of the parasite may pass through the placenta of infected pregnant women and infect the fetus, causing congenital toxoplasmosis [3-5]. *T. gondii* infection causes severe and life-threatening consequences in human beings, and it is particularly a great health concern for pregnant women and developing fetuses or newborns [6].

The detection of one or both IgM antibodies indicates an acute infection. Negative results may indicate either a very recent infection or the absence of infection [7, 8]. Furthermore, positive IgM results may be due to the unreliability of commercial test kits or because IgM can be detected in serum after the acute infection has resolved [9, 10]. To increase the sensitivity and specificity of serological development, additional confirmatory tests such as seroconversion and IgG avidity testing should be performed [11].

The incidence of toxoplasmosis in Arab countries ranges from approximately 30% to 50%, making it one of the most prevalent regions in the world. The widespread prevalence of this infection is likely due to its complex transmission patterns and the coevolution of the parasite with different hosts [12-14].

In Yemen, annual reports on *T. gondii* infection are based entirely on serological surveys, indicating varying seroprevalence across the country's governorates. The overall seroprevalence of *T. gondii* infection ranges from 14% to 65%, with a seroprevalence of toxoplasmosis-specific IgM antibodies ranging from 1.5% to 14% [16-19].

Yemen is an emerging nation that lacks policies and plans to manage or stop the spread of harmful microbes among its population [20-24]. Information on the frequency of *T. gondii* infection among pregnant women in the city of Sana’a is scarce. Thus, the goal of the current investigation was to ascertain the prevalence of *T. gondii* and risk factors among pregnant women in Sana’a city, Yemen.

Materials and Methods

Study area and period

This cross-sectional study, which was conducted from October 2024 to January 2025, was performed on pregnant women at childbearing age (between 18 and 40 years) from public hospitals in Sana’a City.

Data collection

Data were collected using a structured questionnaire that was administered to each pregnant woman who agreed to participate in the current study. The questionnaire included questions related to demographic, clinical data, and other information, including age, residence, education level, occupation, socioeconomic status, and knowledge of toxoplasmosis. In addition, information on potential risk factors that may be related to the prevalence of toxoplasmosis, such as eating behavior, kitchen hygiene, history of blood transfusion, owning cats, direct contact or handling of domestic cats, direct contact with cat boxes and soil, eating raw or undercooked meat, improperly washed vegetables or fruits, and history of blood transfusion, was collected.

Sample size

The sample size was estimated based on the WHO practical manual for sample size determination in health studies [25]. The sample size was estimated according to the prevalence of *T. gondii* in Dhamar governorate of Yemen (12.9%). The sample size was calculated using the following formula:

$$N = \frac{Z^2\ P\ (1 - P)}{d^2}$$

Where:

N represents the sample size required, Z = confidence level at 95% (where Z = 1.96), P indicates the expected prevalence or proportion (p = 12.9%) based on the prevalence of *T. gondii* in Dhamar [26], and d signifies the relative precision (with a margin of error of 5%, d = 5%). Therefore, the minimum sample size was 173. The sample size was increased (24% = 47) to increase the study's power and validity. Therefore, the final sample size was 220 participants.

Ethical statement

The study's ethical statement was approved by the Research Ethics Review Committee of the National University, Faculty of Medical Sciences, Medical Laboratory Department, Yemen. The college deans granted permission to initiate data collection. Before collecting specimens, the study's purpose was explained to the managers of pregnant women in public hospitals in Sana'a City, who agreed to participate. Informed consent was obtained verbally from the women participating in the study. Furthermore, participation was voluntary, and participants completed a consent form provided by the investigators.

Sample collection

In total, 5 ml of venous blood was collected from 220 pregnant women aged 18–40 years from public hospitals in Sana'a City. The blood specimens were then labelled, the blood group was determined, and they were transferred into an anticoagulant-free sterile bottle and allowed to clot. The clotted blood sample was centrifuged (3000 rpm, 5 min), and the serum (supernatant) was used to analyze *T. gondii* antibodies.

Laboratory assay

The screening of anti-T. gondii IgG and IgM antibodies in prepared plasma were performed using an enzyme-linked immunosorbent assay (ELISA) with the Toxoplasma IgG and IgM Kits (Hoffmann-La Roche Ltd., Zwitserland), which were based on the ELISA technique, and the procedures were carried out in accordance with the manufacturer's instructions. ELISA quality control (QC) involves several components: pre-analytical checks (such as kit integrity and temperature), assay-based controls (including positive and negative controls as well as standards), statistical monitoring (which encompasses run charts, Westgard rules, and t-tests), instrument calibration (for both the reader and washer), operator training, and proper pipetting. These measures ensure accuracy, precision, sensitivity, and specificity by detecting errors such as reagent issues, washing problems, or pipetting mistakes, and using QC samples to validate each run against defined acceptance criteria.

