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ORIGINAL ARTICLE

Seroprevalence of *Toxoplasma gondii* and Associated Risk factors Among Pregnant Women Attending Antenatal Care in Ilala Municipality, Dar es Salaam, Tanzania

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ABSTRACT

Background: *Toxoplasma gondii (T. gondii)* infection during pregnancy is associated with various complications for the mother and baby. In Tanzania, there is a paucity of data on exposure to *T. gondii* infection among pregnant women and the associated risk factors. Therefore, this study investigated the seroprevalence of *T. gondii* and associated factors among pregnant women attending antenatal care in Ilala Municipality, Dar es Salaam.

Methods: A cross sectional study was carried out among 383 pregnant women attending antenatal health care. A five mL of blood sample was collected from each recruited pregnant woman, processed to obtain serum, and tested for the presence of IgG and IgM anti *T. gondii* specific antibodies. A structured questionnaire was used to gather information on the risk factors predisposing pregnant women to the infection. Data analysis was performed using descriptive statistics and logistic regression.

Results: Of the 383 participants, 104 (27.2%) were positive for antibodies specific to T. gondii; 102 (26.63%) were positive only for IgG, and 2 (0.52%) were positive for both IgM and IgG antibodies. Significant risk factors for *T. gondii* infection were maternal age of 34-39 years (AOR:3.71;95% CI:1.52-9.06), eating unwashed fruits (AOR:7.39;95% CI:3.99-13.66), not washing hand with soap after meat preparation (AOR:7.53; 95% CI:3.40-16.64), consumption of undercooked meat (AOR:3.75; 95% CI:1.95-7.21), and consumption of raw vegetable (AOR: 1.99; 95% CI: 1.04-3.80). Cat ownership was not statistically significantly associated with toxoplasmosis (AOR:1.90; 95% CI: 0.89-4.08).

Conclusions: The seroprevalence of *T. gondii* infection (27.2%) indicates ongoing transmission, hence the need for regular screening during antenatal care and establishment of a control programme.

BACKGROUND

Toxoplasmosis is a zoonotic disease caused by an intracellular protozoan called *Toxoplasma gondii* (*T. gondii*).[1] Approximately over 60% of the world population has been exposed to *T. gondii* infection, with seropositivity rates ranging from less than 10% to over 90% in different parts of the world or within regions in the same country.[2–4] Acquisition of *T. gondii* is through the ingestion of tissue cysts in meat, ingestion of food, water, or soil contaminated with sporulated oocysts, and directly from the cat feces.[5] Additionally, transfusion of *T. gondii* unscreened blood and organ transplant permit the dissemination of *T. gondii* tachyzoites to a large variety of body organs, causing congenital diseases during pregnancy.[6–8]

The majority of healthy individuals with *T. gondii* infections are asymptomatic. However, immune-compromised individuals, immunosuppressive drugs users, and pregnant women who acquired toxoplasmosis during pregnancy suffer severe infection and high mortality.[6,9] The primary infection during gestation age determines the risk of maternal-fetal transmission, which ranges from (10% to 24%) in the first trimester to (60% to 90%) in the third trimester of which the risk of congenital defect become more severe with earlier infections.[10–13]

The circulation of *T. gondii* parasites across the fetal placenta barrier results in miscarriage, preterm delivery, death in utero, neonatal growth retardation, hydrocephalus, cerebral calcification, neurological or ophthalmic disease in the new-born, during childhood or adolescence.[3,6,9,14–16] The seroprevalence of *T. gondii* infection ranges from 4% to 78% among pregnant women in endemic countries.[17,18] Variation in prevalence's depends on local environmental factors, especially temperature and moisture, kitchen habits, and hygienic standards.[4] Routine maternal screening through serological tests to monitor acute

and latent *T. gondii* infections during pregnancy reduces the possibility of fetal infections and substantial damages. However, in most of the resource-limited countries, including Tanzania, screening of the *T. gondii* is not done. Hence, the pregnant women remain undiagnosed.[17–19]

In Tanzania, there is a paucity of information on the current seroprevalence of *T. gondii* infection and associated risk factors among pregnant women. Also, there is limited information on the level of knowledge on *T. gondii* infection, transmission, prevention, and effects of toxoplasmosis on the fetus among pregnant women. Therefore, this study aimed to determine the current seroprevalence of *T. gondii* and associated factors among pregnant women attending antenatal care in Ilala Municipality, Dar es Salaam. The findings will provide basic information on the current burden of the disease and associated risk factors that might be used to develop appropriate control interventions for the prevention and treatment of toxoplasmosis in pregnant women.

