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RESEARCH ARTICLE

TOXOPLASMOSIS IN PREGNANT WOMEN IN YEMEN: THE IMMUNE STATUS AND POTENTIAL RISK FACTORS

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Abstract

Background and aims: Toxoplasmosis is caused as a result of intracellular protozoan organism, *Toxoplasma gondii*, and is a widespread disease. Toxoplasmosis can progress to a serious systemic disease (congenital form); once a mother becomes infected for the first time for the period of pregnancy, a transient haematopoietic parasite can appear with focal lesions produced within the placenta, thus infecting the fetus. Therefore, this cross-sectional study aimed at assessing the immune status of the pregnant woman towards toxoplasmosis, determining the prevalence of *T. gondii* in Amran city -Yemen, and identifying the potential risk factors that affect the pregnant woman towards toxoplasmosis.
Subjects and methods: This study included 280 pregnant women who were admitted to maternity clinics at Amran General Hospital and Family Health Center in Amran City -Yemen during the period from December 2016 to June 2017. The questionnaire was used to obtain relevant demographic data and potential risk factors. Then, blood samples were collected from pregnant women and tested for identification of IgM and IgG antibodies against *T. gondii* using the ELISA technique.
Results: The total positive rate for IgM antibodies was 3.6%, while for IgG was 27.9%. A high IgM rate equal to 5.3% was observed in the 31-35 age group, and a higher IgG rate (36.8%) was observed in the same age group. There were 69.3% of pregnant women susceptible to infection with toxoplasmosis, 2.9% recently infected, 27.1% protected, and 0.7% had secondary infection. The high rate of IgM positivity was observed in the second trimester of pregnancy (4.7%), while the lowest rate was in the third trimester of pregnancy (2%). A slight increase in the rate of IgG positivity was observed in the third trimester of pregnancy (32%). There was a significant association between contact with animals such as cats and infection with toxoplasmosis, where OR=5.4, CI=1.01-30.13, χ^2=4.59, p=0.04. While there was no significant association with the other studied factors.
Conclusions: Yemen has less seropositivity than other Arab and African countries as a result of variation in risk factors. Data on *T. gondii* infection during pregnancy is scarce in numerous countries, in particular where there is a lack of political constancy such as Yemen. The risk factors identified included proximity to the cats and domestic animals, and increased maternal age. Toxoplasmosis in pregnancy in Yemen may be a really underestimated health problem. More research is needed.
Keywords: Immunological status, pregnant women, risk factors, Toxoplasmosis, Yemen.

INTRODUCTION

Toxoplasma gondii (*T. gondii*), a widespread single-celled parasite that is an intracellular parasite, is one of the most successful eukaryotic pathogens infecting warm-blooded vertebrates comprise humans, and is capable of causing toxoplasmosis[1,2]. The distribution and its capability to preserve a benign symbiosis with its host is a trait that allows it to be widely seen as one of the most successful parasites on Earth[2]. It is estimated that equal to a third of the world's population is carriers of *toxoplasma* infection, and the life cycle of

this parasite participates a large role in its simplicity of transmission[3,4]. Toxoplasmosis is found in every country and rates of seropositivity range from 10% to 90%[5,6]. Globally, more than 6 billion people are infected with *T. gondii*[7]. Humans are generally infected by oral intake of food, water, or ingestion soil polluted with oocycts, or by ingestion of raw vegetables and undercooked meat contaminated with cysts of *T. gondii*[8]. Though *T. gondii* infection is very common, the clinical implication in the immunocompetent host is benign and asymptomatic and only in about 10% of cases, cervical or occipital lymphadenopathy and ocular disease may occur[9]. The significance is mainly attributable to primary infection during pregnancy that may result in congenital Toxoplasmosis, abortions, perinatal deaths and still births[5]. This comprises a wide range of symptoms, expanding from mild chorioretinitis, which can appear many years after birth, to mental retardation, miscarriage, hydrocephalus, microcephaly and seizures[10,11].

