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Seroprevalence and Risk Factors of Toxoplasma Gondii Infection among Pregnant Women Attending Antenatal Care at Logbaba District Hospital: A Hospital-Based Cross-Sectional Study

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Abstract

Background: This study aimed to determine the seroprevalence and risk factors for *Toxoplasma. gondii* infection in women seeking antenatal and medical care in the Logbaba District Hospital, Littoral Region of Cameroon. **Methods:** We conducted a cross-sectional study from January to December 2022 consecutively enrolling 449 consenting pregnant women aged 16 to 51 years attending antenatal care at the hospital. A survey questionnaire was administered to study participants and potential risk factors for Toxoplasma exposure were sought. Venous blood was collected and serum from each participant analysed for *T. gondii* infection as evidenced by the presence of anti-*T. gondii* IgG and IgM antibodies detected using the indirect enzyme-linked immunosorbent assay (ELISA) technique. The proportion of positive to anti-*T. gondii* antibody was calculated as the percentage of antibody seropositivity to *T. gondii* antigens. Predictors of *T. gondii* infection were analysed by univariate and multivariate regression and association with *T. gondii* seropositivity was assessed. The STATA Pac program was used for statistical analyses. A $p < 0.05$ was considered significant for all analyses. **Results:** The prevalence of *T. gondii* infection among pregnant women at Logbaba district hospital was 76.17% with the prevalence of IgG at 58.6%, IgM 39.0% and the prevalence of IgG and IgM

21.4% by the ELISA technique. Among the risk factors evaluated, abortion, contact with cats, hand wash after cleaning, dog owner, consumption of raw or undercooked meat, consumption of raw milk, consumption of fruit by road site, treatment of water, knowledge of toxoplasmosis, contact with soil, HIV status, level of education, marital status, source of water, waste disposal facility were the major risks factors of *T. gondii* infection. **Conclusions:** Our findings suggest recent *T. gondii* exposure was high in our study population, and may constitute a significant risk factor for stillbirths, abortions or congenital defects during pregnancy in women attending antenatal care, or toxoplasmic encephalitis in those who are immunosuppressed such as those with HIV/AIDS. Education and screening of HIV-positive individuals and pregnant women for *T. gondii* infection may be important primary prevention strategies in this population.

Subject Areas

Public Health

Keywords

Toxoplasmosis, IgG, IgM, Antibodies, Pregnancy, HIV

1. Introduction

Toxoplasmosis is a disease caused by an obligate intracellular protozoan parasite, *Toxoplasma gondii* (*T. gondii*) [1]. It is an obligate intracellular zoonotic parasite of the phylum Apicomplexa that causes toxoplasmosis worldwide [2]. This parasite is widely distributed and can infect humans, pets, and livestock. It is one of the leading causes of spontaneous abortion or fetal abnormalities and constitutes a major public health problem especially in low- and middle-income countries (LMICs) [3]-[5]. *T. gondii* infects up to a third of the world's population [6] and is reported to be an opportunistic parasitic infection in immune compromised hosts [7]. In the general population, *T. gondii* infection can remain asymptomatic but can cause lymphadenopathy and flu-like symptoms, which may lead to eye disease, most frequently chorio-retinitis [3]. The parasite in its inactive state remains in an individual without presentable signs but flares up under immunosuppression [8]. Tough *T. gondii* parasite stays in a dormant stage called bradyzoites, the parasite transforms into an active form when the immune system becomes compromised leading to the clinical manifestation known as toxoplasmosis [9]. Pregnant women constitute a specific risk group, and primary infection may be acquired during pregnancy that may lead to abortion, stillbirth, and neurological disorders in the unborn child [10] [11]. According to literature the prevalence of *T. gondii* infection among pregnant women ranges from less than 1% to 92% depending on the geographical location [1] [12] [13]. Among African populations, studies in Tanzania [14], Ghana [15] and Cameroon [12] reported *T. gondii* seroprevalence of 30.9%, 92.5% and 54.5% respectively, among pregnant women. Fac-

tors such as eating undercooked or cured meat, having a cat as a pet, low educational level, contact with soil, crowded conditions, parity, and consumption of raw vegetables have been noted as predisposing factors [16]. In Cameroon, the prevalence of toxoplasmosis varies from one area to another with the prevalence higher in urban areas than in rural areas. Recent studies have reported seroprevalences of 45.5% in Mbou'o-Bandjoun [17], 78.6% in the city of Douala [18] and 80% in the city of Yaoundé [19]. Although toxoplasmosis serology is among the examinations for the first prenatal consultation, pregnant women at the Logbaba District Hospital seem to neglect this examination because of the lack of knowledge about toxoplasmosis and the high cost of this examination. All these parameters emphasize the need to sensitize pregnant women about the disease.

