

Research Article

Sero-Prevalence of Anti-Toxoplasma Gondii IgM and IgG Antibodies among Young Adults with History of Ocular Infection in South-Western Nigeria

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Abstract: *Toxoplasma gondii* causes a vision-threatening parasitic disease (ocular toxoplasmosis) which has been associated with posterior uveitis worldwide both in immunosuppressed and immunocompetent individuals. This study investigated the sero-prevalence of anti-*Toxoplasma gondii* antibodies among undergraduate Students of Babcock University, Ilishan-Remo, Ogun State. The serum samples of 150 participants (75 males and 75 females, aged 16-36 years) with history of eye infection were randomly collected and screened using a one-step Bio-check Toxo IgM/IgG Rapid Antibody Test Cassette (Blue Cross Bio-Medical Co., Ltd, Beijing, China). The demographic and clinical information of the participants were also collected using a structured questionnaire. The outcome of the study shows that out of the 150 participants screened, 3 (2.0%) participants tested positive for anti-*Toxoplasma gondii* IgG antibody only, 1 (0.7%) tested positive for anti-*Toxoplasma gondii* IgM antibody only, while 1 (0.7%) person tested positive to both anti-*Toxoplasma gondii* IgG and IgM antibodies. There was no significant difference ($P>0.05$) in the sero-prevalence of *Toxoplasma gondii* antibodies on the basis of gender and age among the study participants. Associated risk factors identified in this study include: Lack of awareness and poor knowledge of *Toxoplasma gondii* as aetiologic agent of ocular disease, wearing of contaminated contact lens, consumption of raw or undercooked meat, consumption of raw fruits and vegetables, contact with soil through gardening and collection of garbage among several others. Indications for eye infection among the study participants who tested positive for *T. gondii* antibodies include: red eye, itchy eyes, ocular discharge, foreign body sensation, painful eye, and eyestrain among other signs and symptoms. The outcome of this study shows that *Toxoplasma gondii* infection exist among undergraduate students of Babcock University, Ogun State with history of ocular infection; hence the need for sero-positive individuals to visit the Ophthalmology Clinic for further diagnosis and treatment. Public health awareness campaign regarding the mode of transmission and risk factors associated with toxoplasmosis should also be kick-start, intensified and sustained.

Keywords: *Toxoplasma gondii* antibodies, IgG, IgM, ocular disease, Risk factors.

INTRODUCTION

Toxoplasma gondii infection has been identified as an important risk factor in the development of infectious posterior uveitis and retinitis (Kim *et al.*, 2018). Visual impairment and blindness has been associated with the presence of the coccidian parasite in the affected eye (Rahimi-Esboei *et al.*, 2018). Infection is common among children, elderly, pregnant women and immunocompromised individuals (Feleke *et al.*, 2019). About 55% of the world's population harbour *T.*

gondii in their systems without knowing (Mustafa *et al.*, 2019). Infection is more prevalent in developing countries (Abamecha and Awel, 2016; Alvarado-Esquivel *et al.*, 2018) and the level of awareness of this parasite, as a causative agent of eye disease appears to be very low among young adults (Akyar, 2011; Alzaheb and Al-Amer, 2017).

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Epidemiological data suggests that approximately half a billion humans have antibodies to *T. gondii* in their serum globally. However, the incidence and the sources of infection vary among geographic regions (Rouatbi *et al.*, 2019). Only a small proportion (less than 0.1 percent) of people acquire infection congenitally (Ryan and Ray, 2004; Subauste *et al.*, 2011).

Toxoplasma gondii infection rate is usually high in parts of the world that have hot, humid climates and lower altitudes (Rouatbi *et al.*, 2019). Man is infected by the consumption of food, water and hands contaminated by faeces of infected cats or by ingestion of cyst in undercooked meat. It can also be transmitted by congenital means, organ transplant and by blood transfusion. Following ingestion of the cysts, the parasites become intracellular and multiply within the organs and central nervous system (Cheesbrough, 2006).

The parasite causes a spectrum of different diseases and clinical symptoms (CDC, 2017). The adult acquired infections are usually without symptoms, but when they do occur, it is characterized with fever, rash, enlargement of lymph nodes, myocarditis, meningoencephalitis and atypical pneumonia. Other symptoms include intense frontal headache, sore throat, blocked nose with altered senses of taste and smell, stiff neck and Kernig's sign. The infection of the brain can be characterized by a growing mass similar to a tumour with symptoms like headache, seizure, gait instability, weakness or sensory loss (Weiss and Dubey, 2009; Pusch *et al.*, 2009).

Besides the brain, the organism can also enter the eyes and cause ocular toxoplasmosis characterized with inflammation and redness of the eye. In the eye, a focal type of choroiditis often affects both eyes and this is usually at the posterior pole in the macular region (Cheesbrough, 2006; Galloway *et al.*, 2006; Delair *et al.*, 2011). The infection of the retina when examined shows yellow-white fluffy patches that are distinguished from the surrounding red retina (Gladwin *et al.*, 2014; Kim *et al.*, 2018).

