Seroprevalence and associated risk factors of *Toxoplasma gondii* infection in immuno-compromised women and sheep of Bahir Dar City, Ethiopia

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Abstract

Toxoplasmosis is one of the most significant worldwide zoonotic infections caused by the protozoan parasite *Toxoplasma gondii*. It is a major public health and veterinary concern in terms of mortality and morbidity. The objective of this study was to estimate the seroprevalence and assess the potential risk factors of *T. gondii* infection among pregnant women, HIV/AIDS patients, and sheep in Bahir Dar city, North West Ethiopia. A cross-sectional study design and systematic random sampling techniques were employed. Serum samples were analyzed for anti-*T. gondii* antibodies using a commercially available Toxo-latex agglutination test kit. Logistic regression analysis was employed to test associations between variables. The seroprevalences of *T. gondii* infection in the examined pregnant women, HIV/AIDS patients, and sheep were 70.8% (95% confidence interval (CI): 65.1-73.4%), 70% (95% CI: 63.3-76.8%), and 43% (95% CI: 38.5 - 47.4%) respectively. Multivariable logistic analysis showed that *T. gondii* infection was significantly associated with knowing the zoonotic nature of toxoplasmosis (adjusted Odds ratio [AOR] = 0.197, 95% confidence interval [CI]: 0.107 - 0.35), eating raw meat (AOR=3.27, 95% CI: 1.89-5.65), and owning a cat (AOR=9.35, 95% CI: 4.00-21.84) in pregnant women and HIV/AIDS patients. Hence, comprehensive health education about toxoplasmosis, particularly for pregnant women and HIV/AIDS patients, avoiding consumption of uncooked meat, and cat contact for immune-compromised women are of paramount importance.

Keywords*:* Bahir Dar; HIV patient; pregnant woman; Seroprevalence; Sheep; T. gondii.

Introduction

Toxoplasmosis is an infection caused by a protozoan parasite *T. gondii* which is one of the most important zoonotic diseases worldwide (CDC, 2018). *T. gondii* is an obligate intracellular parasite that can infect humans as well as warm-blooded domestic and wild animals (Tenter *et al*., 2000).

T. gondii is a tissue cyst-forming parasite and has two alternative hosts, namely the definitive host and intermediate host. Sexual reproduction occurs in the definitive host and asexual replication occurs in the intermediate host (Dubey, 1996). Sexual reproduction occurs in cats with the ingestion of cysts from tissues of an intermediate host and sporulation occurs in the environment. Asexual development occurs in intermediate hosts in humans, warm-blooded animals, and birds after ingestion of sporulated oocyst (Tenter *et al*., 2000; Cenci *et al.,* 2013).

T. gondii can be transmitted between and within the hosts via ingestion of raw or undercooked meat containing viable cysts and accidental inoculation of tachyzoites (Khan and Khan, 2018). Ingestion of unwashed fruits or vegetables that have been contaminated with feces containing sporulated oocysts is also a means of transmission of the parasite (CDC, 2018). Congenital transmission through the placenta from the mother to her unborn child may occur during pregnancy in case of an acute phase of infection (Peyron *et al*., 2019). Contaminated injection, blood transfusion, and organ transplantation can transmit the infection if the donor has recently acquired toxoplasmosis and parasitemia at the time of blood collecting (Florence and Marie-Laure, 2012).

T. gondii in immune-compromised groups (pregnant women and HIV patients) is a major health concern as the disease is serious in terms of mortality and psychological squeal. In pregnant women, *T. gondii* infections may cause spontaneous abortion, stillbirth, prematurity, and serious fetal damage (Maldonado and Read, 2017). This parasite acquired in the first and second trimesters of pregnancy generally shows a more severe degree of illness in the newborn (Khan and Khan, 2018).

Toxoplasmosis is also a major cause of reproductive failure in sheep, goats, and pigs. Sheep are more exposed to toxoplasmosis due to feeding habits and high susceptible nature of it. They have a big potential to spread the tissue cysts of *T. gondii* to humans through the consumption of raw or undercooked meat

and offal (Gebremedhin *et al*., 2013). Thus, information on the prevalence of toxoplasmosis in sheep is useful for the assessment of the risk of meat of these animals to the public.