METHODS

Study Design and Settings

A quantitative facility based cross sectional study was conducted in August 2020 to determine the seroprevalence of *T. gondii* and associated risk factors among pregnant women attending public antenatal clinics in Ilala municipality. Ilala municipal council is the regional headquarter for the Dar es Salaam Region (Figure 1). Dar es Salaam region has one municipal council (Ilala) and four district councils (Kinondoni, Kigamboni, Temeke, and Ubungo). The Ilala municipal lies between the longitudes of 39° and 40° east and latitude of 60° and 70° south of the equator, having an area of 1,393 km^2.[20] The municipal council has approximately a population of 1,220,611 whereby males are 595,928 and females are 624,683.[21] The Ilala municipal has a total of 36 wards with 2 public health centers and 24 public dispensaries.[20] Ilala municipal was selected because it's among the endemic area for Toxoplasmosis with the highest population of women in Dar es Salaam (Figure 1).

Study Population

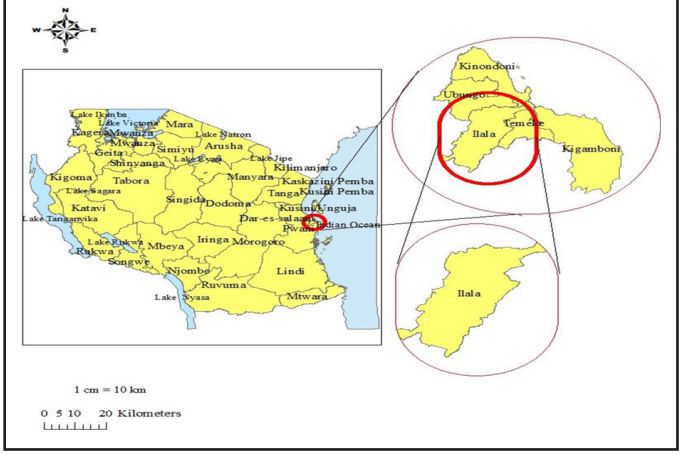
The study population was the pregnant women attending public antenatal clinics in the Ilala municipality. Only pregnant women who agreed and signed informed consent were enrolled in this study.

Sample Size Determination and Sampling Procedures

The minimum sample size for seroprevalence determination was estimated using the formula for a cross-sectional survey: $n = Z^2 P (100-P)/\varepsilon^2$, whereby; n=minimum sample size required, Z= standard normal deviate of 1.96 using a 95% confidence interval, p= expected proportion of *T. gondii* (35%) from the previous study done in Dar es Salaam, Tanzania[10] and ε = margin of error (5%). Through computation with the above formula, a minimum sample size of 349 was obtained. Considering 5% of the sample size for non-response rate and the design effect of 1.5.[22] Therefore, the total sample obtained was 549 pregnant women.

A multi-stage sampling technique was applied to enroll the 549 pregnant women in this study. In the 1st stage, one health center and four dispensaries were selected by simple random sampling technique. In the second stage, a probability proportional to size (PPS) was applied to obtain the sample for recruitment in each facility selected. For the PPS sampling, the preceding month's attendance for ANC services in the selected facilities was extracted from the registries of each facility and summed up. Then the attendance for the preceding month of each facility was divided by the facilities sum attendances and multiplied by the overall sample size (n) to obtain the sample to recruited per selected facility. In the selected facilities, recruitment of pregnant women attending ANC services was done according to daily catchment, where the daily catchment was less than the expected daily eligible recruitment; consecutive pregnant women were recruited until sample for the facility was achieved. Where daily catchment exceeded the expected daily recruitment, systematic sampling was used to recruit until completion of the sample size for the facility. In a month, a total of 118, 75, 72, 58, and 60 pregnant women from Chanika health center, Buyuni, Kinyerezi, Kitunda, and Tabata A dispensaries, respectively accepted to be enrolled in the study by signing the informed consent.