Moreover, reactivation of latent infection in immunocompromised conditions may occur resulting in *T. gondii* encephalitis or disseminated infections[9,12]. Its infection induces several immunological changes in the body which are characterized by the production of the immunoglobulins IgM, IgG and IgA[13]. Detection of toxoplasmosis is at present based on serological techniques including examination of IgM and IgG antibodies, the former indicating recent infection while the latter indicating previous exposure with protective immunity[2,14].

The overall incidence rate of Toxoplasmosis in Arab countries is approximately 30% to 50%, making it among the global regions with the highest prevalence. The broad distribution of the infection is likely due to its complex transmission patterns and co-evolution of the parasite with multiple hosts[15-17]. In Yemen, data on infection among females of childbearing age or during pregnancy are limited. Moreover, few studies have been conducted recently on vulvovaginal candidiasis during pregnancy, vaccination against tetanus among pregnant women, its prevalence, potential risk factors, awareness of congenital CMV, rubella virus infection in pregnant women and markers of hepatitis B virus serum among pregnant women[18-23]. In Yemen, pregnant women are not routinely screened for *T. gondii* during pregnancy, and there is no follow-up. Thus, the current study was carried out to reveal the state of sero-epidemics and potential risk factors for *T. gondii* in pregnant women in Amran area in Yemen.

METHODS

A cross-sectional study was completed during the interval from December 2016 to June 2017. Two hundred and eighty pregnant women, who were attended to the obstetrical clinics in General Amran Hospital, and Family health Centers in Amran city, Yemen, were included in this study.

Inclusion criteria: Inclusion criteria included pregnant women attended to the obstetrical clinics in General Amran Hospital, and Family health Centers in Amran city.

Exclusion criteria: Exclusion criteria included non-pregnant women, pregnant women with active diseases such as tuberculosis, etc., receiving treatment with immunosuppressive drugs, or suffering from immunodeficiency diseases.

Data collection: A full history was taken from each studied pregnant woman, and the findings were written down in predesigned questionnaire. The collected data included: Demographic characteristics of participant, and information about the risk factors.

Sample Collection: Four to five ml of venous blood samples were obtained from each pregnant into a plain tube. Then sera were separated from clotted blood and kept in freezer at (-20ºC) until tested. The samples were tested for the presence of anti-toxoplasma (IgM and IgG) antibodies by using an Enzyme Linked Immunosorbent Assay (ELISA) commercial available (Ratio Diagnostics, RD, Germany).

Ethical considerations

During data collection, pregnant women who gave their written consent for screening of their blood to detect *T. gondii* antibodies were selected. Brief explanation of the objective and the significance of the study were given to each participant in order to obtain verbal consent and to have the signature to avoid misunderstanding. The study proposal was evaluated and approved by the Ethics Committee of Faculty of Medicine and Health Sciences, Sana'a University with a reference number (102) dated 10-04-2016. Also, all data, including patient identification, have been kept confidential.

Statistical analysis

Data were recorded using appropriate descriptive statistics (including frequency, mean, and standard deviation). The odds ratio (OR) was used to determine the strength of the association between two events, such as positive IgG with age, gestation stages, and residence. The association between infection with toxoplasmosis with risk factors as contact with animals etc. The two events in the current study were independent if and only if OR was equal to 1. For sample constraints of odds ratio in small numbers (less than 5), Fisher's exact test was used as an alternative estimator for the association between events in the current study.

RESULTS

The study results illustrated on 5 tables: Table 1 shows the serum level of *Toxoplasma* IgM and IgG antibodies for different age groups of pregnant women. The total positive rate for IgM antibodies was 3.6%, while for IgG was 27.9%. A high IgM rate equal to 5.3% was observed in the 31-35 age group, and a higher IgG rate (36.8%) was observed in the same age group. Table 2 shows the serological patterns of *T. gondii* pregnant women. There were 69.3% of pregnant women susceptible to infection with toxoplasmosis (negative for IgG and IgM), 2.9% recently infected (positive for IgM only), 27.1% protected (IgG positive only), and 0.7% were secondary infected (IgM and IgG positive). Table 3 shows the association of *Toxoplasma* IgM antibodies with stages of pregnancy.