Ocular toxoplasmosis is a vision-threatening parasitic disease and the major cause of posterior uveitis worldwide both in immunosuppressed and immunocompetent individuals (Roberto-Carlos *et al.*, 2015). It can occur in the children of mothers infected with *T. gondii* during pregnancy. However, it is not limited to the congenitally infected, but can also occur following adult-acquired infection or as a result of disease reactivation in immune-compromised and pregnant individuals (Leigh *et al.*, 2007). Ocular toxoplasmosis may be remarkably atypical in situations of evident immunosuppression such as acquired immunodeficiency syndrome, malignancy, and use of chronic immunosuppressive drug therapy. However,

aggressive forms in immunocompetent hosts are very rare. The diagnosis of ocular toxoplasmosis is often based on the presence of characteristic clinical findings including focal retinochoroiditis, retino choroidal scar and vitreous inflammation. Never-the-less, not all the patients show the same clinical picture (Park and Nam, 2013; Rudzinski *et al.*, 2016).

Generally, specimens used in the diagnosis of *Toxoplasma gondii* infection include: serum, sputum, lymph nodes aspirates, bone marrow, cerebrospinal fluid, pleural fluid, peritoneal fluid and ocular fluid amongst others. Laboratory diagnosis is carried out by detection of antibodies particularly IgM antibodies present in a patient's serum and also by identification of parasites in tissues, aspirates or body fluids. The laboratory tests include Indirect fluorescent antibody Test, Enzyme linked immunoabsorbant assay, Complement fixation test, staining aspirates and body fluids with Giemsa or Field's stains (Ochei and Kolhatkar, 2007; Al-Adhami *et al.*, 2016).

Early detection of *Toxoplasma gondii* infection can help in the proper treatment, prevent ocular disease and other associated complications. This will save cost and reduce the number of fruitless visits to the eye Clinic. However, the percentage occurrence of *Toxoplasma gondii* infection among undergraduate Students of Babcock University, Ilishan-Remo, Ogun State with history of eye infection is not known. Besides, there is need to identify factors that predispose young adults in this setting to *Toxoplasma gondii* infection. Scarcity of information in this regard, therefore necessitates this study. The aim of this study was therefore to determine the seroprevalence of *Toxoplasma gondii* antibodies among undergraduate Students of Babcock University, Ilishan-Remo, Ogun State with history of eye infection, as well as to determine the relationship between occurrence of *Toxoplasma gondii* antibodies and the indications for eye infection.

MATERIALS AND METHODS

Study Design

This is a cross-sectional descriptive study.

Study Area

This study was carried out among undergraduate Students of Babcock University, Ilishan-Remo, Ogun State, a first Class Seventh-Day Adventist Institution of higher learning located in the South-Western region of Nigeria, coordinates: 6.8862° N, 3.7055°E. Ogun State is bordered to the South by Lagos State, Oyo and Osun States to the North, Ondo State to the East and the Republic of Benin to the West.

Duration of study

The study was carried out between the months of May and June, 2018.

Study population

Undergraduate Students of Babcock University, Ilishan-Remo, Ogun State with history of eye infection were the target population in this study. They consisted of both male and female genders, singles and married, of various age groups, from different ethnic, religious and cultural background.

Sample Size Calculation

The sample size (N) was estimated using the formula described by Charan and Biswas (2013):

$$N = Z^2PQ/d^2$$

Where;

N = required sample size,

Z = Standard normal variate at 5% ($p < 0.05$) error or 95% confidence interval is 1.96

P = Proportion of the population with *Toxoplasma gondii* infection from previous study,

Q = Proportion of the population without *Toxoplasma gondii* infection ($1 - P$) and

d = Absolute error margin is 0.05.

For the calculation, a 95% confidence interval, a P value of 0.094, *i.e.*, a prevalence rate of 9.4% among undergraduate Students from previous study by Alzaheb and Al-Amer, (2017), and margin of error (d) set at 0.05 was used to determine the minimum sample size required. To minimize errors arising from the likelihood of non-compliance, 10% of the sample size was added giving a final sample size of 150.

Sample Size

A total of 150 blood specimens was collected randomly from consenting undergraduate Students (75 males and 75 females) of Babcock University, Ilishan-Remo, Ogun State with history of eye infection.

Ethical Approval

Ethical approval for the study was obtained from the Babcock University Health Research Ethics Committee (BUHREC) with ethical approval registration number: BUHREC349/18.

ELIGIBILITY OF SUBJECTS

Inclusion Criteria

Consenting undergraduate Students of Babcock University, Ogun State with history of eye infection and no history of antibiotic/anti-parasitic drugs or herbal remedies in the preceding two (2) weeks were randomly recruited for the study.

Exclusion Criteria

Undergraduate Students of Babcock University, Ogun State with no history of eye infection and history of antibiotic/anti-parasitic drugs or herbal remedies in the preceding two (2) weeks, as well as post-graduate Students were excluded from the study.

Consent

Informed consent was obtained from each willing participant whose blood specimen was collected to be used for the study. The objectives, benefits and procedure for the study were made very clear to the participants and they were assured of confidentiality of the study.

Data Collection

Prior to specimen collection, demographic and clinical information was obtained from participants through administration of prepared questionnaires and personal interviews. Each questionnaire had a unique participant identification number (PIDN). The first part of the questionnaires contained the biodata of the patients *e.g.* sex, age, educational level, religion and marital status. Second part second part included history of eye infection (red eye, itchy eye, swollen eye, eye strain, painful eye, photophobia, eye discharge etc), risk factors (if any), personal hygiene and health care-seeking behavior. The study population was stratified by sex and age. Response to structured questionnaire administered was used to collect data on epidemiology and demographic trends of *Toxoplasma gondii* infection. For the purpose of privacy, all information obtained from the participants were treated confidentially.