Blood group methods

The types of species were determined using the species identification kit (Bio Tech Co., Ltd., Germany) on a prepared microscope slide that had three circles drawn with a marker and labeled A, B, and D. Place a small drop of blood in each circle; add anti-A serum to circle A, anti-B serum to circle B, and anti-D serum to circle D. Mix the contents of each circle using a clean wooden or plastic rod; a reaction will appear within 20 to 60 seconds. Lastly, examine the agglutination either visually or under a microscope, and document the findings (Accu Bio Tech Co., Ltd., Germany).

Data analysis

The obtained data were analyzed using the Statistical IBM SPSS Statistics, version 21 (IBM Corp., Armonk, NY, USA). Categorical variables are presented as percentages and frequencies. Additionally, odds ratios (OR) and confidence intervals (95% CI) were used to evaluate the relationships between independent and dependent variables. Furthermore, at P-values < 0.05, all probability values were considered statistically significant.

Results

Socio-demographic parameters of study subjects

The current study targeted two hundred and twenty pregnant women aged between 18 and 40 years, with a mean ± SD of 26.70 ± 0.3691. Regarding age groups, the highest percentage (65.9%) was found in women aged < 25 years. Regarding residence, a high percentage (85.0%) were urban residents. According to occupation, a high percentage (92.3%) occurred in pregnant women who were unemployed. Furthermore, the education level shows the highest percentage (43.6%) of pregnant women with secondary certificates, (25.5%) with university degrees, (13.6%) with primary education, (11.4 %) with basic education (reading and writing), and (5.9%) illiterate. Regarding socioeconomic status, the highest percentage was for middle status (92.3%), as listed in Table 1.

Table 1. Socio-demographic characteristics of the participants.

Variables	Categories	No.	%
Age groups (Years)	< 25	145	65.9
	≥ 25	75	34.1
Residence	Rural	33	15
	Urban	187	85
Education level	Illiterate	13	5.9
	Basic (Read and write)	25	11.4
	Primary	30	13.6
	Secondary	96	43.6
	University	56	25.5
Occupation	Employed	17	7.7
	Unemployed	203	92.3
Income status	Low	15	6.8
	Middle	203	92.3
	High	2	0.9

Seroprevalence of Anti-*T. Toxoplasma gondi*i antibodies among the examined women

Table 2) illustrates the prevalence of *T. gondii*, where 35 examined women were found positive with IgG antibodies, giving 15.9%, whereas only 13 examined women were found positive with IgM antibodies, giving 5.9%, the rate of infection with toxoplasmosis. The total positivity rates for IgG and IgM antibodies were 15.9% and 5.9%, respectively.

Table (2). Seroprevalence of anti-*T. gondii* IgG and IgM antibodies among the examined women

Antibody types	Examined pregnant women (n = 220)			
	Positive		Negative	
	No.	%	No.	%
IgG	35	15.9	185	84.1
IgM	13	5.9	207	94.1

The study revealed that *T. gondii* infections were higher among the age group of < 25 years (62.9%) for IgG and ≥ 25 years (53.9%) for IgM. A high rate of *T. gondii* was observed among the pregnant women residing in the urban area (25; 71.4%) for IgG with a significant difference (P = 0.014) and 9 (69.2%) for IgM; those with a secondary certificate, 16 (45.7%) for IgG and 5 (38.5%) for IgM; those who were unemployed, 35 (100.0%) with IgG and 13 (100.0%) with IgM; and those with a middle income status, 31 (88.6%) with IgG and 12 (92.3%) with IgM with a significant difference (P = 0.019), as listed in Table 3.

Table 3. Prevalence of *T. gondii* (IgG and IgM) according to the sociodemographic characteristics of the participants