The aim of this study was to determine the seroprevalence of toxoplasmosis and the associated risk factors in the transmission of *Toxoplasma gondii* amongst women consulting at the Logbaba District Hospital with the eventual goal to develop control strategies for this disease.

2. Materials and Methods

2.1. Study Design and Population

A hospital-based cross-sectional study was conducted from January to December 2022 and targeted pregnant women attending antenatal consultation (ANC) at the Logbaba District Hospital, known to be the main hospital of the Douala 3 subdivision of the Littoral Region of Cameroon, with an estimated 150 monthly ANC attendance. All pregnant women who accepted to participate in this study voluntarily signed an informed consent form irrespective of the gestation age. Pregnant female nurses working in the hospital and some carers of patients at the Hospital were also included in this study.

2.2. Sample Size

The sample size for the study was calculated using Fischer's sampling formula (N = Z2 PQ/d2), where Z is the critical value of the normal distribution (1.96 at 95% CI); P is the estimated prevalence of *T. gondii* among pregnant women in Cameroon (54.5%) [17]; Q = 100 − P; and d is the absolute precision or sampling error tolerated = 5%. From the above equation, the minimum sample size for this study was 384. However, we recruited 449 consecutive consenting pregnant women attending antenatal care in an effort to increase the statistical power of the study.

2.3. Questionnaire Administration

A validated questionnaire, designed by reviewing previous studies of similar objectives, was used to collect information on sociodemographic factors such as age, marital status, level of education, history of behavioral practices including eating, contact with cats or handling cats; and obstetric history in terms of abortion, owning other animals at home, consumption of unpasteurized milk, consumption of fruit or vegetable by road site, source of drinking water and knowledge on the

disease and HIV status.

2.4. Participant Selection and Criteria

All pregnant women were eligible for the study. Eligible patients who provided consent were enrolled in this study. Those who did not sign the consent form were excluded from the study.

2.5. Sampling Procedure

Five millimeters (5 ml) of venous blood was drawn from each participant. The blood samples were transported to the laboratory and allowed to stand for a few minutes. Then after, it was centrifuged at 3500 rpm for 15 min at 4˚C. Then, the supernatant was collected and kept at −20˚C for further testing.

2.6. Ethical Consideration

Ethical clearance for this study was obtained from the Ethics Review and Consultancy Committee of the Cameroon Bioethics Initiative (CAMBIN) under the reference number CBI/45/ERCC/CAMBIN of May 18th, 2022. An authorization to collect and analyze blood samples was also obtained from the Logbaba District Hospital. All participants were duly informed of the study goals, procedures, potential harm and benefits, cost as well as the finality of the study. They willingly provided informed consent either by signing or placing their thumbprint on the consent form after being satisfied with responses to all questions asked by the investigator. Women under 21 years provided assent and consent from a guardian was also sought for these women. Information was provided in English, French or interpreted in the local dialect by a volunteer independent of the study team. Participants' blood samples and results were anonymized. Leftover blood samples were destroyed according to hospital biosafety procedures.

2.7. Analytical Procedures

Five millimeters (5 ml) of venous blood was drawn from each participant. The blood samples were transported to the Logbaba District Hospital Laboratory. Once in the laboratory, samples were then left on the bench for 30 min at room temperature to allow blood to clot and serum separation was done by spinning it at 3500 rpm for 10 min. Serum samples were then transferred into new plain labeled tubes and stored at −22˚C till further processing. Part of the serum was immediately tested for the presence of HIV antibodies using Determine (Alere Determine™ HIV-1/2) (Alere Determine™ HIV-1/2) and HIV-seropositive cases were confirmed by Enzyme-Linked Immunosorbent Assays (ELISA) (Sino Biological Inc, India).