Specimen Collection and Storage

Blood specimen was collected from each participant via venous puncture and conveyed to the laboratory unit of the Department of Medical Laboratory Science, Babcock University. When the sample was not processed immediately the sera was stored up at $2-8^{\circ}\text{C}$ for up to three days. The frozen specimens were properly thawed and mixed before testing commences. Multiple freeze-thaw cycles of the sera were avoided. Prior to testing, frozen specimens was brought to room temperature slowly and mixed gently. Specimens containing visible particulate matter was clarified by centrifugation before testing. Samples demonstrating gross lipemia, gross hemolysis or turbidity were not used in order to avoid interference on result interpretation.

LABORATORY ANALYSIS

Detection of Serum Anti-Toxoplasma Gondii IgM and IgG Antibodies

Serum anti-*Toxoplasma gondii* IgM and IgG antibodies were detected using a one-step Bio-check Toxo IgM/IgG Rapid Antibody Test Cassette supplied by Blue Cross Bio-Medical Co., Ltd, Beijing, China according to the manufacturer instruction.

INTERPRETATION OF RESULTS

Positive Result

In addition to the presence of the Control "C" line, if only the IgM "M" line is developed, the test indicates the presence of IgM anti-*T. gondii* in the specimen. The result is positive or reactive. In addition

to the presence of the C line, if only the IgG “G” line is developed, the test indicates the presence of IgG anti-*T. gondii* in the specimen. The result is positive or reactive. Also in addition to the presence of the C line, if both the “M” and the “G” lines are developed, the test indicates the presence of both IgG and IgM anti-*T. gondii* in the specimen. The result is also positive or reactive.

Negative Result

If only the C line is present, the absence of any pink color in both the test lines (M and G) indicates that no anti-*T. gondii* antibodies are detected in the specimen. The result is negative or non-reactive

Invalid Result

If no Control “C” line is developed, the assay is invalid regardless of any pink color in the test bands as indicated. A total absence of color in either regions or only one color band appearing on the test region indicates procedure error and/or the test reagent has deteriorated. If this occurs, the assay will be repeated with a new device.



Fig. 1: Bio-Check Toxoplasma gondii Diagnostic Test Cassette negative for both IgG/IgM antibodies

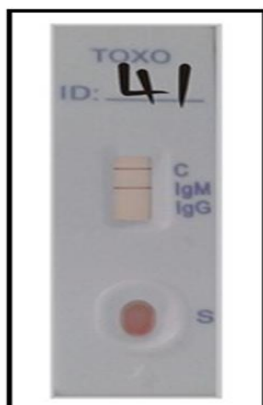


Fig. 2: Bio-Check Toxoplasma gondii Diagnostic Test Cassette positive for only IgM antibody

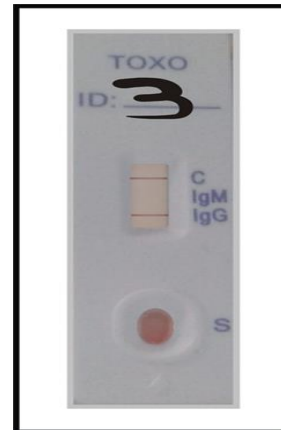


Fig. 3: Bio-Check Toxoplasma gondii Diagnostic Test Cassette positive for only IgG antibody

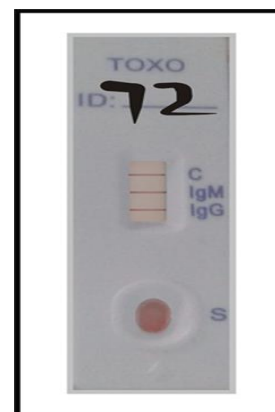


Fig. 4: Bio-Check Toxoplasma gondii Diagnostic Test Cassette positive for both IgM and IgG antibodies

Data Analysis

Data obtained from the serum antibody screening, as well as from the questionnaires were entered into Microsoft Excel. Statistical analysis was carried out using SPSS-18.0 (Statistical packages for social scientists version 18.0) statistical program. One-way analysis of variance (ANOVA) and Tukey-Kramer Multiple Comparisons Test was used to test for significant differences between the seroprevalence rate of anti-*Toxoplasma gondii* IgG and IgM antibodies, as well as the percentage occurrence of past and present *Toxoplasma gondii* infection.

RESULTS AND DISCUSSION

The present study investigated the seroprevalence of anti-*Toxoplasma gondii* antibodies (IgM and IgG) among Undergraduate Students of Babcock University, Ilishan-Remo, Ogun State, Nigeria with history of ocular infection. A total number of 150 students (75 males and 75 female) were screened using rapid diagnostic method. A larger proportion of the participants were between the age range 21-25 years (58.7%), followed by 16-20 years (40.0%), 26-30 years (0.7%) and ≥36 years (0.7%) Table 1.