Variables	Subgroups	IgG antibodies			IgM antibodies		
		Positive No. (%)	Negative No. (%)	P-value	Positive No. (%)	Negative No. (%)	P-value
Age groups (Years)	< 25	22 (62.9)	132 (71.5)	3170.	6 (46.1)	127 (68.6)	<0.001
	≥ 25	13(37.1)	53 (28.5)		7 (53.9)	58 (31.4)	
Residence	Rural	10 (28.6)	23 (12.4)		4 (30.8)	29 (14.0)	
	Urban	25 (71.4)	162 (87.6)	0.014	9 (69.2)	178 (8)	0.101
Education level	Illiterate	3 (8.6)	10 (5.4)		0 (0.0)	13 (6.3)	
	Basic	4 (11.4)	21 (11.4)		3 (23.1)	22 (10.6)	
	Primary	3 (8.6)	27 (14.6)	0.857	3 (23.1)	27 (13.0)	
	Secondary	16 (45.7)	80 (43.2)		5 (38.5)	91 (44.0)	0.403
	University	9 (25.7)	47 (25.4)		2 (15.4)	54 (26.1)	
Occupation	Employed	0 (0.0)	17 (9.2)		0 (0.0)	17 (8.2)	
	Unemployed	35 (100)	168 (90.8)	0.062	13 (100)	190 (91.8)	0.282
Income status	Low	4 (11.4)	11 (5.9)		0 (0.0)	15 (7.2)	
	Middle	31 (88.6)	172 (93.0)	0.419	12 (92.3)	191 (92.3)	0.019
	High	0 (0.0)	2 (1.1)		1 (7.7)	1 (0.5)	

P value = P < 0.05: significant)

The present study revealed that the *T. gondii* infection was significantly higher among the pregnant women who rear cats in the house, 24 (68.6%) with IgG; the pregnant women who come in contact with the soil: 24 (68.6%) with IgG; the pregnant women who eat food from outside the home: 30 (85.7%) with IgG; the pregnant women who regularly wash kitchen knives: about 35 (100.0%) with IgG; the pregnant women who do not eat raw or undercooked meat: 33 (94.3%) with IgG; the pregnant women who wash fruits or vegetables before eating: about 35 (100.0%) with IgG; and the pregnant women who drink untreated water: 21 (60.0%) with IgG antibodies, with significant differences (P < 0.05). The high-risk factors were recorded in rearing cats in-house (OR = 6.67; Cl = 3.30-13.4), as listed in Table 4.

Table 4. Prevalence of *T. gondi*i (IgG antibodies) according to risk factors

Risk factors		IgG antibodies		Odd ratio 95% CI	χ2	P-value
		Positive No. (%)	Negative No. (%)			
Rearing cats in the house	Yes	24 (68.6)	168 (90.8)	6.67 3.30-13.4	12.003	0.002
	No	11 (31.4)	17 (9.2)			
Contact with soil	Yes	24 (68.6)	41 (22.2)	4.42 2.63-7.41	30.082	<0.001
	No	11 (31.4)	144 (77.8)			
Eating food from outside the home	Yes	30 (85.7)	156 (84.3)	1.07 0.46-2.51	0.043	0.997
	No	5 (14.3)	29 (15.7)			
Regularly washing a kitchen knife	Yes	35 (100)	181 (97.8)	2.14 0.12-37.73	1.026	0.794
	No	0 (0.0)	4 (2.2)			
Eating raw or undercooked	Yes	2 (5.7)	7 (3.8)	1.53 0.43-5.46	0.868	0.832
	No	33 (94.3)	178 (96.2)			
Washing fruits or vegetables before eating	Yes	35 (100)	173 (93.5)	0.84 0.24-2.95	10.721	0.013
	No	0 (0.0)	12 (6.5)			
Drinking untreated water	Yes	15 (42.9)	49 (26.5)	0.84 0.24-2.95	102.576	<0.001
	No	20 (57.1)	136 (73.5)			
Drinking unpasteurized milk	Yes	21 (60.0)	33 (17.8)	2.07 1.12-3.82	13.659	0.003
	No	14 (40.0)	152 (82.2)			

OR: Odd Ratio; 95% CI: 95% Confidence Interval; P value: Probability value <0.05 (significant)

The present finding showed that a high rate of *T. gondii* was reported among women who had undergone abortion before 18 (51.4% with IgG and 10 (76.9%) with IgM), with a significant difference ($P < 0.05$). Among the pregnant women who did not have premature births, 27 (77.1%) were positive for IgG and 7 (53.8%) for IgM. Among the pregnant women who did not give birth to children with eye problems, 35 (100.0%) and 13 (100.0%) were positive for IgG and IgM, respectively. Among the pregnant women who did not give birth to children with intellectual retardation, 35 (100.0%) and 13 (100.0%) were positive for IgG and IgM, respectively. Among the pregnant women who did not give birth to children who died after birth, 28 (80.0%) and 10 (76.9%) were positive for IgG and IgM, respectively. The highest prevalence of *T. gondii* IgG was present in pregnant women in the third trimester, 14 (40%), with a significant difference ($P < 0.05$), while the

highest prevalence of *T. gondii* IgM was present in pregnant women in the first trimester, 8 (61.5%), with a non-significant difference (P < 0.05), as listed in Table 5.