The high rate of IgM positivity was observed in the second trimester of pregnancy (4.7%), while the lowest rate was in the third trimester of pregnancy (2%). Table 4 shows the association of *Toxoplasma* IgG antibodies with stages of pregnancy. A slight increase in the rate of IgG positivity was observed in the third trimester of pregnancy (32%). Table 5 shows the association of *toxoplasma* IgG antibodies with potential risk factors. There was a significant association between contact with animals such as cats and infection with toxoplasmosis among pregnant women, where OR=5.4, CI=1.01-30.13, χ^2=4.59, p=0.04. While there was no significant association with the other studied factors.

Table 1: Seroprevelance of *Toxoplasma* IgM and IgG antibodies for different age groups of pregnant women in Amran city– Yemen 2017.

Age groups(years)	*Toxoplasma* antibodies positive			
	IgM		IgG	
	No.	%	No.	%
16-20 (n=30)	1	3.3	8	26.7
21-25 (n=101)	3	3.0	24	23.8
26-30 (n=63)	2	3.2	16	25.4
31-35 (n=57)	3	5.3	21	36.8
≥36 (n=29)	1	3.4	9	31.0
Total (n=280)	10	3.6	78	27.9

Table 2: Serological patterns in pregnant women for *T. gondii* in Amran city –Yemen 2017.

Serological pattern	Number	Percentage	Status
Negative Toxo-IgM with Negative Toxo-IgG	194	69.3	Susceptible
Positive Toxo-IgM only	8	2.9	Infected (recently)
positive Toxo-IgG only	76	27.1	Protected
Positive Toxo-IgM with positive Toxo-IgG	2	0.7	Infected (secondary)
Total	280	100.0	

Table 3: The association of *Toxoplasma* IgM antibodies with gestational stages of pregnant women in Amran city-Yemen 2017.

Trimesters	*Toxoplasma* IgM antibodies				χ^2	*p*
	Positive		Negative			
	No.	%	No.	%		
First trimester (n=74)	2	2.7	72	97.3		
Second trimester (n=148)	7	4.7	141	95.3	1.06	0.58
Third trimester (n=50)	1	2.0	49	98.0		
Total N=272*	10	3.6	262	96.3		

DISCUSSION

This study showed an overall 27.9% sero-prevalence of anti-*T. gondii* IgG antibody among pregnant women in Amran City (Table 1).This result is within the range of seroprevalence of anti- *T. gondii* IgG antibody among pregnant women reported in previous studies in which they have shown a seropositivity rate in Arab region ranging from 22.9 to 58.2%[24-27].This results was lower than that reported from Saudi Arabia, which it range from 38-61%[27-29]. While 27.9% seroprevalence of anti-*T. gondii* antibody was slightly higher than that reported from UAE (22.9%)[24]. When age was considered as a factor effects the prevalence of anti-*T. gondii* IgG antibody among pregnant women there was slight evaluating in the prevalence of anti-*T. gondii* IgG antibody with increasing age of pregnant women, e.g. rate in age group 20-24 years was 23.8%, this rate rise to 36.8% in age group 30-34 years (Table 1). This is similar to the results in the North Africa region, where the seroprevalence of *T. gondii* is higher in older age groups compared to younger age groups[30,31], indicating that *T. gondii* may increase with age.

Table 4: The association of *Toxoplasma* IgG antibodies with stages of pregnancy in Amran city-Yemen 2017.

Trimesters	*Toxoplasma* IgG antibodies				χ^2	*P*
	Positive		Negative			
	No.	%	No.	%		
First trimester (n=74)	22	29.7	52	70.3		
Second trimester (n=148)	38	25.7	110	74.3	0.90	0.63
Third trimester (n=50)	16	32.0	34	68.0		
Total (n=272*)	76	27.9	196	72.1		

*8 missing cases. χ^2 Chi square ≥ 3.84 (significant), p Probability value ≤ 0.05 (significant)