Table 1: Demographic characteristics of the participants

Variable	Category	Frequency	Percent
Gender	Male	75	50.0
	Female	75	50.0
	Total	150	100.0
Age	16-20 Yrs	60	40.0
	21-25 Yrs	88	58.7
	26-30 Yrs	1	0.7
	≥36 Yrs	1	0.7
	Total	150	100.0

Table 2 shows the frequency of occurrence of *Toxoplasma gondii* infection by gender distribution. While 2 (1.3%) of the male participants tested positive for the *T. gondii* IgG antibody only, just 1 (0.7%) of their female counterparts tested positive. With regard to the presence of *T. gondii* IgM only among the study population, one person 1 (0.7%) from the female category tested positive. Also, 1 (0.7%) of the male category tested positive for both the *T. gondii* IgG and IgM antibodies. There were no significant differences ($P>0.05$) in the number of male and female participants who tested positive for *T. gondii* IgG only, IgM only or both antibodies.

Table 3 shows the frequency of occurrence of *Toxoplasma gondii* infection by age distribution. The highest occurrence of *T. gondii* IgG antibody only was seen among participants belonging to the age range of 21-25years (1.3%), while the least was recorded among 16-20 years age range (0.7%). There was no record of occurrence of *T. gondii* IgG antibody only among other age categories (0%). One person from 16-20 years and 21-25 years age range, tested positive for *T. gondii* IgM antibodies only (0.7%) and for both *T. gondii* IgG and IgM antibodies (0.7%), respectively. There were no

significant differences ($P>0.05$) in the occurrence of *Toxoplasma gondii* infection between and within the various age categories.

Table 4 shows relationship between occurrences of *Toxoplasma gondii* IgG antibodies and associated risk factors. 67.3% were not aware that *Toxoplasma gondii* can cause ocular disease, among which 2.7% tested positive for *Toxoplasma* IgG antibody. All the participants (100%) had history of eye infection, of which 2.7% of the participants tested positive for the *Toxoplasma gondii* IgG antibody. 45.3% of the participants use either eye glasses or contact lens, among which 1.3% tested positive for *Toxoplasma gondii* IgG. Still, 30.7% of the participants keep dogs or cats as pets and none from this category tested positive for *Toxoplasma gondii* IgG antibody. None of the participants had history of toxoplasmosis but 4 (2.7%) tested positive for *Toxoplasma gondii* IgG. 8.7% of the participants have histories of blood transfusion however none from this group tested positive for *Toxoplasma gondii* IgG antibody. 15.3% of the participants consume raw/undercooked meat but none tested positive for the *Toxoplasma gondii* IgG antibody. 82% consume.

Table 2: Frequency of occurrence of *Toxoplasma gondii* infection by gender distribution

Antibody Present	Gender	No. Negative N (%)	No. Positive N (%)	Total Examined	Pearson Chi-Square (χ^2)	df	P-Value
IgG Only	Male	73 (48.0)	2 (1.3)	75 (50)	1.027 ^a	1	.311
	Female	74 (49.3)	1 (0.7)	75 (50)			
	Total	147 (98)	3 (2.0)	150 (100)			
IgM only	Male	75 (50)	0 (0)	75 (50)	0.000 ^a	1	1.000
	Female	74 (49.3)	1 (0.7)	75 (50)			
	Total	149 (98.6)	1 (0.7)	150 (100)			
IgG & IgM	Male	74 (49.3)	1 (0.7)	75 (50)	0.000 ^a	1	1.000
	Female	75 (50)	0 (0)	75 (50)			
	Total	149 (98.6)	1 (0.7)	150 (100)			

P value >0.05 is considered statistically non-significant.

Table 3: Frequency of occurrence of *Toxoplasma gondii* infection by age distribution

Antibody Present	Age Range	No. Negative N (%)	No. Positive N (%)	Total Examined	Pearson Chi-Square (χ^2)	df	P-Value
IgG only	16-20 Yrs	59 (39.3)	1(0.7)	60 (40)	0.473 ^a	3	0.925
	21-25 Yrs	86 (57.3)	2(1.3)	88 (58.7)			
	26-30 Yrs	1 (0.7)	0 (0)	1 (0.7)			
	≥36 Yrs	1 (0.7)	0 (0)	1 (0.7)			
	Total	147 (98)	3 (2.0)	150 (100)			
IgM only	16-20 Yrs	59 (39.3)	1 (0.7)	60(40)	0.104 ^a	3	0.991
	21-25 Yrs	88 (58.7)	0 (0)	88(58.7)			
	26-30 Yrs	1(0.7)	0	1(0.7)			

	≥36 Yrs	1 (0.7)	0	1(0.7)			
	Total	149 (99.3)	1 (0.7)	150 (100)			
IgG & IgM	16-20 Yrs	60 (40)	0 (0)	60(40)	0.125 ^a	3	0.985
	21-25 Yrs	87 (58)	1 (0.7)	88(58.7)			
	26-30 Yrs	1 (0.7)	0 (0)	1(0.7)			
	≥36 Yrs	1 (0.7)	0 (0)	1(0.7)			
	Total	149 (99.3)	1 (0.7)	150 (100)			

P value >0.05 is considered statistically non-significant.