Table 5. Prevalence of *T. gondii* (IgG and IgM) according to complications of infection.

Complications		IgG antibodies			IgM antibodies		P-value
		Positive No. (%)	Negative No. (%)	P-value	Positive No. (%)	Negative No. (%)	
Abortion	Yes	18 (51.4)	49 (26.5)	0.003	10 (76.9)	57 (27.5)	<0.001
	No	17 (48.6)	136 (73.5)		3 (23.1)	150 (72.5)	
Early birthing	Yes	8 (22.9)	22 (11.9)	0.083	6 (46.2)	24 (11.6)	<0.001
	No	27 (77.1)	163 (88.1)		7 (53.8)	183 (88.4)	
Children with eye problems	Yes	0 (0.0)	2 (1.1)	0.537	0 (0.0)	2 (1.0)	0.722
	No	35 (100)	183 (98.9)		13 (100)	205 (99.0)	
Children with mental retardation	Yes	0 (0.0)	3 (1.6)	0.448	0 (0.0)	3 (1.4)	0.662
	No	35 (100)	182 (98.4)		13 (100)	204 (98.6)	
Death after birthing	Yes	7 (20.0)	15 (8.1)	0.32	3 (23.1)	19 (9.2)	0.105
	No	28 (80.0)	170 (91.9)		10 (76.9)	188 (90.8)	
Trimester	First	13 (37.1)	53 (28.6)	0.430	8 (61.5)	58 (28.0)	0.018
	Second	8 (22.9)	61 (33.0)		4 (30.8)	65 (31.4)	
	Third	14 (40.0)	71 (38.4)		1 (7.7)	84 (40.6)	

(P value = P < 0.05: significant**)**

Table (6) shows the prevalence of *T. gondii* antibodies among the participants in relation to blood groups. In addition, Table 6 lists the high prevalence of *T. gondii* among pregnant women with blood group O, with 21 (6.0%) having IgG antibodies and 8 (61.5%) having IgM antibodies. However, there was no statistically significant association between blood groups and the presence of *T. gondii* with IgG antibodies and IgM infection (P > 0.05).

Table (6): Association between positive *T. gondii* antibodies and blood groups.

Blood groups	*T. gondii* antibodies					
	IgG antibodies			IgM antibodies		
	Positive	Negative	*P. value*[*]	Positive	Negative	*P. value*[*]
	No. (%)	No. (%)		No. (%)	No. (%)	
O	21 (60.0)	117 (63.2)		8 (61.5)	130 (62.3)	
A	13 (37.1)	52 (28.1)		4 (30.8)	61 (29.5)	
B	1 (2.9)	14 (7.6)	0.751	1 (7.7)	14 (6.7)	0.941
AB	0 (0.0)	2 (1.1)		0 (0.0)	2 (1.0)	
Total	35 (100.0)	185 (100.0)		13 (100.0)	207 (100.0)	

(P value = P < 0.05: significant**)**

Discussion

Toxoplasmosis is a zoonotic infection that occurs worldwide. Humans become infected through various routes, such as ingestion of raw or undercooked meat containing tissue cysts (bradyzoites), ingestion of cysts in soil, or through contaminated food and water [16]. It can cause serious complications in pregnant women, such as intellectual retardation, miscarriage, and damage to the eyes and nervous system [27, 28].

In the current study, approximately 35 cases of pregnant women in this study were positive for *T. gondii* IgG antibodies, with a prevalence of (15.9 %), this prevalent is lower than the study carried out by Al-Eryani et al. (2016) among pregnant women in Sana'a City (43.7 %), Aden City (53.5 %), and rural areas of Taiz governorate 46.2 % [17, 29], but higher than the result shown in the study carried out on pregnant women in Dhamar (12.9 %), and in Sana'a governorate (6.0%) [26, 30], and this rate is lower than that reported in other countries such as Brazil (71%), Lebanon (82.6%), Ethiopia (85.3%), Ghana (92.5%), and Libya (32.7%) [31–35]. Variations in the seroprevalence of toxoplasmosis may be due to differences in geographical location and characteristics of the study participants, such as age, educational level, cat handling, hygiene, and feeding habits. The use of different serological methods may also contribute to these discrepancies. In contrast, the current study showed that only 13 pregnant women were positive for *T. gondii* IgM, with a prevalence of (5.9 %), which is lower than that reported by Al-Eryani et al. among pregnant women in Sana'a city (9.1 %) [17] and also lower than the study conducted by Muqbil and Alqubatii among women in Aden city (14.0 %) [18]. However, the prevalence of *T. gondii* IgM Ab in the present study is higher than that reported by Al-Adhroey et al. [26] in pregnant women from Dhamar (1.2 %) and also higher than that reported by Mahdy et al. in pregnant women in rural areas of Taiz governorate (3.3 %) [29]. The prevalence of *T. gondii* IgM in the present study was higher than that reported in several regional and cosmopolitan studies [36, 37] but lower than that reported in other studies [38, 39].