Serological test for *T. gondii* antibodies

The presence of *T. gondii* antibodies in the participants' sera was determined using an indirect Enzyme-Linked Immunosorbent Assay (ELISA). This was done using the AccuDiag™ Toxo IgM and IgG ELISA Kits (The Diagnostic Automation/Cortez Diagnostics, Inc. Toxoplasma gondii [Toxo] IgM and IgG Enzyme-

Linked Immuno-sorbent Assay [ELISA]). The Toxo IgM ELISA Kits had a specificity of 100% and a sensitivity of 100%, while the Toxo IgG ELISA Kits had a specificity of 100% and a sensitivity of 95.3%. Calibrator and controls were run with each test assay. The optical densities (OD) obtained were used to calculate the cut-off calibrator value and the Immune Status Ratio (ISR). The interpretation of results was done with respect to the ISR values. For IgM, a sample with OD ≤ 0.90 was considered negative, OD ≥ 1.10 was considered positive, and OD = 0.91 - 1.09 was considered indeterminate. For IgG, a sample with OD < 0.90 was considered negative, OD > 1.10 was considered positive, and an OD range of 0.91 - 1.09 was considered indeterminate.

2.8. Statistical Analysis

Data were entered into the Microsoft Excel program and transferred to the STATA Pac program for statistical analyses. To compare the diagnostic consistency between Determine RDT strip and ELISA, Cohen's kappa coefficient (κ) was used. Diagnostic accuracy tests including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under the curve (AUC) were performed using ELISA as the reference. The associations between *T. gondii* infection and possible risk factors were tested with a chi-squared test (X^2). The magnitude of associations was assessed using odds ratios (OR) at a 95% confidence interval (CI). A multivariate logistic regression model was used to identify the explanatory variables among confounding risk variables that would explain the occurrence of toxoplasmosis. A p value < 0.05 was considered statistically significant.

3. Results

A total of 527 eligible women were approached and 449 women aged between 16 and 51 years provided consent for this study. The mean age of participating women was 33.17 ± 7.98 years. The majority of the women were aged between 30 and 40 years, 40.51% (182/449), 60.6% (272/449) of the women were married, 82.20% (369/449) were living in the urban area, most of the women 63.7% (286/449) were in the informal sector and 53.9% (242/449) were in the university. No significant difference was observed between sociodemographic and the seroprevalence of *Toxoplasma gondii* as shown in Table 1.

The seroprevalence of *T. gondii* in our study population was found to be 76.59% with the prevalence of IgG scoring 58.6%, IgM 39.0% and the co-prevalence of IgG and IgM 21.4%.

The study of hygiene predisposing factors with *T. gondii* seroprevalence within the study population showed some statistical significance with abortion (p = 0.029), contact with cats (p = 0.0001), consumption of cat meat (p = 0.0001), hand washing after cleaning (p = 0.0001), dog owner (p = 0.0001), consumption of raw meat or undercook meat (p = 0.002), consumption of raw milk (p = 0.001), consumption of fruits by the road side (p = 0.0001), treatment of water (p = 0.001), knowledge on toxoplasmosis (p = 0.0001), contact with soil (p = 0.006) and HIV

status (p = 0.001) (See Table 2).

Table 1. Socio demographic factors and *Toxoplasma gondii* seroprevalence.

Variable	Positive N (%)	Negative N (%)	Total out of 100 N (%)	χ^2, df	p value
Age (years)					
20 - 29	121 (26.9)	32 (07.10)	153 (34.1)	1.85, 02	0.39
30 - 39	139 (31.0)	43 (09.60)	182 (40.5)		
40 and above	82 (18.30)	32 (07.10)	114 (25.4)		
Residence					
Rural	63 (14.0)	17 (03.8)	80 (17.8)	0.36, 01	0.33
Urban	279 (62.1)	90 (20.0)	369 (82.2)		
Marital status					
Married	204 (45.4)	68 (15.1)	272 (60.6)	0.52, 01	0.27
Single	138 (30.7)	39 (8.70)	177 (39.4)		
Occupation					
Civil servant	43 (9.60)	14 (3.10)	57 (12.7)	2.63, 04	0.62
Farmer	10 (2.20)	02 (0.40)	12 (2.70)		
House wife	12 (2.70)	06 (1.30)	18 (4.00)		
Informal sector	215 (47.9)	71 (15.8)	286 (63.7)		
Student	62 (13.8)	14 (3.10)	76 (16.9)		
Level of education					
Primary	24 (5.30)	02 (0.40)	26 (5.80)	5.25, 02	0.072
Secondary	114 (31.4)	40 (8.90)	181 (40.3)		
University	117 (39.4)	65 (14.5)	242 (53.9)		

Table 2. Hygienic predisposing factors and *Toxoplasma gondii* seroprevalence.