raw or undercooked meat among which 4 (2.7%) persons tested positive for *Toxoplasma gondii* IgG antibody. 91.3% of the participants consume raw fruits and vegetables, among which 2 (1.3%) tested positive for *Toxoplasma gondii* IgG antibody. 45.3% have contact with soil through farming, 1 (0.7%) tested positive for *Toxoplasma gondii* IgG antibody. 25.3% of the participants collected garbage as children and 3 (2%) of them tested positive for *Toxoplasma gondii* IgG antibody. With regard to type of water taken as a child, 3 (2.0%) participants who took portable water tested

positive for *Toxoplasma gondii* IgG antibody, followed by those that took boiled or filtered among which 1 (0.7%) tested positive for *Toxoplasma gondii* IgG antibody. With regard to type of water taken as an adult, 2 (1.3%) participants who drank boiled or filtered tested positive for *Toxoplasma gondii* IgG antibody, followed by 1 (0.7%) participant who drank portable water tested positive for *Toxoplasma gondii* IgG antibody. Also, 1(0.7%) person that drank neither boiled nor filtered water tested positive for *Toxoplasma gondii* IgG antibody.

Table 4: Relationship between occurrence of *Toxoplasma gondii* IgG antibodies and associated risk factors

Characteristics	Responses	No. Negative N (%)	No. Positive N (%)	Total Number Examined	Pearson Chi-Square (χ^2)	P-Value
Awareness that <i>T.gondii</i> can cause eye disease	Yes	49(32.7)	0(0)	49(32.7)	1.994 ^a	0.158
	No	97(64.7)	4(2.7)	101(67.3)		
History of eye infection	Yes	146(97.3)	4(2.7)	150(100)	. ^a	
	No	0(0)	0(0)	0(0)		
Use of glasses/contact lens	Yes	66(44)	2(1.3)	68(45.3)	0.036 ^a	0.849
	No	80(53.3)	2(1.3)	82(54.7)		
Keep cats/dogs as pets	Yes	46(30.7)	0	46(30.7)	1.818 ^a	0.178
	No	100(66.7)	4(2.7)	104(69.3)		
History of toxoplasmosis	No	146(97.3)	4(2.7)	150(100)	. ^a	
	Yes	0(0)	0(0)	0(0)		
History of blood transfusion	Yes	13(8.7)	0(0)	13(8.7)	0.390 ^a	0.532
	No	133(88.7)	4(2.7)	137(91.3)		
History of organ transplant	No	146(97.3)	4(2.7)	150(100)	. ^a	
	Yes	0(0)	0(0)	0(0)		
Consumption of raw/undercooked meat	Yes	23(15.3)	0(0)	23(15.3)	0.744 ^a	0.388
	No	123(82)	4(2.7)	127(84.7)		
Consumption of raw vegetables/fruit	Yes	135(90)	2(1.3)	137(91.3)	8.870 ^a	0.003*
	No	11(7.3)	2(1.3)	13(8.7)		
Contact with soil through farming	Yes	67(44.7)	1(0.7)	68(45.3)	0.686 ^a	0.408
	No	79(52.7)	3(2)	82(54.7)		
Garbage collection as a child	Yes	35(23.3)	3(2)	38(25.3)	5.359 ^a	0.021*
	No	111(74)	1(0.7)	112(74.7)		
Garbage collection as adult	Yes	23(15.3)	0(0)	23(15.3)	0.744 ^a	0.388
	No	123(82)	4(2.7)	127(84.7)		
Type of water consumed as a child	Portable	76(50.7)	3(2)	79(52.7)	.855 ^a	0.652
	Filtered/boiled	66(44)	1(0.7)	67(44.7)		
	Neither boiled/filtered	4(2.7)	0(0)	4(2.7)		

Of all the risk factors considered, only consumption of raw vegetables/fruits, garbage collection as a child and type of water consumed as adult were found to be significantly ($P < 0.05$) associated with the occurrence of *toxoplasma gondii* IgG antibodies among the study participants.

Table 5 shows the relationship between the occurrence of *Toxoplasma gondii* IgM antibodies and

associated risk factors. 67.3% of the participants were not aware that *Toxoplasma gondii* can cause ocular disease, among which 2 (1.3%) tested positive to *Toxoplasma* IgM antibody. All the participants (100%) had history of eye infection of which 2 (1.3%) of them tested positive for the *Toxoplasma gondii* IgM antibody. 45.3% of the participants use either eye glasses or contact lens, among which 1 (0.7%) tested positive for *Toxoplasma gondii* IgM.

Table 5: Relationship between occurrence of *Toxoplasma gondii* IgM antibodies and associated risk factors

