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Seroprevalence and risk factors associated with toxoplasmosis among women of childbearing age in Gombe metropolis, Gombe state, Nigeria

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ABSTRACT

Background: Toxoplasmosis due to *Toxoplasma gondii (T. gondii)* is one of the major global zoonotic diseases that affect man and other animals. About 30% to 65% of all person's worldwide are exposed to *T. gondii*. **Aim:** This study aimed to determine the prevalence and risk factors associated with toxoplasmosis among women of childbearing age attending Women and Children Hospital in Gombe metropolis, Nigeria. **Method and Results:** Five (5) mls of venous blood was each collected from the 182 women who consented for the study and transferred into a labeled EDTA container. Samples were then centrifuged at 1400rmp for 10 minutes to obtain plasma and stored at -20°C in a refrigerator. Samples were subsequently analyzed using human *T. gondii* Enzyme Linked Immunosorbent Assay (ELISA) detection kits (Voyage Medical Co., LTD China, Hong Kong; Batch No: 20200213). Information on sociodemographic and risk factors of all the consented women were collected using structured questionnaire. Of the 182 women who participated in the study, 39 (21.43 %) were positive for anti *T.gondii* IgG antibodies and 0 (0.00 %) IgM specific antibodies were detected. Risk factors to *T. gondii* infection were assessed using structured questionnaire, ethnic groups and educational attainment showed that they were statistically significant (p<0.05). Similarly, infection with *T. gondii* among those who consumed beef, fish, goat, chicken, and other form of meat (dog, rat, and pork) was assessed. Those who consumed other forms of meat were found to have statistically significant association with *T. gondii* infection (p <0.05). Consumption of suya (roasted meat), pasteurized or unpasteurized milk, washing vegetables and water source were not significantly associated with *T. gondii* seropositivity (p <0.05). Also, there was no statistical association between owning a cat, cleaning of cat excretes and handling of pet animals and *T. gondii* infection. Number of miscarriages was however significantly associated with *T. gondii* sero-positivity (p <0.05). **Conclusion:** Seroprevalence of IgG antibodies to *T. gondii* among women reported in this study indicates past exposure to the parasite, therefore, routine serological screening of women of childbearing age and health education on the prevention and control of *T. gondii* are strongly recommended.

Introduction

Toxoplasmosis due to *Toxoplasma gondii* (*T. gondii)* is one of the global major zoonotic diseases that affect man and other animals. About 30% to 65% of all person's worldwide are exposed

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to *T. gondii* [1]. The prevalence of toxoplasmosis in food animals is 25.5% in West Africa including Nigeria [2]. Toxoplasmosis was first described in 1908 when found in the blood, spleen, and liver of a North Africa rodent, *Ctenodactylus gondii* named *Toxoplasma* (which means arc-like form and *gondii* after the rodent host [3]. *Toxoplasma gondii* infection is acquired orally usually through consumption with food or water contaminated with sporulated oocysts shed by cats or by consumption of undercooked meat or infected soil vegetables, blood transfusion or organ transplant, intrauterine or organ transplacental transmission and drinking of unpasteurized milk [4]. The shedding of resistant oocysts by cats, to the environment has been associated with outbreaks of the disease in humans [5]. Two principal forms of infection occur these are the inherited, which is transmitted vertically from the infected mother to the feotus by means of placental tissues; and the acquired, which mostly occur through the digestive route by ingesting undercooked meat or accidental contact with cat faeces, the unique definitive host of parasite [6]. The prevalence of toxoplasmosis throughout the world is high ranging from 20%–90% depending on the locality [7].

High prevalence of the toxoplasmosis was among either pregnant women or women of childbearing age. It is believed that Women of child bearing age who get infected with *T. gondii* before pregnancy do not transmit the disease to the fetus. The infection in pregnant women is mainly asymptomatic without marked clinical symptoms [8]. It can however, be transmitted to the fetus congenitally [9]. Clinical symptoms in some of the severely infected infants include fever, hydrocephaly or microcephaly, hepatosplenomegaly, jaundice, convulsions, chorioretinitis and cerebral calcifications [10]. Most of the infected infants however, have no or mild symptoms at birth with major sequels as chorioretinitis, strabismus, blindness, hydrocephaly or microcephaly, cerebral calcifications, developmental delay, epilepsy, or deafness in months or years later [10]. To effectively prevent congenital toxoplasmosis, it is necessary to determine the epidemiology and risk factors of *Toxoplasma* infection in women of childbearing age. Therefore, the prevalence of feotal infection could be decreased in the community by implementing preventive measures in high-risk women and diagnosis and treatment of maternal infection at the early stages of the disease. Hence the need to diagnose the infection which is based on the analysis of specific antibody prevalence.