In the current study, a higher prevalence of *T. gondii* IgG was observed among individuals aged < 25 years, which is consistent with many local and global studies [39] but inconsistent with previous studies [17, 18, 32] that showed a higher prevalence rate among women older than 25 years. The

higher prevalence of *T. gondii* IgM in the present study was observed among pregnant women in the age group of ≥ 25 years, with a statistically significant association (P > 0.05).

This study indicated that the higher prevalence of *T. gondii* IgG occurs among pregnant women during the third trimester without a statistically significant association, whereas the higher prevalence of *T. gondii* IgM occurs among pregnant women during the first trimester with a statistically significant association, which is similar to some previous studies [18, 29] and inconsistent with previous local [18] and global studies [38, 40]. In relation to premature birthing, a high prevalence of *T. gondii* Ab occurred among pregnant women who were not exposed to early birthing, with a statistically significant association only with *T. gondii* IgM. This result was inconsistent with a previous study [26].

In relation to risk factors, the current study showed a high prevalence of *T. gondii* among women who rear cats at home, with a statistically significant association. This finding was in disagreement with that of previous local and global studies [30, 38, 40] and was in agreement with several previous local and global studies [17, 41-42], which showed a statistically significant association. In relation to drinking unpasteurized milk, the high prevalence of *T. gondii* among pregnant women who drink unpasteurized milk was statistically significant. This result was inconsistent with some previous local studies [26], which did not indicate a statistically significant association, and several previous global studies [40, 41], which found a significant association. There are various explanations for Yemen's high prevalence of Toxoplasmosis infections, particularly in Sana'a city. These challenges encompass living situations, environmental factors, economics, a lack of public health awareness, a lack of sanitary facilities and infrastructure, and a lack of access to safe drinking water [43-45].

The present study showed a high prevalence of toxoplasmosis among pregnant women who had blood group type O, without a statistically significant association; this result was inconsistent with many previous global studies [46, 47]. Finally, the World Health Organization provided several tips to avoid infection with *T. gondii*, including washing hands thoroughly with soap and water before and after eating, before preparing food, and after using the bathroom; non-contact with cats; washing vegetables and fruits before eating them; avoiding ready-made food from unknown brands; drinking only pasteurized milk; and boiling water properly or using clean, boiled water [48].

This study has several limitations that should be considered, including the use of rapid testing techniques, which may have yielded unreliable results, particularly regarding the prevalence of IgM antibodies. We were unable to confirm serological findings using polymerase chain reaction (PCR), which would have provided a more accurate diagnosis of toxoplasmosis infection and differentiated between active and past infections. Furthermore, the follow-up period was insufficient to monitor the progression of the infection or its potential consequences during pregnancy, thus limiting the ability to assess long-term effects on the mother and fetus.

Conclusion

This study revealed a high prevalence of *T. gondii* infection, indicating a public health problem among pregnant women in Yemen. These findings highlight the importance of developing standardized screening programs for toxoplasmosis during pregnancy in Yemen. These findings draw attention to the need to integrate health education, prenatal counselling, and routine screening for toxoplasmosis into antenatal care services.

Conflict of Interest

The authors have no conflict of interest.

Acknowledgments

The authors would like to thank the team investigators, including Asma'a Saleh, Amal Abdalhameed, Emtenan Shamsan, Entesar Al-Mansory, Bushra Sharhan, Haneen Al-Hakimi, Rola Al-sanawi, Shaima Al-marpa'ai, Monia Al-hraishi, and

Hadeel Al-qubati, for their generous help in collecting data and specimens. All authors would like to express their gratitude to the pregnant women at the public hospitals in the City of Sana'a for their help with sample collection.

Author Contributions

Al-Wajeeh and Al-Hadheq conceived and designed the experiments; Al-Wajeeh performed the experiments; and Al-Wajeeh, Al-Sheikh, and Edress analyzed the data and wrote the first draft of the manuscript. Almansoob and Alkhazan agreed with the results and conclusions of the manuscript. All authors read, revised, and approved the final manuscript.

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