Characteristics	Responses	No. Negative N (%)	No. Positive N (%)	Total Number Examined	Pearson Chi-Square (χ^2)	P-Value
Awareness that <i>T. gondii</i> can cause eye disease	Yes	49(32.7)	0(0)	49(32.7)	0.983 ^a	0.321
	No	99(66)	2(1.3)	101(67.3)		
History of eye infection	Yes	148	2(1.3)	150	.a	
	No	0(0)	0(0)	0(0)		
Use of glasses/contact lens	Yes	67(44.7)	1(0.7)	68(45.3)	0.018 ^a	0.894
	No	81(54)	1(0.7)	82(54.7)		
Pets (cats/dogs)	Yes	46(30.7)	0(0)	46(30.7)	0.897 ^a	0.344
	No	102(68)	2(1.3)	104(69.3)		
History of toxoplasmosis	Yes	0(0)	0(0)	0(0)	.a	
	No	148	2(1.3)	150(100)		
History of blood transfusion	Yes	13(8.7)	0(0)	13(8.7)	0.192 ^a	0.661
	No	135(90)	2(1.3)	137(91.3)		
History of organ transplant	No	148(98.7)	2(1.3)	150(100)	.a	
	Yes	0(0)	0(0)	0(0)		
Consumption of raw/undercooked meat	Yes	23(15.3)	0(0)	23(15.3)	0.367 ^a	0.545
	No	125(83.3)	2(1.3)	127(84.7)		
Consumption of raw vegetables/fruit	Yes	136(90.7)	1(0.7)	137(91.3)	4.375 ^a	0.036*
	No	12(8)	1(0.7)	13(8.7)		
Contact with soil through farming	Yes	67(44.7)	1(0.7)	68(45.3)	0.018 ^a	0.894
	No	81(54)	1(0.7)	82(54.7)		
Garbage collection as a child	Yes	37(24.7)	1(0.7)	38(25.3)	0.652 ^a	0.419
	No	111(74)	1(0.7)	112(74.7)		
Garbage collection as adult	Yes	23(15.3)	0(0)	23(15.3)	0.367 ^a	0.545
	No	125(83.3)	2(1.3)	127(84.7)		
Type of water consumed as a child	Portable	78(52)	1(0.7)	79(52.7)	7.432 ^a	0.024*
	Filtered/ boiled	67(44.7)	0(0)	67(44.7)		
	Neither boiled/ filtered	3(2)	1(0.7)	4(2.7)		
Type of water consumed as an adult	Portable	89(59.3)	1(0.7)	90(60)	14.020 ^a	0.001*
	Filtered/ boiled	55(36.7)	0(0)	55(36.7)		
	Neither boiled nor filtered	4(2.7)	1(0.7)	5(3.3)		

Furthermore, 30.7% of the participants keep dogs or cats as pets and none of them tested positive for *Toxoplasma gondii* IgM antibody. None (0%) of the participants had history of toxoplasmosis, but 2 (1.3%) tested positive for *Toxoplasma gondii* IgM antibody. 8.7% of the participants have histories of blood transfusion however none of them tested positive for *Toxoplasma gondii* IgM antibody. 15.3% of the participants consume raw/undercooked meat but none (0%) tested positive for the *Toxoplasma gondii* IgM antibody. 91.3% of the participants consume raw fruits and vegetables among which 1 (0.7%) tested positive for *Toxoplasma gondii* IgM antibody. 45.3% have contact with soil through farming and only 1 (0.7%) person tested positive for *Toxoplasma gondii* IgG antibody. 25.3% of the participants collected garbage as children and 1 (0.7%) of them tested positive for *Toxoplasma gondii* IgM antibody. 15.3% collect garbage as adults but none (0%) from this category tested positive for *Toxoplasma gondii* IgM antibody.

With regard to type of water drunk as a child, just 1 (0.7%) person who drank portable water tested positive for *Toxoplasma gondii* IgM antibody, also, 1 (0.7%) person who drank boiled or filtered tested positive for *Toxoplasma gondii* IgM antibody. Similarly, 1 (0.7%) person among those who drank

portable water tested positive for *Toxoplasma gondii* IgM antibody, none tested positive for *Toxoplasma gondii* IgM antibody among those who drank boiled or filtered. Also, 1 (0.7%) person from among those who drank neither boiled nor filtered water tested positive for *Toxoplasma gondii* IgM antibody. Analysis shows that of all the risk factors considered, only consumption of raw vegetables/fruits, type of water consume as a child and adult were found to be significantly ($P < 0.05$) associated with occurrence of *Toxoplasma gondii* IgM antibodies among the study participants.

The relationship between the occurrences of *Toxoplasma gondii* IgG antibodies and indications for eye infection is presented using a histogram (Figure 5). Out of the 69.3% of the participants who indicated red eye, 4 (2.7%) tested positive for *Toxoplasma gondii* IgG antibody. 20% indicated swollen eye, but none (0%) of them tested positive to *T. gondii* IgG antibody. 2.7% out of the 70.7% who indicated itchy eyes tested positive to *Toxoplasma* IgG antibody. 1 (0.7%) person out of the 20% that indicated ocular discharge tested positive for *Toxoplasma gondii* IgG antibody. 1.3% out of the 20% that indicated foreign body sensation tested positive for *T. gondii* IgG antibody. 35.3% of the participants indicated painful eye, just 2 (1.3%) of them tested positive for *T. gondii* IgG antibody. Still, 3 (2%) out of

the 22% participants that indicated eyestrain tested positive for *T. gondii* IgG antibody. All the 34% of the

participants who indicated blurred vision tested negative for *T. gondii* IgG antibody.