FIGURE 1: A Map Showing the Study Area, Ilala Municipal Council in Dar Es Salaam



Data Collection Tool

The structured questionnaire adapted and modified from Mwambe et al, Paul et al, and Teweldemedhin et al[17,18] was used to collect the required information. The questionnaire had four sections; section A was used to collect information on socio-demographic characteristics such as age, marital status, occupation, level of education, gravidity, trimester of pregnancy, section B collected information on the risk exposures to *T. gondii* infection such as cat ownership, history of contact with cats, history of consumption of undercooked meat, eating unwashed fruits, drinking of raw milk and unboiled water and domestic/ household gardening, and section C focused on awareness and knowledge about toxoplasmosis causes, mode of transmission, symptoms, effects, and preventive measures. All participants (383) were asked awareness questions. However, in the knowledge section, only forty participants who were

aware of toxoplasmosis were interviewed.

Blood Collection and Serological Analysis

Following completion of the structured interview at antenatal clinics, trained laboratory technologists aseptically collected 5mL of venous blood from each study participant using a sterile vacutainer tube and dispensed it into a sterile tube. Collected samples were uniquely labeled with code numbers and then transported from collection sites to Muhimbili National Hospital (MNH) for examination. The collected blood samples were centrifuged at 3000 rpm for 10 minutes to obtain serum samples. Then the serums samples were examined for anti-*T. gondii* immunoglobulin M and G using the Abbot Architect analyzer. The architect Toxo IgG and IgM analyzer had sensitivity of 97.5% and 89.9%, respectively and specificity of 99.1% and 99.8%, respectively.[23,24]

The internal quality control and respondents immunoglobulin results were interpreted as per manufacture instruction as IgG with <1.6, 1.6-3, and ≥3 considered as non-reactive (negative), gray zone, and reactive (positive) antibody results respectively, while with IgM<0.50,0.50-1 and ≥1 were regarded as non-reactive (negative), gray zone and reactive (positive) antibody respectively.[19] The labeled aliquots of examined serum samples were stored in the freezer at -20°C or colder at MNH.

Data Analysis

The obtained results were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 22.0 software produced by IBM Corporation, Armonk, NY, USA. Descriptive statistics were used to summarize and describe the variables in the frequency tables with their proportions. Pearson's chi-square test was used to compare proportions and to assess the association between a *T. gondii* seroprevalence and independent variables. Knowledge was assessed using five questions, each answer was given a mark of one for a correct, zero for the incorrect, and then the total score for each participant was calculated. Subsequently, the mean score was calculated, aiding in the classification of the levels of knowledge. The obtained mean score was 2.3. Hence, a score >2 was classified as a high level of knowledge and a score ≤2 as a low level of knowledge. Univariate logistic regression was used to identify the variables for multivariable logistic regression. All independent variables with a P value <0.25 in the univariate analysis were subjected to the multivariable analysis to adjust potential confounders. The P values <0.05 were considered statistically significant.

Ethical Consideration

Ethical clearance was obtained from the Institutional Review Board (IRB) of the Muhimbili University of Health and Allied Sciences (IRB#: MUHAS-REC-07-2020-390). Permission was obtained from the Ilala municipality administrative authorities in all respective study sites before beginning the study. Signed informed consent was obtained from each study participant before blood collection, and the collected information was kept confidential.

RESULTS

Socio-Demographic Characteristics of the Study Participants

A total of 383 participants were recruited, with a response rate of 69.76%. Of the 383 pregnant women recruited, more than half (55.1%) were aged <27 years and had primary education (56.7%). The majority of the pregnant women were married (88.8%), with less than half (40.2%) in the second trimester (Table 1).

Seroprevalence of *T. gondii* Infection among Pregnant Women

The overall prevalence of *T. gondii* infection among pregnant women was 104 (27.2%), with 102 (26.6%) positive for *T. gondii* specific IgG while 2 (0.52%) tested positive for both *T. gondii* specific IgG and IgM antibodies (Figure 2).