This high rate of seropositivity at older ages may be the result of prolonged exposure to high environmental contamination of toxoplasma oocytes from animal sources, inadequate hygiene, and climatic factors appropriate for oocyst survival[32]. There was a significant association between *T. gondii* infection and contact with domestic animals or farm animals (OR =5.4, CI=1.01-30.13, χ^2=4.59, p=0.04). Current results are similar to what Fakhfakh *et al.*,[31] and Zemene *et al.*,[33] findings showing that contact with animals, especially cats, is significantly associated with toxoplasmosis seropositivity. There was no association between eating uncooked or raw meat (OR rate 1.08, 95% CI=0.13-8.99; p=0.939) and *T. gondii* seropositivity in the current study. This finding is contradicted by Walle *et al.*, study[34] in Africa where there is a strong association between eating undercooked or raw meat (OR=5.73, 95% CI=1.35-24.39; p=0.02) and toxoplasmosis[34-37]. These results can be explained by the fact that daily consumption of raw meat is very common in many parts of Africa[38-40]. There was no significant association between residence in rural areas (OR=1.05, 95% CI=0.41 -1.6; p=0.47) and *T. gondii*-positive antibody (Table 5).

Table 5: The association of *Toxoplasma* IgG antibodies with potential risk factors among pregnant women in Amran city –Yemen 2017.

Risk factors		*Toxoplasma* IgG antibodies				OR	CI	χ^2	*P*
		Positive		Negative					
		NO	%	No	%				
Contact with animals (cat)	Yes (n=6)	4	66.7	2	33.6	5.40	1.01-30.13	4.59	0.04*
	No (n=274)	74	27.0	200	73.0				
Contact with soil	Yes (n=43)	10	23.3	33	76.7	0.75	0.35-1.60	0.54	0.29
	No (n=233)	67	28.8	166	71.2				
Consumption of uncooked meat	Yes (n=29)	5	17.2	24	82.8	0.49	0.18-1.36	1.90	0.12
	No (n=248)	73	29.4	175	70.6				
Consumption of raw vegetables	Yes (n=209)	57	27.3	152	72.7	0.86	0.46-1.61	0.20	0.38
	No (n=63)	19	30.2	44	69.8				
Residence	Urban (n=150)	42	28.0	108	72.0	1.05	0.62-1.78	0.03	0.47
	Rural (n=124)	36	29.0	88	71.0				

OR Odd ratio > 1 at risk, CI Confidence intervals, χ^2 Chi square ≥ 3.84 (significant), p Probability value ≤ 0.05 (significant)

These results differ from studies conducted in Egypt and Saudi Arabia, where they located that live in a rural region was an independent predictor of toxoplasmosis[27,39]. The elevated prevalence in rural regions is an acceptable result in places where there are deprived sanitation facilities, contact with soil or animals, and drinking unpasteurized or un-boiled water and milk, but these conditions are similar in rural and urban areas in Yemen, so there was a similar prevalence in rural areas and urban areas in current study. Unwashed raw vegetables or fruits consumption has been reported as a non-significant factor for *T. gondii* infection in the current study (OR=0.86, 95% CI=0.46 -1.6; p=0.38). This result differs from studies conducted in the Arab countries and China where the seropositivity of toxoplasmosis was significantly associated with eating vegetables that had not been washed[35,40]. It was found that the seropositivity of *T. gondii* is not significantly correlated with soil contact in the current study (OR=0.75, 95% CI=0.35-1.0; p =0.29). This is separate from the results reported by several studies elsewhere which found that soil contact was associated with increased toxoplasmosis infection[27,32,41,42].

CONCLUSIONS

Yemen has the lowest seropositivity than other Arab and African countries because of dissimilarity in risk factors. Information on *T. gondii* infection during pregnancy is scarce in various countries, in particular where there is a lack of political stability such as Yemen. Risk factors identified integrated proximity to cats and pets, and increased maternal life. Toxoplasmosis during pregnancy in Yemen may be a health problem that has not really been underrated. More research is needed.

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AUTHOR'S CONTRIBUTION

Alqaisi NANS: writing original draft, methodology. **AL-Mekhlafi AM:** investigation, conceptualization, literature survey. **Al-Shamahy HA:** supervision. **Al-Rukeimi AAD:** data curation, conceptualization. **Foras KA:** interpretation of data. **Sheiban AA:** formal analysis, critical review. All authors revised the article and approved the final version.