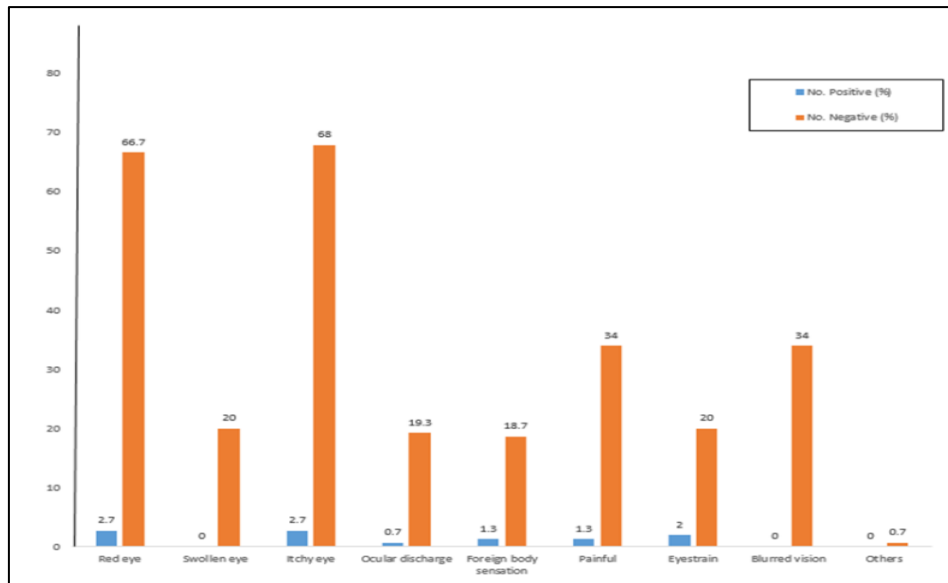


Fig. 5: Relationship between occurrence of *Toxoplasma gondii* IgG antibodies and indications for eye infection among the study participants

The relationship between occurrence of *Toxoplasma gondii* IgM antibodies and indications for eye infection among the study participants is also presented using a histogram (Figure 6). Out of the 104 participants who indicated red eye, 2 (1.3%) were positive for *T. gondii* IgM antibodies. 30 participants indicated swollen eye, but none tested positive for *T. gondii* IgM antibodies. 1.3% tested positive for *T. gondii* IgM antibodies among the 106 participants who

indicated itchy eye. Also 1.3% tested positive for *T. gondii* IgM antibodies among the 30 participants that indicated ocular discharge. Only 1 (0.7%) tested positive for *T. gondii* IgM antibodies among the participants who indicated foreign body sensation, painful eye and eyestrain. None of the 51 (34%) participants who indicated blurred vision was positive for *T. gondii* IgM antibodies.

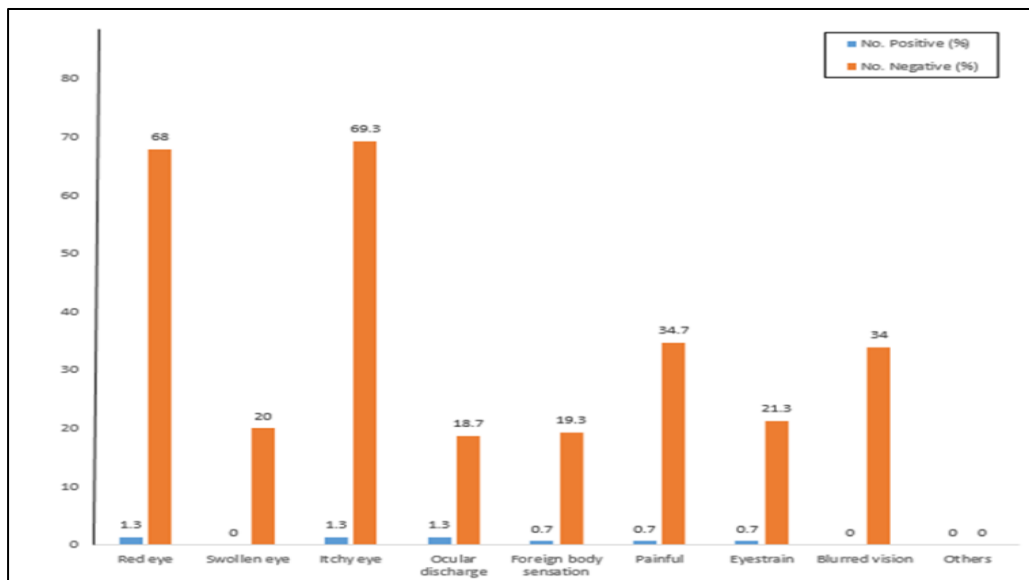


Figure 6: Relationship between occurrence of *Toxoplasma gondii* IgM antibodies and indications for eye infection

The result obtained from this study differ somewhat from those of previous studies. Some were higher, while others were lower. For instance, Negash *et al.*, (2008), reported a prevalence of 60% for anti-toxoplasma antibodies among out-patients at Adama

Hospital, Nazareth, Ethiopia. Gyang *et al.*, (2015), reported a prevalence of 24% for anti-toxoplasma antibodies among primary school children in Lagos, South-Western Nigeria. Cong *et al.*, (2015), reported a prevalence of 12.6%, 0.3% and 2.6% for anti-

toxoplasma IgG only, IgM only, as well as both IgG and IgM antibodies, respectively, among pregnant women in Eastern China. Sharif *et al.*, (2016), recorded a prevalence of 55.5% for anti-toxoplasma IgG antibodies and 14.4% for anti-toxoplasma IgM among out-door patients referred to the Medical Laboratory in Mazandaran province, Northern Iran. Shuralev *et al.*, (2017), reported a prevalence of 30.9% among participants in Kazan city, the state capital of the Republic of Tatarstan, Russia. Rahimi-Esboei *et al.*, (2018), reported a prevalence of 65.8% for anti-toxoplasma IgG antibody and 6.8% for anti-toxoplasma IgM antibody among patients with ocular toxoplasmosis referred to the Farabi Eye Clinic, Tehran, Iran. Still, Khan *et al.*, (2018), reported a prevalence of 2.4% for anti-toxoplasma IgM among people living in District Bannu Khyber Pakhtunkhwa, Pakistan. Meanwhile, Mustafa *et al.*, (2019), reported a prevalence of 81%, 15% and 4% for anti-toxoplasma IgG, IgM and both antibodies respectively, among apparently immunocompetent Sudanese women. Plausible reasons for these variations may include: differences in environmental conditions, prevalence of reservoir hosts, cultural habits, and hygiene status of the study population among several others.