TABLE 1: Socio-demographic Information of Study Participants (N=383)

Socio-Demographics	Categories	n (%)
Age (years)		
	≤ 27	211 (55.1)
	28-33	119 (31.1)
	34-39	44 (11.5)
	≥ 40	09 (2.3)
Marital status		
	Single	36 (9.4)
	Divorced/separated	07 (1.8)
	Married	340 (88.8)
Occupational		
	Student	04 (1.0)
	Housewife	152 (39.7)
	Peasant	27 (7.0)
	Businesswomen	188 (49.1)
	Employed	12 (3.1)
Education level		
	None	14 (3.7)
	Primary school	217 (56.7)
	Secondary & above	152 (39.7)
Gravidity		
	Primigravid	91 (23.8)
	Multigravid	292 (76.2)
Trimester of pregnancy		
	First trimester	80 (20.9)
	Second trimester	154 (40.2)
	Third trimester	149 (38.9)
Health facilities		
	Chanika health center	117(30.5)
	Buyuni dispensary	73 (19.1)
	Kinyerezi dispensary	75 (19.6)
	Tabata A dispensary	60 (15.7)
	Kitunda dispensary	58 (15.1)

Association of Socio-Demographic Characteristics with *T. gondii* Infection

The prevalence of *T. gondii* was higher among the pregnant women in the first trimester (31.3), aged 34 -39 years (45.5%), married (27.6%), businesswomen (28.7%), and multigravid (28.4%). Also, there was a statistically significant association between the age groups of the pregnant women and the prevalence of *T. gondii* infection (Table 2).

Risk Factors Associated with the *T. gondii* Infection among Pregnant Women

Few of the pregnant women (15.4 %) own domestic cats, and of which more than half (54.2%) had a history of cat contact. Also, nearly one-third (32.6%) reported eating unwashed fruits, while more than half reported eating raw vegetables (56.7%) and undercooked meat (50.7%). The prevalence of *T. gondii* infection was statistically significantly associated with owning the cat, eating unwashed fruits, handwashing practice before meat preparation and after household gardening, and history of consuming undercooked meat, and raw vegetables (Table 3).

Pregnant Women's Awareness on Toxoplasmosis

Out of 383 pregnant women surveyed, less than a quarter (10.4%) had heard of toxoplasmosis, while the rest had never heard of toxoplasmosis (89.6%). Of 40 study participants who were aware, most of them (40.0%) mentioned they heard of Toxoplasmosis on social media (WhatsApp, Facebook, and Instagram), followed by hospital/health clinics (27.5%), schools (17.5%), news media [television, radio, magazine] (10.0%) and few participants (5.0%) had heard from all sources.

Participants' awareness on toxoplasmosis varied with education. Pregnant women with secondary and above education were more aware of toxoplasmosis compared to pregnant women with primary education and none (Table 4).

Pregnant Women's Knowledge on Toxoplasmosis

Of the 40 participants who had heard of toxoplasmosis, nearly half (47.5%) of the pregnant women did not know the cause of toxoplasmosis. However, almost two-third (65%) knew the correct mode of toxoplasmosis transmission. Almost two-thirds (65%) of the pregnant women reported miscarriage as the complication of toxoplasmosis in pregnant women, and more than one-third (37.5%) correctly reported avoiding contact with cats as the preventive measure of acquiring toxoplasmosis (Table 5). Of the 40 participants, 17 (42.5%) had a low level of knowledge on toxoplasmosis, while the rest 23 (57.5%) had a high level of knowledge.

Association of Socio-demographic Factors with Knowledge on Toxoplasmosis Among Pregnant Women

A high level of knowledge was observed among the women aged 28-33 years, while a low level of knowledge was high among women aged 34-39 years compared to the rest of the age groups. There was a statistically significant association between the age of the participants and the level of education. A high level of knowledge was observed among the primigravid pregnant women (66.7%) compared to multigravid and pregnant women in the first trimester (61.5%) compared to other trimesters. However, the differences were not statistically significant (Table 6).

Factors Associated with *T. gondii* Seropositivity Among Pregnant Women

The results of bivariate logistic regression analysis show that maternal age, presence of a domestic cat at home, eating unwashed fruits, not washing hands with soap after meat preparation, not washing hands with soap after household gardening, consumption raw/undercooked meat, and consumption of raw/undercooked vegetable were significantly associated with *T. gondii* infection. However, upon adjusting for the confounders, the result of multivariate logistic regression analysis showed that age of 34-39 years, eating unwashed fruits, not washing hands with soap after meat preparation, consumption of raw/undercooked meat, and consumption of raw vegetable were the statistically significant risk factors of *T. gondii* infection (Table 7).