Variable	***T. gondii* seroprevalence**				
	Positive N (%)	**Negative N (%)**	**Total out of 100 N (%)**	**χ^2, df**	**p value**
Type of house floor					
Cemented	267 (59.5)	83 (18.5)	350 (78.0)	0.012, 01	0.505
Uncemented	75 (16.7)	24 (5.30)	99 (22.0)		
Abortion					
Yes	19 (4.20)	01 (0.20)	20 (4.50)	4.09, 01	0.029*
No	323 (71.9)	106 (23.6)	429 (95.5)		

Continued

Cat Owner					
Yes	148 (33.0)	41 (9.10)	189 (57.9)	0.82, 01	0.214
No	149 (43.2)	66 (14.7)	260 (57.9)		
Contact with cats					
Yes	231 (51.4)	19 (4.20)	250 (55.7)	81.864, 01	0.0001*
No	111 (24.7)	88 (19.6)	199 (44.3)		
Consumption of cat meat					
Yes	161 (35.9)	01 (0.20)	162 (36.1)	75.24, 01	0.0001*
No	181 (40.3)	106 (23.6)	287 (63.9)		
Hand wash after cleaning					
Yes	262 (58.4)	107 (23.8)	187 (41.6)	196.82, 01	0.0001*
No	80 (17.8)	107 (23.8)	187 (41.6)		
Dog owner					
Yes	54 (12.0)	03 (0.70)	57 (12.7)	12.40, 01	0.0001*
No	288 (64.1)	104 (23.2)	392 (87.3)		
Other animal					
Yes	89 (19.8)	25 (5.60)	114 (25.4)	0.304, 01	0.339
No	253 (56.3)	82 (18.3)	335 (74.6)		
Consumption of raw meat					
Yes	30 (6.70)	01 (0.20)	31 (6.90)	7.79, 01	0.002*
No	312 (69.5)	106 (23.6)	418 (93.1)		
Consumption of raw milk					
Yes	89 (19.8)	12 (2.70)	101 (22.5)	10.25, 01	0.001*
No	253 (56.3)	95 (21.2)	348 (77.5)		
Consumption of roadside fruits					
Yes	215 (47.9)	34 (7.60)	249 (55.5)	31.891, 01	0.0001*
No	127 (28.3)	73 (16.3)	200 (44.5)		
Source of water					
Community	70 (15.6)	20 (4.50)	90 (20.0)		
Bore hole	164 (36.5)	43 (9.60)	207 (46.1)		
Rain	01 (0.20)	00 (0.00)	01 (0.20)	9.804, 05	0.081
Streams	23 (5.10)	03 (0.70)	26 (5.80)		
Tap water	52 (11.6)	28 (6.20)	80 (17.8)		
Well	32 (7.10)	13 (2.90)	45 (10.0)		
Treatment of water					
Yes	59 (13.1)	35 (7.80)	94 (20.9)	11.767, 01	0.001*
No	283 (63.0)	72 (16.0)	355 (79.1)		

Continued

Knowledge of Toxo					
Yes	00 (0.00)	28 (6.20)	28 (6.20)	95.448, 01	0.0001*
No	342 (76.2)	79 (17.6)	421 (93.8)		
Waste disposal facility					
Land	07 (1.60)	00 (0.00)	07 (1.60)	2.762, 02	0.251
Public toilet	41 (9.10)	16 (3.60)	57 (12.7)		
WC	294 (65.5)	91 (20.3)	385 (85.7)		
Contact with soil					
Yes	81 (18.0)	13 (2.90)	94 (20.9)	6.551, 01	0.006*
No	261 (58.1)	94 (20.9)	355 (79.1)		
HIV status					
Negative	292 (65.0)	103 (22.9)	395 (88.0)	9.121, 01	0.001*
Positive	50 (11.1)	04 (0.90)	54 (12.00)		

*-Statistically significant at 0.05 significance level.