Despite the severe consequence of toxoplasmosis among pregnant women, HIV patients, and sheep there is no intervention measure in our study area and the knowledge about the epidemiological status of this parasite is limited in Ethiopia. *T. gondii* screening in pregnant women and HIV patients was not practiced and hence no follow-up has been put in place. Therefore, this study was conducted to estimate the seroprevalence and potential risk factors of *T. gondii* infection among pregnant women, HIV/AIDS patients at public hospitals, and sheep slaughtered at the abattoir in Bahir Dar city, northwest Ethiopia.

Materials and methods

Study area and period

This study was conducted in Bahir Dar City. Bahir Dar is found in the northwestern part of Ethiopia, which is 565 km away from Addis Ababa, the capital city of Ethiopia. The city is located near Lake Tana, the headwaters of the Blue Nile. Its latitude and longitude are 11°36'N and 37°23'E, respectively, humidity is 69% and temperature ranges from 10 to 38°C and the town has an elevation of 1840 meters above sea level (Bahir Dar Land Administration and Use Bureau, 2018). The area receives a mean annual rainfall of 750mm (Ethiopian Metrology Agency, 2018). The city administration has a total population of 455,901 including 222,474 males and 233,428 females (CSA, 2021). The number of animals in the city includes 46096 cattle, 12070 sheep, 4468 goats, 7736 equines, 76526 poultry, and 4021 bee colonies (Amhara Livestock Resource Development and Promotion Agency, 2019).

Study design

Hospital and abattoir-based cross-sectional study designs were conducted from September 2019 to May 2021 to estimate seroprevalence and associated risk factors of *T. gondii* infection among immunocompromised individuals who visited Felege Hiwot and Adiss Alem Hospitals and sheep slaughtered at Bahir Dar Municipal abattoir, Northwest Ethiopia.

Source and study population

The source population was all pregnant women who came to antenatal care centers at Felege Hiwot and Adiss Alem hospitals and all sheep that came to the abattoir for slaughter at Bahir Dar, Ethiopia during the study period. The study population consists of those pregnant women who attended antenatal service for visitors first at Felege Hiwot and Adiss Alem hospitals that fulfilled the inclusion criteria during the data collection period and the number of sheep that came for slaughter to the abattoir.

Eligibility criteria

Inclusion criteria

Pregnant women who were able to communicate, not critically ill, and able to see, and those who voluntarily provided vital information were included in the study

Exclusion criteria

Pregnant women and HIV patients who were critically ill, unable to communicate, unable to see, and not volunteered to provide vital information were excluded from the study.

Sample size determination and sampling method

Sample size determination

The sample size was determined using a single population proportion formula to estimate the seroprevalence of *T. gondii* infection among pregnant women and sheep. The sample size was calculated based on the following assumptions; the prevalence of *T. gondii* infection among pregnant women, 68.4% in Debre Tabor (Agmas *et al*., 2015); 95% level of confidence, and 5% margin of error. The sample size was calculated by using single population proportion formulas as follows (Thursfield, 2007).

$$n = \frac{(Z\alpha/2)^2 \text{ P exp } (1 - Pexp)}{\text{d}^2}$$

n= (1.96)^2 [0.684 (1-0.684)

$$\frac{(0.05)^2}{}$$

n=332 pregnant women

Where, n = sample size, d^2d^2=of error, and $Z\alpha/2Z\alpha/2$=the value of standard normal distribution corresponding to a significant level of alpha.

Similarly, for sheep, considering the previous study, the seroprevalence of *T. gondii* infection among sheep slaughtered for human consumption in central Ethiopia was 20% (Gebremedhin *et al.,* 2014). Therefore, the calculated minimum sample size for sheep slaughtered in Bahir Dar abattoir was 245. However, due to logistic limitations, only 150 slaughtered sheep were sampled.

Sampling method

The method for selecting the study individuals was a systematic random sampling technique in which study subjects were picked during the time of data collection until the required sample size was reached. Our preliminary assessment before the start of the study was based on the previous year's data and one-month data from the antenatal care registration book of the health institutions were taken to approximate the total number of pregnant women attending antenatal care during the study period. Based on that assumption, about 1,500 pregnant women were estimated to visit Felege Hiwot referral hospital. Similarly, about 1300 women were expected to visit Addis Alem hospital for antenatal care. The expected total sample size was 332 as computed above. Therefore, the K^{th} interval = N/n= 2800/332 = 8.