DATA AVAILABILITY

The data and material are available from the corresponding author on reasonable request.

CONFLICT OF INTEREST

None to declare.

REFERENCES

1. Bogitsh BJ, Carter CE, Oeltmann TN. Human parasitology. Academic Press; 2013.

2. El-Shahawy IS, Khalil MI, Bahnass MM. Seroprevalence of *Toxoplasma gondii* in women in Najran City, Saudi Arabia. Saudi Med J 2014; 35(9):143-1146. *PMID: 25228193*
3. Jiang W, Sullivan AM, Su C, Zhao X. An agent-based model for the transmission dynamics of *Toxoplasma gondii*. J Theor Biol 2012; 293:15-26. *https://doi.org/10.1016/j.jtbi.2011.10.006*
4. Shirbazou S, Delpisheh A, Mokhetari R, Tavakoli G. Serologic detection of anti *Toxoplasma gondii* infection in diabetic patients. Iran Red Crescent Med J 2013; 15(8):701-703. *https://doi.org/10.5812/ircmj.5303*
5. Tenter AM, Heckeroth AR, Weiss LM. *Toxoplasma gondii*: from animals to humans. Int J Parasitol 2000; 30:1217–1258. *https://doi.org/10.1016/S0020-7519(00)00124-7*
6. Robert-Gangneux F, Dardé ML. Epidemiology of and diagnostic strategies for toxoplasmosis. Clin Microbiol Rev 2012; 25(2):264-96. *https://doi.org/10.1128/CMR.05013-11*
7. Singh M, Ranjan R, Pradeep Y, Quereshi S, Sahu M. Seroprevalence of toxoplasmosis in pregnant females attending a tertiary care Hospital in Uttar Pradesh, India and its effect on perinatal morbidity and mortality. Acta Medica Int 2016; 3(1):50-55. *https://doi.org/10.5530/ami.2016.1.12*
8. Sroka S, Bartelheimer N, Winter A, *et al*. Prevalence and risk factors of toxoplasmosis among pregnant women in Fortaleza, Northeastern Brazil. Am J Trop Med Hyg 2010; 83(3):528-533. *https://doi.org/10.4269/ajtmh.2010.10-0082*
9. Borkakoty B, Biswas D, Jakharia A and Mahanta J. Seroprevalence of *Toxoplasma gondii* among pregnant women in Northeast India. The J Assoc Phys India 2016; 64(10):24-28. *PMID: 27766799*.
10. Alghamdi J, Elamin MH, Alhabib S. Prevalence and genotyping of *Toxoplasma gondii* among Saudi pregnant women in Saudi Arabia. Saudi Pharm J 2016 Nov; 24(6):645-651.*https://doi.org/10.1016/j.jsps.2015.05.001*
11. Vimercati A, Chincoli A, De Gennaro A, *et al*. Clinical management of infections in pregnancy: update in congenital cytomegalovirus and toxoplasmosis. Management and Therapy of Late Pregnancy Complications 2017; 339-358. *https://doi.org/10.1007/978-3-319-48732-8_20*
12. Derouin F, Pelloux H; ESCMID Study Group on Clinical Parasitology. Prevention of toxoplasmosis in transplant patients. Clin Microbiol Infect 2008; 14(12):1089-101. *https://doi.org/10.1111/j.1469-0691.2008.02091.x*
13. Ashraf M, Abdul-Haleem S. Seroprevalence of anti *Toxoplasma gondii* IgG and IgM among pregnant women in Sana'a capital and capital trusteeship. Scient J King Faisal Univ (Basic and applied Sciences) 2010; 11(2):1431. *https://doi.org/10.13140/RG.2.2.24704.07688*
14. Oz HS. Maternal and congenital toxoplasmosis, currently available and novel therapies in horizon. Front Microbiol 2014; 5:385. *https://doi.org/10.3389/fmicb.2014.00385*
15. Ahmadpour E, Daryani A, Sharif M, *et al*. Toxoplasmosis in immunocompromised patients in Iran: a systematic review and meta-analysis. J Infect Dev Ctries 2014; 8(12):1503–1510. *https://doi.org/10.3855/jidc.4796*
16. Pappas G, Roussos N, Falagas ME. Toxoplasmosis snapshots: global status of *Toxoplasma gondii* sero prevalence and implications for pregnancy and congenital toxoplasmosis. Int J Parasitol 2009; 39 (12):1385–1394. *https://doi.org/10.1016/j.ijpara.2009.04.003*
17. Lamberton PH, Donnelly CA, Webster JP. Specificity of the *Toxoplasma gondii*-altered behaviour to definitive versus non-definitive host predation risk. Parasitol 2008; 135(10):1143–1150. *https://doi.org/10.1017/S0031182008004666*