The seroprevalence of antibodies to *Toxoplasma gondii* according to HIV status showed that, there were 26 (5.8%) HIV positive patients with a positive IgG result for *T. gondii*. In the same light, there were 5 (1.1%) HIV positive patients with a positive IgM result for *T. gondii*. However, patients positive for HIV, IgG and IgM were 19, constituting a total percentage score of 4.2%. More so, only 4 (0.9%) HIV positive patients in this study but were negative for *T gondii* IgG and/or IgM as presented in Table 3.

Table 3. Seroprevalence of antibodies to *Toxoplasma gondii* according to HIV status.

	HIV status	N (%)	Total
IgG+	Positive	26 (5.80)	167 (37.2)
	Negative	141 (31.4)	
IgM+	Positive	05 (1.10)	79 (17.6)
	Negative	74 (16.5)	
IgG+ and IgM+	Positive	19 (4.20)	96 (21.4)
	Negative	77 (17.1)	
Toxo Negative	Positive	04 (0.9)	107 (23.8)
	Negative	103 (22.9)	

The serological diagnosis among the study participants showed unfortunately no observed statistical significance between the immunoglobulin distribution and socio-demographic characteristics of the participants ($p > 0.05$). Even though there was no statistically significant association between serum immunoglobulins and level of education ($p = 0.21$) and profession ($p = 0.48$), the distribution be-

tween the variables was really segregated (See Table 4).

Table 4. Results of serological diagnosis among the study participants.

Variable	Immunoglobulins						
	IgG+ N (%)	IgM+ N (%)	IgM+ and IgG+ N (%)	Negative N (%)	Total N (%)	χ^2, df	p value
Age (years)							
20 - 29	61 (13.6)	24 (5.30)	36 (8.00)	32 (7.10)	153 (34.1)	9.45, 06	0.15
30 - 39	60 (13.4)	33 (7.30)	46 (10.2)	43 (9.60)	182 (40.5)		
40 and above	46 (10.2)	22 (4.90)	14 (3.10)	32 (7.10)	114 (25.4)		
Residence							
Rural	26 (5.80)	18 (4.00)	19 (4.20)	17 (3.80)	80 (17.8)	2.44, 03	0.49
Urban	141 (31.4)	61 (13.6)	77 (17.1)	90 (20.0)	90 (20.0)		
Marital status							
Married	103 (22.9)	47 (10.5)	54 (12.0)	68 (15.1)	272 (60.6)	1.27, 03	0.74
Single	64 (14.3)	32 (7.10)	42 (9.40)	39 (8.70)	177 (39.4)		
Abortion							
Yes	07 (1.60)	07 (1.60)	05 (1.10)	01 (0.20)	20 (4.50)	6.87, 03	0.07
No	160 (35.6)	72 (16.0)	91 (20.3)	106 (23.6)	429 (95.5)		

Table 5 presents the simple logistic regression between variables and positive to *T. gondii*. The variables that showed significant association with *T. gondii* included level of education in which respondents who attended only the primary level of education had significantly (p = 0.005) 10.8 times the risk (OR = 10.8) of being *T. gondii* positive than other educational levels. Also, married persons had significantly (p = 0.03) 0.16 risk chances (OR = 0.16) of being *T. gondii* positive. Another variable is the source of water. Those who drank community water (p = 0.001), bore hole water (p = 0.001), stream (p = 0.002) and tap water (p = 0.009) had as ORs, 0.003, 0.005, 0.002, and 0.002 respectively of being *T. gondii* positive than others. Waste disposal facility like public toilets, had significantly (p = 0.0001) 39.5 chances (OR = 39.5) of contamination with *T. gondii*, compared to other waste disposal facilities. Those who had contact with soil also independently and significantly had 189.4 times the chance of infection with *T. gondii* (p = 0.005) compared to those who were not associated with *T. gondii*.