Thus using systematic random sampling every 8^{th} pregnant woman was included in the study. The sample size of each hospital was determined using a proportional allocation formula:

$$\mathbf{ni} = \mathbf{n} \times \frac{\mathbf{Nj}}{\mathbf{N}}$$

Where ni is the sample size of each hospital, n is the total sample size, Nj is the total number of pregnant women in each hospital, and N is the total number of pregnant women who attended all hospitals. However, the real number surges the calculated assumptions thus 200 from Felege Hiwot hospital and the rest 132 from Addis Alem hospital were selected.

Since our preliminary study showed a small number of sheep slaughtered; every 2nd sheep were included in the study. However, during the study period, a total of 830 sheep were slaughtered at Bahir Dar abattoir.

Method of data collection

Questionnaire survey

A structured and pre-tested questionnaire (on 5% of the sample size) was used to collect data from study participants. Questionnaire surveys were used to assess the socio-demography, behavioral, clinical, and obstetrics characteristics of pregnant women and HIV patients of Bahir Dar city. Health professionals holding BSc (Bachelor of Science) degrees and above as laboratory workers in health centers were engaged in data collection after obtaining training on how to collect data through face-to-face interviews with the respondents.

Sample collection for laboratory processing

Blood samples were aseptically collected from venous tissue from pregnant women during their first visit (n=332) at Felege Hiwot referral hospital (n=200) and Addis Alem hospital (n=132), using vacutainer tubes. Out of the 332 blood samples, 20 samples were obtained from HIV patients. From sheep presented at Bahir Dar abattoir, blood samples were collected from the jugular vein (n=150) before slaughtering. These samples were transported in an icebox with ice packs to the Amhara Public Health Institute laboratory; Bahir Dar city Ethiopia; for testing. The samples were centrifuged at 5000 rpm for 10 minutes to separate the serum from the other blood components. Until the samples were serologically examined, they were maintained at -20°C. The Latex agglutination slide test was used for the serological examination.

Study variables

Dependent variable

The dependent variable was a dichotomous variable of *T. gondii* infection's positive or negative (presence or absence of specific antibodies).

Independent variables

Independent variables included in the study were socio-demographic characteristics (age, source of cat food, owning cats at home, educational status, knowing the zoonotic nature of toxoplasmosis and knowing toxoplasmosis as a foodborne disease, the presence of rats in and around the house, housing condition, and cat litter cleaning activities), behavioral characteristics (habit of eating sheep raw meat (undercooked or '*tibis*'), the culture of eating raw fruits), clinical and obstetrical characteristics (presence of another disease, blood transfusion history, history of organ transplantation and stages of pregnancy).

Serological tests

Detection of *T. gondii* antibodies was done using a commercial latex agglutination test kit. The test was conducted according to the instructions of the latex agglutination test manufacturers. All collected serum samples of pregnant women, HIV patients, and sheep were tested for antibodies against *T. gondii*. The test kit was provided with a buffer, a freeze-dried positive and negative control that is latex suspension was sensitized with a *T. gondii* antigen. The presence or absence of a visible agglutination indicates the presence and absence of anti-toxoplasma antibodies in the sample tested. The test was considered positive when a layer of agglutination was formed, while it was considered negative when agglutination was not formed. The proper working of the latex agglutination test kit was checked by the use of positive and negative controls (Mazumder *et al*., 1988).

Data management and analysis

Raw data generated from field and laboratory findings were encoded into Microsoft Excel and exported into SPSS version 20. Descriptive statistics were performed to look into the data pattern frequency distribution of various risk factors and were applied to quantify the magnitudes of seroprevalence among study subjects and the percentages of the questionnaire survey. A binary logistic regression model was employed and variables having a p-value of < 0.25 were exported to a multivariable logistic regression model to assess the effect of confounders. Variance inflation factor (VIF) was used to check the multicollinearity problem. However, in the data set no collinearity problem was detected. The degrees of associations of risk factors with the occurrence of toxoplasmosis in pregnant women, HIV/ADIS patients, and sheep serum samples were quantified using an adjusted prevalence odds ratio (AOR). In all

the analyses, the confidence level and level of significance were held at 95% and ≤0.05 respectively.