TABLE 2: Association of Socio-demographic Characteristics With *T. gondii* Infection Among Pregnant Women (N=383)

Variable	Categories	n	Seropositivity (%)	P value
Age group	≤ 27	211	45 (21.3)	.007*
	28-33	119	37 (31.1)	
	34-39	44	20 (45.5)	
	≥ 40	09	02 (22.2)	
Marital status	Single	36	09 (25.0)	.700
	Divorced/separated	07	01 (14.3)	
	Married	340	94(27.6)	
Occupational	Student	04	01 (25.0)	.669
	Housewife	152	42 (27.6)	
	Peasant	27	04 (14.8)	
	Businesswomen	188	54 (28.7)	
	Employed	12	03 (25.0)	

Continue

TABLE 2: Continued

Variable	Categories	n	Seropositivity (%)	P value
Education level	None	14	04 (28.6)	.659
	Primary school	217	55 (25.3)	
	Secondary and above	152	45 (29.6)	
Gravidity	Primigravid	91	21 (23.1)	.317
	Multigravid	292	83 (28.4)	
Trimester	First trimester	80	25 (31.3)	.651
	Second trimester	154	40 (26.0)	
	Third trimester	149	39 29.2)	
Health facilities	Chanika health center	117	30 (25.6)	.759
	Buyuni dispensary	73	17 (23.3)	
	Kinyerezi dispensary	75	24 (32.0)	
	Tabata A dispensary	60	18 (30.0)	
	Kitunda dispensary	58	15 (25.9)	

TABLE 3: Risk Factors Associated With *T. gondii* Infection Among Pregnant Women in Ilala Municipality of Dar es Salaam (N=383)

Variable	Categories	n	Seropositivity (%)	P value
Own domestic cats				
	Yes	59 (15.4)	27 (45.8)	.000*
	No	324 (84.6)	77 (23.8)	
History of cat contact				
	Yes	32 (54.2)	18 (56.2)	.078
	No	27 (45.8)	09 (33.3)	
Eat unwashed fruits				
	Yes	125 (32.6)	74 (59.2)	.000*
	No	258 (67.4)	30 (11.6)	
Wash hands after meat preparation				
	Yes	177 (46.2)	12 (6.8)	.000*
	No	206 (53.8)	92 (44.7)	
Wash hands after household gardening				
	Yes	173 (45.2)	29 (16.8)	.000*
	No	210 (54.8)	75 (35.7)	
Source of drinking water				
	Tape water	176 (46.0)	48 (27.3)	.387
	Well water	202 (52.7)	56 (27.7)	
	Mineral bottled water	05 (1.3)	00 (0.0)	
Boil drinking water				
	Yes	109 (28.5)	33 (30.3)	.386
	No	274 (71.5)	71 (25.9)	
Drinking raw milk				
	Yes	110 (28.7)	35 (31.8)	.193
	No	273 (71.3)	69 (25.3)	
History of consuming undercooked meat				
	Yes	194 (50.7)	82 (42.3)	.000*
	No	189 (49.3)	22 (11.6)	

Continue

TABLE 3: Continued

Variable	Categories	n	Seropositivity (%)	P value
History of consuming raw vegetable				
	Yes	217 (56.7)	78 (35.9)	.000*
	No	166 (43.3)	26 (15.7)	
Awareness				
	Yes	40 (10.4)	11 (27.5)	.959
	No	343(89.6)	93 (27.1)	
Level of Knowledge				
	High	23 (57.5)	06 (35.3)	.343

TABLE 4: Study Participants' Awareness on Toxoplasmosis According to Socio-demographic Characteristics (N=383)

Variable	Categories	n	Awareness status Yes (%)	P value
Age	≤ 27	211	23 (10.9)	.344
	28-33	119	15 (12.6)	
	34-39	44	02 (4.5)	
	≥ 40	09	00 (0.0)	
Marital status	Single	36	04 (11.1)	.657
	Divorced/separated	07	00 (0.0)	
	Married	340	36 (10.6)	
Occupation	Student	04	01 (25.0)	.092
	Housewife	152	13 (8.6)	
	Peasant	27	00 (0.0)	
	Businesswomen	188	23(12.2)	
	Employed	12	03 (25.0)	
Educational level	None	14	00 (0.0)	.000*
	Primary school	217	11 (5.1)	
	Secondary and above	152	29 (19.1)	
Gravidity	Primigravid	91	12 (13.2)	.327
	Multigravid	292	28 (9.6)	
Trimester	First trimester	80	13 (16.2)	.144
	Second trimester	154	15 (9.7)	
	Third trimester	149	12 (8.1)	