In addition, the present study agreed with the report of a previous study carried out by Meng *et al.*, (2015), using Toxo ELISA test kit. They reported a non-significant difference in the prevalence of *T. gondii* antibodies among the male counterpart (15.6%) in comparison with their female counterparts (14.7%). The study also agrees with that of Gyang *et al.*, (2015), who reported a non-significant difference between male (26.34%) and female (21.54%) using a latex agglutination test kit. A study carried out by Ogoina *et al.*, (2013), shows a non-significant high rate of prevalence in females (43.1%) than in males (30.8%) who were HIV positive and also a study carried out by Sharif *et al.*, (2016), reported a non-significantly higher prevalence in females than males, 36.1% and 19.4% respectively, who both used the ELISA test kit. A study carried out by Hayat *et al.*, (2014), however reported a significant prevalence among male (44%) and female (40%) using a latex agglutination test kit.

On the basis of age distribution, the result shows that the prevalence of *Toxoplasma gondii* antibodies was more prevalent among participants within the age group of 21-25 years of age than in other age groups. According to Hayat *et al.*, (2014), the prevalence was more among the age group 41-50 years (68.75%) than in other age groups. Negash *et al.*, (2008) reported a high level of prevalence among those greater than 44 years of age (66.7). Ogoina *et al.*, (2013), reported a high prevalence also among people greater than 40 years of age (45.7%). Sharif *et al.*, (2016) reported a high prevalence among those above 40 years of age. All this results show an increase in prevalence of anti-toxoplasma antibodies with age,

which is indicative of the fact that the prevalence is higher among the elderly ones than the young ones as a result of decline in the immune system function with aging.

Furthermore, from the results obtained in this present study, 49 (32.7%) of the 150 participants had knowledge of *Toxoplasma gondii* leaving 101 (67.3%) participants with no knowledge of *Toxoplasma gondii*. Knowledge and information is very vital to disease prevention and control in epidemiology. The percentage of people not aware of the parasite and the infection it causes was quite high, hence the need for more public awareness among the study participants in this regard.

According to the present study, there was a significant association between prevalence of IgG and IgM *Toxoplasma gondii* antibodies and consumption of raw fruits and vegetables, Garbage collection as a child, the type of water consumed as a child and as well as adult. Contact with soil has been associated with the spread of toxoplasmosis (Dubey, 2010). However this study shows no significant association between prevalence of *T. gondii* antibodies and contact with soil. This is in accordance with the earlier report by Meng *et al.*, (2015).

In addition, the results obtained from the study suggests that there is a relationship between the presence of *Toxoplasma gondii* antibodies and indications for ocular infection. For example, out of the 33(22%) participants that indicated eyestrain, 3(2%) were positive to the *Toxoplasma gondii* IgG antibody. Still, out of the 28(18.7%) participants who indicated ocular discharge, 2(1.3%) tested positive to the *Toxoplasma gondii* IgM antibody.

Immunologically speaking, antibody production is one of the body's response to the presence of infectious agents, including parasites like *T. gondii*. The detection of anti-*T. Gondii* antibodies in the patient's serum is an indication that the individual must have been exposed to the said pathogen at one time or the other. Generally, IgM and IgG antibodies are produced as a result of primary (first 1-7 days) and secondary (7-21 days) immune responses to infectious agents, respectively. IgM disappears within 2-3 weeks of infection and is replaced by IgG which tend to persist longer in the patient's blood providing lasting immunity. The detection of only *T. gondii* IgM antibody in patient's serum suggests that the individual has current toxoplasma infection, while the detection of only *T. gondii* IgG antibody suggests recent or previous toxoplasma infection. On the other hand, the detection of both *T. gondii* IgM and IgG antibodies suggests both current, as well as recent and previous infection. Meanwhile, the non-detection of both *T. gondii* IgM and IgM antibodies denotes absence of *T. gondii* infection and that the individual is susceptible to *T.*

gondii infection and should therefore take necessary precautions against exposure in the future.

The detection of *T. gondii* antibodies among undergraduate Students of Babcock University with history of eye infection, shows that *T. gondii* infection exist among the study participants and further clinical examination is required, including eye examination by an Ophthalmologist to confirm the presence of posterior uveitis which is often associated with ocular toxoplasmosis.

CONCLUSION

Toxoplasma gondii infection exist among undergraduate students of Babcock University, Ogun State with history of eye infection; hence the need for sero-positive individuals to visit the Ophthalmology Clinic for further diagnosis and treatment. Public health awareness campaign regarding the mode of transmission and risk factors associated with toxoplasmosis should also be kick-start, intensified and sustained.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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