Ethical consideration

Before the study, ethical clearance letters were obtained from Bahir Dar University College of Agriculture and Environmental Sciences (Ref. No:1/983/1.2.6; Date: 08/08/2019 G.C.). Furthermore, written informed consent was obtained from all study participants before involvement in the study. Confidentiality of the collected information and laboratory test results was maintained and appropriate counseling was done as per the routine procedures of Ethiopian hospitals. For those unable to read and write (illiterates) pregnant women's researchers read loudly and then asked about their voluntariness and their signatures with their thumbs obtained.

Results

Prevalence of *T. gondii* infection

In the present findings out of 332 pregnant women, 235 (70.8%, 95% Confidence Interval (CI): 65.1-73.4%) were seropositive for *T. gondii* infection. Of the 20 HIV/AIDS patients tested, 14 (70%, 95% CI: 63.3-76.8%) had *T. gondii* infection. Among 150 sheep tested, 65 (43%, 95% CI: 38.5 - 47.4%) of sheep were seropositive for *T. gondii* infection.

Socio-demographic characteristics of respondents

The majority of 213 (64.2%) of the pregnant women who participated in the present study were in the age range of 20-30 years old. Of the pregnant women participants in our study, 35(10.5%) were illiterate. Out of the pregnant women who participated in our study, 97(29.2%) had cats in their homes. The description of study subjects; socio-demographic characteristics are summarized in Table 1 below.

Table 1. Summary of respondent's sociodemographic characteristics in Bahir Dar city (n=332)

Variables	Categories	Number Tested n(%)	Seroprevalence Positive n (%)
Educational status	Illiterate	35 (10.5)	21 (60)
	Write and read	79 (23.8)	56 (70.9)
	Secondary	114 (34.3)	82 (71.9)
	College and above	104 (31.3)	76 (26.9)
Age (in years)	20-30	213 (64.2)	153 (71.8)
	31-40	112 (33.7)	77 (68.8)
	41-50	7 (2.1)	5 (71.4)
Owning cat	Yes	97 (29.2)	90 (92.8)
	No	235 (70.8)	145 (61.7)
Source of food	Municipal abattoir	1 (1.0)	1 (100.0)
	Slaughter slab	4 (4.1)	3 (75.0)
	Butcher	6 (6.2)	4 (66.7)
	House food	85 (87.6)	81(95.3)
Cat litter cleaning activity	Yes	64 (66.0)	61 (95.3)
	No	33 (34.0)	29 (87.9)
Knowing the zoonotic nature of toxoplasmosis	Yes	53 (23.9)	
	No	110 (33.1)	66 (60.0)
Know toxoplasmosis as a foodborne disease	Yes	204 (61.4)	153 (75.0)
	No	128 (38.6)	82 (64.1)
Have mud house	Yes	178 (53.6)	130 (73.0)
	No	154 (46.4)	105 (68.2)
Presence of rats at home	Yes	135 (59.3)	142 (72.1)
	No	135 (40.7)	93 (68.9)

Behavioral characteristics of respondents

Of the respondents, 175 (52.7%) had raw sheep meat eating habits, and among those 140 (80%) were seropositive for *T. gondii* infection. In addition, as shown

in table 2 below, 219 (66%) had the habit of eating raw fruit of which 159 (72.6%) were seropositive for *T. gondii* infection.

Table 2. Summary of respondent's behavioral characteristics

Variables	Seroprevalence		Total n (%)
	Positive n (%)	Negative n (%)	
Eating raw sheep meat			
Yes	140 (80.0)	35 (20.0)	175 (52.7)
No	95 (60.5)	62 (39.5)	157 (47.3)
Eating raw vegetable			
Yes	159 (72.6)	60 (27.4)	219 (66.0)
No	79 (67.3)	37 (32.7)	113 (34.0)

Clinical and obstetrics characteristics of respondents

Of the 332 pregnant women, 110 (33.1%) had limited information knowing the zoonotic nature of toxoplasmosis. Based on the presence of another disease history; 180(54.2%) had other diseases. The seroprevalence of *T. gondii* infection was highest in the first trimester 110 (72.8%), followed by the second trimester 69(70.4), and the third trimester 56 (67.5%) (Table 3).