TABLE 5: Pregnant Women's Knowledge on Toxoplasmosis (N=40)

Variable	Categories	Respondent n (%)
Causative agent	Worms	02 (5.0)
	Plasmodium	07 (17.5)
	Toxoplasma	09 (22.5)
	Amoeba	03 (7.5)
	I don't know	19 (47.5)
Mode of transmission	Contact with infected person	03 (7.5)
	Drinking treated water	03 (7.5)
	Eating raw/undercooked meat	26 (65.0)
	Eating food poison	01 (2.5)
	Sexual intercourse	02 (5.0)
	I don't know	05 (12.5)
Symptom	Swollen glands	14 (35.0)
	Diarrhoea	03 (7.5)
	Legs swelling	06 (15.0)
	Nausea	04 (10.0)
	I don't know	13 (32.5)
Effects	Blindness	01 (2.5)
	Eclampsia	01 (2.5)
	Anaemia	00 (0.0)
	Gestational diabetes	03 (7.5)
	Miscarriage	26 (65.0)
	I don't know	09 (22.5)
Preventive measures	Avoid eating meat and fruits	06 (15.0)
	Avoid contact with cats	15 (37.5)
	Avoid hands shaking	04 (10.0)
	Avoid drinking untreated water	02 (5.0)
	Abstain from sexual intercourse	02 (5.0)
	I don't know	11 (27.5)

TABLE 6: Association of Pregnant Women's Socio-demographic Characteristics With Knowledge on Toxoplasmosis (N=40)

Variable	Categories	n	Low Level (%)	High Level (%)	P value
Age (years)	≤27	23	13 (56.5)	10 (43.5)	.008*
	28-33	15	02 (13.3)	13 (86.7)	
	34-39	02	02 (100.0)	-	
	≥40	-	-	-	
Marital status	Single	04	03 (75.0)	01 (25.0)	.166
	Divorced/separated	-	-	-	
	Married	36	14 (38.9)	22 (61.1)	
Occupation	Student	01	-	01 (100.0)	.934
	Housewife	13	05 (38.5)	08 (61.5)	
	Businesswomen	23	11 (47.8)	12 (52.2)	
	Employed	03	01 (33.3)	02 (66.7)	
Educational level	None	-	-	-	.096
	Primary school	11	07 (63.6)	04 (36.4)	
	Secondary and above	29	10 (34.5)	19 (65.5)	
Gravidity	Primigravid	12	04 (33.3)	08 (66.7)	.341
	Multigravid	28	13 (46.4)	15 (53.6)	
Trimester	First trimester	13	05 (38.5)	08 (61.5)	.849
	Second trimester	15	06 (40.0)	09 (60.0)	
	Third trimester	12	06 (50.0)	06 (50.0)	