The multiple logistic regression for adjusted ORs for the above statistically significant variables showed that, only contact with soil was associated independently and statistically significant (p = 0.039*) with *T. gondii*. Those who had contact with soil had 2.01 times higher chances (OR = 2.01) of being *T. gondii* positive (Table 6).

Table 5. Simple logistic regression with suspected variables.

	No of subjects tested N (%)	Odd ratio (95% CI)	p value
Age (years)			
20 - 29	153 (34.1)	0.2 (0.02 - 1.07)	0.06
30 - 39	182 (40.5)	0.3 (0.05 - 1.71)	0.18
40 and above	114 (25.4)	-	-
Level of education			
Primary	26 (5.80)	10.8 (2.02 - 57.4)	0.0055
Secondary	181 (40.3)	0.01 (0.001 - 6.2)	0.99
University	242 (53.9)	-	-
Marital status			
Married	272 (60.6)	0.16 (0.03 - 0.85)	0.03*
Single	177 (39.4)	-	-
Residence			
Rural	80 (17.8)	3.7 (0.16 - 85.7)	0.42
Urban	90 (20.0)	-	-
Type of house floor			
Cemented	350 (78.0)	2.2 (0.2 - 24.04)	0.53
Uncemented	99 (22.0)	-	-
Abortion			
Yes	20 (4.50)	2.8 (0.02 - 9.41)	0.99
No	429 (95.5)	-	-
Cat Owner			
Yes	189 (57.9)	0.6 (0.14 - 2.66)	0.52
No	260 (57.9)	-	-
Contact with cats			
Yes	250 (55.7)	1.5 (0.37 - 6.44)	0.56
No	199 (44.3)	-	-
Consumption of cat meat			
Yes	162 (36.1)	9.7 (0.53 - 178.2)	0.13
No	287 (63.9)	-	-
Hand wash after cleaning			
Yes	187 (41.6)	1.3 (0.01 - 2.88)	0.98
No	187 (41.6)	-	-
Dog owner			
Yes	57 (12.7)	0.2 (0.01 - 4.79)	0.34
No	392 (87.3)	-	-

Continued

Other animal			
Yes	114 (25.4)	0.7 (0.12 - 2.58)	0.46
No	335 (74.6)	-	-
Consumption of raw meat			
Yes	31 (6.90)	17.8 (0.40 - 799.3)	0.14
No	418 (93.1)	-	-
Consumption of raw milk			
Yes	101 (22.5)	0.9 (0.23 - 3.48)	0.87
No	348 (77.5)	-	-
Consumption of fruit by the road side			
Yes	249 (55.5)	1.5 (0.02 - 2.98)	0. 89
No	200 (44.5)	-	-
Source of water			
Community	90 (20.0)	0.003 (0.0001 - 0.110)	0.001*
Bore hole	207 (46.1)	0.005 (0.0001 - 0.107)	0.001*
Rain	01 (0.20)	0.0001 (0.0001 - 1.00)	1.0
Streams	26 (5.80)	0.002 (0.0001 - 0.110)	0.002*
Tap water	80 (17.8)	0.002 (0.0001 - 0.225)	0.009*
Well	45 (10.0)	-	-
Treatment of water			
Yes	94 (20.9)	0.48 (0.02 - 11.77)	0.65
No	355 (79.1)	-	-
Knowledge of Toxo			
Yes	28 (6.20)	1.3 (0.001 - 2.14)	0.68
No	421 (93.8)	-	-
Waste disposal facility			
Land	07 (1.60)	0.0001 (0.0001 - 1.0)	0.99
Public toilet	57 (12.7)	39.5 (5.33 - 292.81)	0.0001*
WC	385 (85.7)	-	-
Contact with soil			
Yes	94 (20.9)	189.4 (5.33 - 292.81)	0.005*
No	355 (79.1)	-	-
HIV status			
Negative	395 (88.0)	0.31 (0.03 - 2.95)	0.31
Positive	54 (12.00)	-	-

*-Statistically significant at 0.05 significance level.

Table 6. Multiple logistic regression of selected variables.