Table 3. Clinical and obstetrics status of the respondents in Bahir Dar Public hospitals, Northwest Ethiopia

Variables	Seroprevalence		Total n (%)
	Positive n (%)	Negative n (%)	
Presence of other diseases			
Yes	133 (73.9)	47 (26.1)	180 (54.2)
No	102 (67.1)	50 (32.9)	152 (45.8)
Blood transfusion history			
Yes	18 (58.1)	13 (41.9)	31 (9.3)
No	217 (72.1)	84 (27.9)	301 (90.7)
Organ transplantation history			
Yes	3 (60.0)	2 (40.0)	5 (1.5)
No	232 (70.9)	95 (29.1)	327 (98.5)
Pregnancy stage			

1st trimester	110 (72.8)	41 (27.2)	135 (45.5)
2nd trimester	69 (70.4)	29 (29.6)	98 (29.5)
3rd trimester	56 (67.5)	27 (32.5)	83 (25.0)

Risk factors associated with seropositivity of *T. gondii* infection

In the present findings by using binary logistic regression model analysis; pregnant women who were in their second (COR= 0.89, 95% CI (0.51-1.56) and third trimester (COR= 0.77, 95% CI (0.43-1.38) had an almost similar risk of toxoplasmosis when comparing those who were in the first trimester. Bivariate analysis indicated that age, cat litter cleaning activity, knowing toxoplasmosis as a foodborne disease, educational status, presence of other diseases, eating raw fruit, blood transfusion history, presence of rat, organ transplantation history, and pregnancy stage did not show any statistically significant association with the seroprevalence of *T. gondii* infection (Table 4).

Table 4. Binary logistic regression result of *T. gondii* infection occurrence with different risk factors in Bahir Dar city, northwest Ethiopia

Independent Variables	Sero-prevalence		COR (95%CI)	p-value
	Positive n (%)	Negative n (%)		
Educational status				
Illiterate	21 (60)	14 (40)	0.55 (0.25-1.23)	0.15
Able to write and read	56 (70.9)	23 (29.1)	0.89 (0.47-1.72)	0.74
Secondary	82 (71.9)	32 (28.1)	0.94 (0.52-1.71)	0.85
College and above educated	76 (29.9)	97 (73.1)	1	
Age in years				
20-30	153 (71.8)	60 (28.2)	1	
31-40	77 (68.8)	35 (31.3)	0.86 (0.52-1.42)	0.05
41-50	5 (71.4)	2 (28.6)	9.80 (0.19-5.19)	0.98
Owning cat				
Yes	90 (92.8)	7 (7.2)	7.98 (3.54-17.99)	0.00
No	145 (61.7)	90 (38.3)	1	
Food source				
Municipal abattoir	1 (100.0)	0 (0.0)	0.00 (0.00)	1.00

Independent Variables	Sero-prevalence		COR (95%CI)	p-value
	Positive n (%)	Negative n (%)		
Slaughter slab	3 (75.0)	1 (25.0)	6.75 (0.57-80.27)	0.13
Butcher	4 (66.7)	2 (33.3)	10.13 (1.41- 2.75)	0.21
House food	81 (95.3)	4 (4.7)	1	
Cat litter cleaning activity				
Yes	61 (95.3)	3 (4.7)	0.36 (0.08-1.70)	0.20
No	29 (87.9)	4 (12.1)	1	
Knowing the zoonotic nature of toxoplasmosis				
Yes	169 (76.1)	53 (23.9)	2.13 (1.30-3.47)	0.00
No	66 (60.0)	44 (40.0)	1	
Presence of other diseases				
Yes	133 (73.9)	47 (26.1)	1.39 (0.86-2.23)	0.18
No	102 (67.1)	50 (32.9)	1	
Know toxoplasmosis as a food-borne disease				
Yes	153 (75.0)	51 (25.0)	1.68 (1.04 -2.72)	0.03
No	82 (64.1)	46 (35.9)	1	
Eating raw sheep meat				
Yes	140 (80.0)	35 (20.0)	2.61 (1.60-4.26)	0.00
No	95 (60.5)	62 (39.5)	1	
Eating raw vegetable				
Yes	159 (72.6)	60 (27.4)	0.78 (4.74-1.27)	0.31
No	79 (67.3)	37 (32.7)	1	
Blood transfusion history				
Yes	18 (58.1)	13 (41.9)	0.54 (0.25 - 1.14)	0.11
No	217 (72.1)	84 (27.9)	1	
Organ transplantation history				
Yes	3 (60.0)	2 (40.0)	0.61 (0.10 -3.74)	0.60
No	232 (70.9)	95 (29.1)	1	
Presence of rat				
Yes	142 (72.1)	55 (27.9)	1.17 (0.72 -1.88)	0.53
No	93 (68.9)	42 (31.1)	1	
Pregnancy stage				