TABLE 7: Factors Associated With *T. gondii* Seropositivity Among Pregnant Women

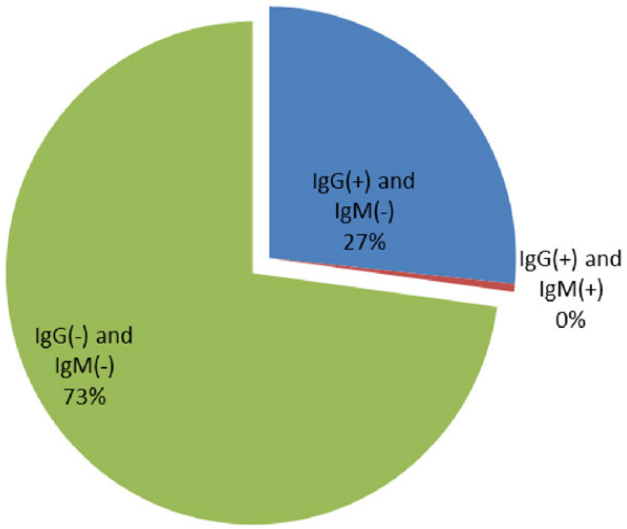
Variable	Univariate		Multivariate	
	COR (95% CI)	P value	AOR (95% CI)	P value
Age				
≤ 27	1		1	
28-33	1.66 (1.00-2.77)	0.050	1.86 (0.94-3.67)	0.074
34-39	3.07 (1.56-6.06)	0.001*	3.71 (1.52-9.06)	0.004*
≥ 40	1.05 (0.21-5.25)	0.949	0.67 (0.09-4.94)	0.697
Marital status				
Single	1			
Divorced/separated	0.50 (0.05-4.73)	0.546		
Married	1.15 (0.52-2.53)	0.735		
Occupation				
Student	1			
Housewife	1.15 (0.12-11.32)	0.908		
Peasant	0.52 (0. 04-6.34)	0.610		
Businesswomen	1.21 (0. 12-11.88)	0.871		
Employed	1.00 (0.07-13.64)	1.000		
Educational level				
None	1			
Primary school	0.85 (0.23-2.82)	0.789		
Secondary and above	1.05 (0.31-3.53)	0.935		
Gravidity				
Primigravid	1			
Multigravid	1.32 (0.76-2.29)	0.318		
Trimester				
First trimester	1			
Second trimester	0.77 (0.426-1.40)	0.393		
Third trimester	0.78 (0.423-1.42)	0.415		
Presence of domestic cat				
Yes	2.71 (1.53-4.80)	0.001*	1.90 (0.89-4.08)	0.098
No	1		1	
History of cat contact				
Yes	2.57 (0.89-7.44)	0.081		
No	1			
Eat unwashed fruits				
Yes	11.03 (6.55-18.58)	0.000*	7.39 (4.00-13.66)	0.000*
No	1		1	
Wash hands after meat preparation				
Yes	1		1	
No	11.10 (5.81-21.20)	0.000*	7.53(3.40-16.64)	<0.001*
Wash hands after household gardening				
Yes	1		1	
No	2.80 (1.69-4.50)	0.000*	0.90 (0.46-1.80)	0.765
Source of drinking water				
Tape water	1			
Well water	1.02 (0.65-1.61)	0.922		
Mineral bottled water	0.00 (0)	0.999		
Boil drinking water				
Yes	1.24 (0.76-2.03)	0.387		
No	1			
Drinking raw milk				
Yes	1.38 (0.85-2.24)	0.194	0.98 (0.51-1.90)	0.947
No	1		1	
History of consuming undercooked meat				
Yes	5.60 (3.30-9.42)	0.000*	3.75 (1.95-7.23)	<0.001*
No	1		1	

Continue

TABLE 7: Continued

Variable	Univariate		Multivariate	
	COR (95% CI)	P value	AOR (95% CI)	P value
History of consuming raw vegetable				
Yes	3.02 (1.90-4.99)	0.000*	1.99 (1.04-3.80)	0.038*
No	1		1	
Awareness				
Yes	1.02 (0.49-2.12)	0.959		
No	1			
Level of knowledge				
High	0.51 (0.13-2.07)	0.346		
Low	1			

FIGURE 2: Prevalence of *T. gondii* Infection among Pregnant Women



DISCUSSION

In the current study, the overall *T. gondii* infection rate was 27.2% among the surveyed pregnant women, thus indicating the ongoing transmission in the studied area. The overall seroprevalence was lower than 35%, 30.9%, and 44.6% reported in Dar es Salaam, Mwanza, and Kilimanjaro in Tanzania, respectively.[10,17,18] This might be due to differences in food consumption habits, occupation status, age groups, sanitary conditions, and urban setting.[5] The findings showed the majority of surveyed seropositive pregnant women had chronic infection suggesting for either past infection or acquired immunity thus cannot infect their fetus unless they are immune suppressed.[25] Less than one percent of the seropositive respondents (0.52%) were positive for IgG and IgM. This observation is in agreement with the findings reported in Ethiopia [13] but was low compared to that reported in northern Tanzania and Brazil.[18,26] Availability of the IgM antibodies during pregnancy predicts the presence of acute *T. gondii* infection that poses a potential risk of maternal-fetal transmission.[13]

The pregnant women aged 34-39 years were three times higher at risk of *T. gondii* compared to the age group <27 years. It can be interpreted that one of the three pregnant women above 34-39 years has *T. gondii* antibodies. This is similar to the findings of the study conducted in Mwanza-Tanzania, and in Ethiopia.[17,19] This association does not mean that older age is a risk factor predisposing to *T. gondii* infection but might be explained that as the age increases, the chances of being exposed is high, and anti-toxoplasma antibodies may retain at a constant level in serum for years. Thus, call for special attention to the screen for anti-toxoplasma antibodies to all older pregnant women attending antenatal services.