18. Al-Rukeimi AA, Al-Hatami SMM, AL-Danany DA, Al-Shamahy HA, Al Rukeimi RAA. Prevalence and risk factors associated with vulvovaginal candidiasis during pregnancy in Sana'a, Yemen. Universal J Pharm Res, 2020; 5(3):1-5.*https://doi.org/10.22270/ujpr.v5i3.407*
19. Aljedry ZAHS, Shaib AA, Al-Shamahy HA, Al-Jaufy AY. Tetanus immunization among pregnant women: coverage rate and rate of protection at time of delivery. Universal J Pharm Res 2019; 4(1):1-5. *https://doi.org/10.22270/ujpr.v4i1.233*
20. Edrees WH, Al-Asbahi AA, Al-Shehari WA, Qasem EA. Vulvovaginal candidiasis prevalence among pregnant women in different hospitals in Ibb, Yemen. Universal J Pharm Res 2020; 5(4):1-5. *https://doi.org/10.22270/ujpr.v5i4.431*
21. Almoaish A, Al-Shamahy HA, Ali MM, *et al*. Prevalence of cytomegalovirus IgG antibodies, potential risk factors and awareness of congenital cytomegalovirus among female doctors. Universal J Pharm Res 2018; 3 (5):1-5. *https://doi.org/10.22270/ujpr.v3i5.199*
22. Abdullah AD Al Rukeimi, Hassan A Al Shamahy, *et al*. Association of cytomegalo-virus and rubella virus infections in pregnant women with bad obstetric history association of cytomegalo-virus and rubella virus infections in pregnant women with bad obstetric history. W J Gynecol Women's Health 2019; 2(3): 2019. *https://doi.org/10.33552/WJGWH.2019.02.000538*
23. Al-Shamahy HA, Rabbad IA, Al-Hababy A. Hepatitis B virus serum markers among pregnant women in Sana'a, Yemen. Ann Saudi Med 2003; 23(1-2):87-9. *https://doi.org/10.5144/0256-4947.2003.87*
24. Shawky S, Soliman NK. Going beyond the curriculum to promote medical education and practice in Saudi Arabia. Saudi Med J 2001; 22:477–480. *PMID: 11426235*
25. Dar FK, Alkarmi T, Uduman S, *et al*. Gestational and neonatal toxoplasmosis: regional seroprevalence in the United Arab Emirates. Eur J Epidemiol. 1997; 13:567–571. *https://doi.org/10.1023/A:1007392703037*
26. Al-Nakib W, Ibrahim ME, Hathout H, Moussa MA, *et al*. Seroepidemiology of viral and toxoplasmal infections during pregnancy among Arab women of child-bearing age in Kuwait. Int J Epidemiol 1983; 12:220–223. *https://doi.org/10.1093/ije/12.2.220*
27. Al-Mohammad HI, Amin TT, Balaha MH, Al Moghannum MS. Toxoplasmosis among the pregnant women attending a Saudi maternity hospital: seroprevalence and possible risk factors. Ann Trop Med Parasitol 2010; 104:493–504. *https://doi.org/10.1179/136485910X12786389891443*
28. Bin Dajem SM, Almushait MA. Detection of *Toxoplasma gondii* DNA by PCR in blood samples collected from pregnant Saudi women from the Aseer region, Saudi Arabia. Ann Saudi Med 2012; 32:507–512. *https://doi.org/10.5144/0256-4947.2012.14.7.1200*
29. Almogren A. Antenatal screening for *Toxoplasma gondii* infection at a tertiary care hospital in Riyadh, Saudi Arabia. Ann Saudi Med 2011; 31:569–572. *https://doi.org/10.4103/0256-4947.87090*
30. Bouratbine A, Siala E, Chahed MK, *et al*., Sero-epidemiologic profile of toxoplasmosis in northern Tunisia. Parasite (Paris, France) 2001; 8(1):61-66. *https://doi.org/10.1051/parasite/2001081061*
31. Fakhfakh N, Kallel K, Ennigro S, *et al*. Risk factors for *Toxoplasma gondii* and immune status of pregnant women: cause and effect? Tunis Med 2013; 91:188–190. *PMID: 23588632*.
32. Alanazi AD. Determination of seropositivity for *Toxoplasma gondii* in sheep, goats and camels slaughtered for food and human consumptions in Riyadh municipal abattoirs, Saudi Arabia. J Egypt Soc Parasitol, 2013; 43(3):569-76. *https://doi.org/10.12816/0006414*