Independent Variables	Sero-prevalence		COR (95%CI)	p-value
	Positive n (%)	Negative n (%)		
1st trimester	110 (72.8)	41 (27.2)	1	
2nd trimester	69 (70.4)	29 (29.6)	0.89 (0.51-1.56)	0.68
3rd trimester	56 (67.5)	27 (32.5)	0.77 (0.43-1.38)	0.39

Key: Statistically significant at P < 0.05, CI = Confidence interval, COR = Crude odds ratio,

In multivariable analysis, showed that significantly high seroprevalence of *T. gondii* infection in study participants who own cats (AOR =9.35, 95% CI (4.0 - 21.84), eating raw meat (AOR=3.27, 95% CI (1.89 - 5.65), and know about zoonotic nature of toxoplasmosis (AOR=0.20, 95% CI (0.11-0.35) (Table 5). In the present study, there was no significant statistical association between independent variables and seropositivity of *T. gondii* infection among immunocompromised women.

Table 5. Multivariable logistic regression result of *T. gondii* infection seroprevalence with different risk factors in Bahir Dar city, northwest Ethiopia

Variables	Sero-prevalence			
	Positive n (%)	Negative n (%)	AOR (95% CI)	p-value
Owning cat				
Yes	90 (92.8)	7 (7.2)	9.351 (4.0 -21.84)	0.00
No	145 (61.7)	90 (38.3)	1	
Knowing the zoonotic nature of toxoplasmosis				
Yes	169 (76.1)	53 (23.9)	0.20 (0.11-0.35)	0.01
No	66 (60.0)	44 (40.0)	1	
Presence of other diseases				
Yes	133 (73.9)	47 (26.1)	1.18 (0.68 -2.07)	0.20
No	102 (67.1)	50 (32.9)	1	
Know toxoplasmosis as a foodborne disease				
Yes	153 (75.0)	51 (25.0)	1.68 (1.04 -2.72)	0.56
No	82 (64.1)	46 (35.9)	1	
Eating raw meat				
Yes	140 (80.0)	35 (20.0)	3.271 (1.9 - 5.65)	0.000

No	95 (60.5)	62 (39.5)	1	
Blood transfusion history				
Yes	18 (58.1)	13 (41.9)	5.49 (0.23 -1.28)	0.18
No	217 (72.1)	84 (27.9)	1	

Key: Statistically significant at $p < 0.05$, AOR = Adjusted odds ratio, CI = Confidence interval.

Discussion

The present study reveals that, out of 332 pregnant women, 235 (70.8 %) of them were seropositive for *T. gondii* infection. This finding is in agreement with the report of 68.4% (Agmas *et al*., 2015) in Debre Tabor. The seroprevalence finding of *T. gondii* infection in this study is slightly lower than the reported results of 88.6% (Endris *et al*., 2014), 86.4% (Gebremedhin *et al*., 2013) and 85.3% (Abamecha *et al*. 2016). However, the *T. gondii* infection seroprevalence found in the present study was higher than the reports of 9.3% (Finda *et al*., 2015), 25% (Andiappan *et al*., 2014), 30.9% (Mwambe *et al*., 2013) and 23.6% (Mosti *et al*., 2012). The variations in the *T. gondii* infection result found in the present study in Ethiopia as well as in other countries could be due to variations in climatic conditions, cat management system, housing conditions, socioeconomic status, and feeding habits of study participants and diagnostic methods (Ibrahim *et al*., 2017).