The cat is the only definitive host producing feces that contain millions of oocysts within a short time and play a critical role in transmitting *T. gondii*.[5,9,13] Though the history of owning a cat increases the risk for toxoplasmosis, this study showed no significant association between cat ownership and *T. gondii* infection. This was contrary to other studies reported in Burkina Faso, Egypt and Ethiopia reported a significant association between of presence of cats at home and history of cat contact to *T. gondii* infection.[19,25,27]

Eating undercooked meat had been inconsistently reported as a potential risk factor for contracting *T. gondii* infection in many parts of Africa.[5,27,28] Pregnant women with habits of eating undercooked meat had 3.7 times increased odds of *T. gondii* infection compared with their counterparts. This could be explained by the fact that pregnant women in the study area consume barbeque from animals and birds, which is an important food that might contain tachyzoites. This finding is in agreement with studies conducted elsewhere.[5,6,25,28]

An association was found between the consumption of raw vegetables and *T. gondii* infection, with more than one-third of pregnant women (35.9%) consuming raw vegetables/salads being infected. This is because raw

vegetable (salads) might contain *T. gondii* oocysts that remain infective for 12 to 24 months under favorable conditions.[29] However, our observation was contrary to the finding reported from other studies.[27,29,30] The variation of the current results with others might be due to eating habits and food preparation practices among the studied populations.

Thoroughly washing of fruits before eating is one of the important preventive measures for toxoplasmosis. About one-third (32.6%) of pregnant women were eating unwashed fruits. Pregnant women eating unwashed fruits had 7.3 times increased risk of contracting with *T. gondii* infection compared to their counterparts. Similar to the findings from Ethiopia.[19,29,31,32] Also, more than half of the surveyed pregnant women do not wash their hands with soap following raw meat preparation and household gardening to prevent them from contracting with *T. gondii* infection. The findings show that not washing hands with soap following meat preparation increases 7.5 times more risk of being infected with *T. gondii* parasites. The cysts from infected meat might be ingested during hand-to-mouth contact following contact with raw/undercooked meat. This is in line with findings from India.[30]

Regarding awareness on toxoplasmosis, the present study shown that the large majority (89.6%) of the pregnant women were unaware that there is a disease called toxoplasmosis i.e. they never heard, read or saw any information regarding toxoplasmosis.

This is due to a lack of health education about the disease when attending antenatal care. Social media was reported as one of the leading sources of toxoplasmosis, and there was a significant association between awareness and the level of education, whereby respondents with secondary and above education were more aware compared to their counterparts. Individual with secondary school and above education acquires a good ability to explore toxoplasmosis knowledge from different sources such as socio media. This finding is in agreement with other authors reported in Malaysia and Brazil.[33,34]

In the current study, more than half (57.5%) of pregnant women aware of toxoplasmosis had high knowledge. However, close to two-thirds (62.5%) of them did not know the preventive measures. In this study, pregnant women had a high level of knowledge compared to the reports from Nigeria, in which none of the pregnant women was knowledgeable.[35] However, the level of knowledge of the surveyed population was not associated with *T. gondii* infections. This disagrees with the findings from Cameroon, which reported a high prevalence (68.25 %) of the disease among knowledgeable pregnant women compared to none knowledgeable (32.24%).[30] It has been shown that prenatal toxoplasmosis prevention education programs significantly improved the knowledge of cat owners and self-reported cat hygiene behavior of cat owners.[36]

Study Limitations

The study had the following limitations, the inability to follow up on the trend regarding IgG antibody titers for at least two months to confirm congenital toxoplasmosis. The use of serological diagnosis without molecular technique could have underestimated the prevalence of *T. gondii*. In addition, obtaining retrospective information from the participants could be subjected to recall bias.

CONCLUSIONS

The current study showed a seroprevalence of *T. gondii* infection among pregnant women in Ilala Municipality in Dar es Salaam was 27.2%. The main risk factors for transmission in the study area were increasing maternal age, eating unwashed fruits, lack of handwashing following meat preparation, consumption of undercooked meat, and consumption of raw vegetables. Therefore, we recommend regular screening of toxoplasmosis among pregnant women attending antenatal care. Provision of health education to pregnant women attending antenatal care enhances awareness and knowledge on toxoplasmosis preventive measures. In addition, the burden of maternal and congenital toxoplasmosis should be established using avidity tests and molecular techniques to advise policymakers on the need to establish toxoplasmosis control programmes.

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