	Adjusted odd ratio (95% CI)	p value
Level of education		
Primary	1.33 (0.84 - 2.12)	0.23
Secondary	0.34 (0.07 - 1.52)	0.16
University	-	-
Marital status		
Married	1.13 (0.71 - 1.80)	0.62
Single	-	-
Source of water		
Community	0.61 (0.27 - 1.42)	0.25
Bore hole	0.54 (0.25 - 1.14)	0.12
Rain	0.18 (0.0001 - 1)	1.0
Streams	0.43 (0.12 - 1.74)	0.24
Tap water	1.10 (0.49 - 2.48)	0.82
Well	-	-
Waste disposal facility		
Land	0.0001 (0.0001 - 1.0)	0.99
Public toilet	1.46 (0.76 - 2.81)	0.26
WC	-	-
Contact with soil		
Yes	2.01 (1.04 - 3.91)	0.039*
No	-	-

*-Statistically significant at 0.05 significance level.

4. Discussion

This study investigated the seroprevalence of *T. gondii* infection among pregnant women in the Douala 3 subdivision using the commercially available ELISA test kits that detect anti-Toxoplasma IgG and IgM antibodies. Infection with *T. gondii* in early pregnancy presents the risk of fetal transmission, where the rate of transmission ranges between 60% and 81% in the third trimester [1] [4] [20]. Classically, congenital infection results from primary acquired maternal infection during gestation. The severity of fetal infection is inversely correlated to the stage at which infection occurs, and 80% of neonates are asymptomatic when infected during the third trimester of gestation [21]. However, in the first trimester transplacental transmission, the consequences for fetal development are heavy and severe, often leading to severe abnormalities or to abortion. Neonatal manifestations of congenital toxoplasmosis have been related to fetal conditions, including hydrocephalus, microcephaly, intracranial calcifications, retinochoroiditis, strabis-

mus, blindness, epilepsy, and psychomotor and mental retardation [22] [23]. Hence, a timely method of detection of *T. gondii* infection in pregnant women is key.

Our results showed that more than half of the study participants were positive for IgG or IgM (76.59%), indicative of acute and previous exposure. *T. gondii* IgG seropositivity solely was 58.6% in our study, suggesting past or previous exposure. Even though the seroprevalence was high in this study, it was relatively low as compared to the 88.7% detected by Wam *et al.* [12] in Njinikom, Western Cameroon. In our study, *T. gondii* positivity to IgM was found in only 39.0% of our participants, indicating recent infection. Several other similar studies have reported a few positive results for IgM compared to IgG [24]. Contrarily, *T. gondii* IgM seropositivity in a systematic review conducted by Bigna *et al.* [25] indicated a global IgM seroprevalence of 1.9%, with the highest noted in the Eastern Mediterranean (4.1%) and America being the lowest in *T. gondii* IgM (1.1%) seroprevalence. Moreover, global IgG seroprevalence was found to be 32.9% which is a little lower than our findings.

Moreover, global IgG seroprevalence was found to vary from one area to another and even in the same region as conducted by Nadia *et al.* [26] in the West region of Cameroon. Literature review shows that several other similar studies have reported no or few positive results for IgM compared to IgG [27]. This is contrary to our study. In Sri Lanka, however, Bessières *et al.* [28] found a *T. gondii*-specific IgM seropositivity as low as 0.3% and IgG seropositivity far lower than we obtained in our finding, that is, 29.9%, indicating that most of the investigators are susceptible to primary acute infection during pregnancy and possible fetal anomalies. In patients with acute infection, *T. gondii* specific IgM appears initially and antibody levels become negative in a few months. However, persistent positivity to IgM in chronic stages of toxoplasma infection has been reported [25]. Thus, the presence of IgM antibodies does not always confirm acute infection. However, the negative toxoplasma IgM test rules out recently acquired toxoplasma infection [29]. In antibody detection for diagnosis of toxoplasmosis, anti-IgM suggests recent, acute, or ongoing infection because these anti-bodies are not usually in acquired immunity and are very rare in chronic infections [15] [30]. In high-income countries, like the USA and the UK, it has been estimated that between 10% and 40% of the population is infected, while in Central and South America and continental Europe, the prevalence ranges from 50% to 80% [31]. In our study, IgM antibodies were detected in 39.0% of the study population, implying the possible presence of both acute and chronic infection.