This study identified statistically significant associations between owning cats and seropositivity. For pregnant women owning a cat, the probability of being infected by *T. gondii* infection is 9.35 times more likely as compared with pregnant women not owning a cat (AOR =9.35, 95% CI (4.0 - 21.84). This finding was in agreement with that of Zemene *et al*.(2012). This might be due to frequent contact with cat feces and accidental ingestion of oocysts. The cat carrier state remains a basic factor for the possible survival and spread of toxoplasma oocyst through their feces. The oocysts, in particular, can survive for long periods in sandy soil thus causing a source of accidental contamination (Tenter *et al*., 2000; CDC, 2018). Semi-urban peoples of Bahir Dar city have low living standards and mostly keep cats for hunting rats due to their homes being wood and mud infested by rodents.

Pregnant women who have raw meat eating habits had a significantly higher risk of being infected with *T. gondii*. They were 3.27 times more likely to be infected by *T. gondii* infection as compared with those who don't have raw meat eating habits (AOR=3.27, 95% CI (1.89-5.65). This finding was in agreement

with those of Fenta (2019), Abamecha and Awel (2016), Awoke (2015), and Mandour *et al*. (2017).

In the present study, knowing the zoonotic nature of toxoplasmosis (AOR=0.20, 95% CI (0.11-0.35) has a protective effect on the occurrence of *T. gondii* infection. This might be due to their awareness they protect themselves from contacting reservoir host cats. However, no significant difference was observed between the different educational levels of respondents. The reason might be in different educational levels; there was relatively similar awareness about *T. gondii* infection.

The current study also revealed that out of the 150 sheep investigated, 65 (43%) were seropositive for *T. gondii* infection. The seroprevalence of *T. gondii* infection in this study was lower than that of the 77% result recorded elsewhere (Elmore *et al*., 2010). However, the *T. gondii* seropositivity found in the present study was higher than the 19.5% reports of Opsteegh *et al.* (2014). The management system, feed type, and geographic location might bring such different findings. The highest prevalence recorded in our study area might be because of free grazing farming practices that access freely contaminated pastures by *T. gondii* oocysts. Sheep are important reservoirs for *T. gondii* pathogens because of their grazing character in oocyst-contaminated pastures. In-home-based consumption, sheep are the most common farm animal slaughtered in individual households in our study area. Raw meat of sheep consumed in Bahir Dar like other goat and beef, especially undercooked thick muscle (*kitfo/libleb or tibs)*, tongue, and liver. There is also cross-contamination of cooking materials that contact with the raw meat of sheep thus transmitting to immune-compromised women (CDC, 2018).

Toxoplasma gondii infection is a neglected zoonotic disease, but its high prevalence among immunocompromised women in our study showed that it could lead to transmitting the disease vertically to their unborn babies (Cenci *et al*., 2013). Different scholars indicate that in women, infection with *T. gondii* affects the pregnancy thus leading to abortion and stillbirth. Vertical transmission affecting the newborn leads to psychomotor retardation, schizophrenia spectrum disorders, hydrocephalus, etc. Similarly, anxiety, depression, suicide attempts, and hearing problems are seen in immunocompromized women. It also causes significant economic loss due to treatment costs, labor costs, poor

growth performance, high mortality, and morbidity (Mizani *et al.*, 2017; Fallahi *et al.*, 2018).

The limitation of this study was that the kit did not measure the acute or chronic nature of toxoplasmosis. In addition, not all the calculated sample size for sheep was tested due to a shortage of kits.

Conclusions

This study gives an insight that the occurrence of *T. gondii* infection among pregnant women, and HIV/AIDS patients at public hospitals of Bahir Dar city, northwest Ethiopia is high. Our study confirms that *T. gondii* infection remains a major public health importance in our study area. Thus, it might cause significant economic and health loss due to high mortality and morbidity. *T. gondii* infection occurrence among pregnant women was found to be significantly associated with owning cats at home and eating raw meat. In the present finding, the seroprevalence of *T. gondii* infection in sheep was high in the study area. Thus, the higher seroprevalence in these encountered animal species used as a food source revealed the potential risk of *T. gondii* infection presented to people through the consumption of their raw meat.

Taking the result of this study into account, we strongly advise better cat management activities be practiced to minimize *T. gondii* oocyst contamination. It is also advised to avoid eating raw or uncooked meat through integration with other disease control programs. A compulsory continuous health care awareness creation about *T. gondii* infection like other diseases should also be given. Building belief among scientists (i.e. veterinarians and public health workers) to generate a robust one-health approach; applied and coordinated interventions, long term strategy to manage *T. gondii* infection dynamics will also be essential.

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