33. Zemene E, Yewhalaw D, Abera S, *et al.* Seroprevalence of *Toxoplasma gondii* and associated risk factors among pregnant women in Jimma town, south western Ethiopia. BMC Infect Dis 2012; 12:337. *https://doi.org/10.1186/1471-2334-12-337*
34. Walle F, Kebede N, Tsegaye A, Kassa T. Seroprevalence and risk factors for toxoplasmosis in HIV infected and non-infected individuals in Bahir Dar, Northwest Ethiopia. Parasit Vectors 2013; 6:15. *https://doi.org/10.1186/1756-3305-6-15*
35. Cook AJ, Gilbert RE, Buffolano W, *et al*. Sources of toxoplasma infection in pregnant women: European multicentre case-control study. European research network on congenital toxoplasmosis. BMJ 2000; 321:142–147. *https://doi.org/10.1136/bmj.321.7254.142*
36. Jones JL, Dargelas V, Roberts J, *et al*. Risk factors for *Toxoplasma gondii* infection in the United States. Clin Infect Dis 2009; 49:878–884. *https://doi.org/10.1086/605433*
37. Elnahas A, Gerais AS, Elbashir MI, *et al*. Toxoplasmosis in pregnant Sudanese women. Saudi Med J 2003; 24:868–870. *PMID: 12939674*
38. Almushait MA, Dajem SM, Elsherbiny NM, *et al*. Seroprevalence and risk factors of *Toxoplasma gondii* infection among pregnant women in South Western, Saudi Arabia. J Parasit Dis 2014; 38:4–10. *https://doi.org/10.1007/s12639-012-0195-z*
39. Tammam AE, Haridy MA, Abdellah AH, *et al*. Seroepidemiology of *Toxoplasma gondii* infection in women with first trimester spontaneous miscarriage in Qena governorate, Egypt. J Clin Diagn Res 2013; 7:2870–2873. *https://doi.org/10.7860/JCDR/2013/6480.3780*
40. Alsammani MA, Ahmed SR, Alsheeha MA, *et al*. Co-infection with *Toxoplasma gondii* and Clostridium perfringens in a postpartum woman with uterine gas gangrene: a case report. J Obstet Gynaecol Res 2012; 38:1024–1027. *https://doi.org/10.1111/j.1447-0756.2011.01817.x*
41. Liu Q, Wei F, Gao S, *et al*. *Toxoplasma gondii* infection in pregnant women in China. Trans R Soc Trop Med Hyg 2009; 103:162–166. *https://doi.org/10.1016/j.trstmh.2008.07.008*
42. Abu-Madi MA, Behnke JM, Dabritz HA. *Toxoplasma gondii* seropositivity and co-infection with TORCH pathogens in high-risk patients from Qatar. Am J Trop Med Hyg 2010; 82:626–633. *https://doi.org/10.4269/ajtmh.2010.09-0530*