Importantly, in this study, there was an association with contact with cat, cats have been implicated in the transmission of *T. gondii* infection [12]. Owning cats and subsequent exposure to their feces facilitate the transmission of the parasite [9]. Congruently, Al Hamdani and Mahdi [13] also found that toxoplasma antibodies were more prevalent in pregnant women with cats at home than in pregnant women that did not own cats.

Our work found abortion to be associated with *Toxoplasma gondii*. This result corroborated those obtained by Nayeri *et al.* [30] who found in a systematic review and meta-analysis that *T. gondii* infection could be considered a potential risk factor for abortion [4]. In fact, fetuses are at high risk of this parasite during acute infection due to Toxoplasma's ability to cross the placental barrier and infect the fetus before it can acquire immunity [24].

The consumption of cat meat, was significantly associated with *T. gondii* infection. Toxoplasma antibodies were also more prevalent in pregnant women with cats at home than in pregnant women who did not own cats, suggesting it is a great risk factor for the transmission of *T. gondii* infection.

In addition, hand wash after cleaning places [p = 0.0001*] or roadside consumption of fruit and dog owners were observed to be significantly associated with toxoplasma seropositivity. Similar results have been observed in studies conducted in Mexico [30], Ethiopia [10], and Sudan [30]. Whereas studies conducted in Douala-Cameroon [19] and Thailand [22] showed a significant association between *T. gondii* infection and source of water. Although domestic cats are probably the major source of contamination [1] [13] speculated oocysts survive in moist soil for months to years [22]. A significant association was noted between *T. gondii* infection and untreated water. It is likely that oocysts might have been present in some of the untreated water sources in our study area. Poor sanitation methods along with poor quality water used to wash raw meat at abattoirs or vegetables and fruit sold in the market, might have led to their contamination with oocysts.

The seroprevalence of anti-*T. gondii* antibodies in HIV-positive participants in this study was 11.1%. This was lower than the 42.1% (56/133) obtained among HIV/AIDS patients in the University Teaching Hospital in Yaoundé [18]. However, the number of HIV patients in our study was lower to the latter. Similarity in the prevalence of toxoplasma seropositivity among HIV-infected or uninfected women in our study conforms to what has been reported by researchers in the North-West region of Cameroon [12], Ethiopia [25], United States of America [25], and Ethiopia [26].

We also found that low level of education (Primary), source of water (Community, Streams, bore hole and tap water), being married and the use of public toilet were found to be associated with higher *T. gondii* seroprevalence. Several researchers have attempted to establish a correlation between *T. gondii* infection and husbandry risk factors in meat-producing animals, mainly swine and sheep. Risk factors related to increased prevalence of *T. gondii* infection included farm type, feeding practices, presence of cats, rodent control methods, bird control methods, farm management, carcass handling and disposal, and water source and quality [12] [24] [25].

Our study results however should be interpreted with some caution. Our sample size was not too large and conclusions from the present study necessitate investigation with a larger sample size. It is likely that we might obtain different results with increased sample size. The number of equivocal results obtained using the selected ELISA technique in some cases was high, and difficult to interpret

with the absence of reference testing facilities for toxoplasmosis in or around our study area. This could affect our results by increasing or decreasing the observed prevalence. Secondly, we might have obtained a different result if we considered sampling women of child bearing age.

5. Conclusions

The prevalence of *T. gondii* infection among pregnant women at Logbaba District Hospital was 76.59% with the prevalence of IgG being 58.6%, IgM 39.0% and the simultaneous prevalence of IgG and IgM 21.4% by the ELISA technique.

Abortion, contact with cats, hand washing after cleaning, dog owners, consumption of raw or undercooked meat, consumption of raw milk, consumption of fruit by the roadside, treatment of water, knowledge of toxo, contact with soil, HIV status, level of education, marital status, source of water, and waste disposal facility were the major risk factors of *T. gondii* infection. Since *T. gondii* infection is acquired predominantly from the environment, the education of pregnant women will be an inexpensive but significant mode of reducing the risk of acquisition and transmission of the infection.

Data Availability

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Author Contributions

LFS and SS designed the study. LFS and PAWM performed sampling and laboratory analyses. GFK and FS performed statistical analyses. All authors participated in manuscript writing and approved the final version of the manuscript.

Conflicts of Interest

The authors declare that they have no competing interests.

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