Materials and Methods

Study area

The study was conducted at the Gombe State Specialist Women and Children Hospital at Gombe metropolis. Gombe town is the capital of Gombe State and Gombe LGA. It is located in North Eastern Nigeria lying between latitude 9°3N and longitude 8°45 and 11°45E of the Greenwich Meridian.

Study design

This was a cross-sectional study carried out among 182 women of child bearing age attending Gombe Women and Children Hospital who consented for the study.

Ethical clearance

Ethical clearance was obtained from the Research and Ethics Committee of the Ministry of Health, Gombe State for the conduct of this research.

Inclusion criteria

All consented women of child bearing age attending Gombe Women and Children Hospital formed the inclusion criteria.

Exclusion criteria

All non-consented women and women of childbearing age not attending Gombe Women and Children Hospital were excluded.

Data collection

Data on socio-demographic and risk factors to *T.gondii* infection were assessed using structured questionnaire.

Sample size determination

A sample size of 182 was estimated for sampling using the formula described by [11]

Sample collection

Five (5) ml of each participants' blood was collected by venipuncture of the left arm and put into a well labeled EDTA container and transported on dry ice packs to heamatology laboratory of Gombe Specialist Hospital. All blood samples were then centrifuged at 1400rmp for 10 minutes to obtain the plasma. Plasma obtained was stored at -20°C in refrigerator until required for analysis.

Sample analysis

Antibodies to human *T. gondii* were tested using Enzyme Linked Immunosorbent Assay (ELISA) detection kits (Voyage Medical Co., LTD China,

batch number 20200213). The plates were read with spectrophotometer at a wavelength of 450 nm. Interpretation of the results was then carried out according to the kit's manufacturer's instructions on the kit and data analyzed using the software SPSS version 20 (SPSS Inc., Chicago,IL, USA).

Results

A study to detect IgG and IgM antibodies against *T. gondii* among women of child bearing age was conducted in Gombe State, Nigeria. A total of 182 women participated in this study, of which 39 (21.43%) were positive for IgG and none of the women was reactive to *T. gondii* IgM antibodies **(Figure 1)**.

The socio-demographic variables of the women were assessed of which those aged 26-35 years had the highest prevalence of 33.33% IgG antibodies against *T. gondii* with all the women who were widows testing positive to the antibodies. In relation to educational status, those who had other forms of education had the highest prevalence of 75.0% of *T. gondii* antibodies followed by women who had primary education (29.41%). Women with tertiary education had the least occurrence of 11.63%. On assessment of type of occupation and settlement, though not statistically significant, women who settled in rural areas had higher antibody prevalence of 29.70% compared to 21.95% among urban dwellers. However, those who were civil servants, farmers and corpers were not positive to *T. gondii* antibodies, while higher prevalence of 66.70% and 33.33% antibodies was observed among women of other occupation and tailors respectively **(Table 1).**

Our findings on the type of food consumed by the women enrolled in this study showed that 2(20.00%) of the women who do not consume beef tested positive to *T. gondii* infection while 37(21.51%) others who consume beef tested positive to *T. gondii* infection accounting for the highest prevalence of the infection rate. Out of the 32 women who do not consume goat meat in the study, 7 tested positive to *T. gondii* infection giving an infection rate of 21.88% which is higher compare to those that consume goat meat that had infection rate of 21.33%. Women who do not consume chicken in the study had higher sero-prevalence rate of 22.22% compare to those who consume chicken in the study that recorded sero-prevalence of 21.34%. On fish consumption, the least infection rate of 11.8% was observed in women that do not consume fish while 94.87% was recorded in women who consume fish accounting for the highest infection rate. Women who consume other meat comprising of rat, dog and pork showed higher risk factor of OR=3.64 (0.60-12.28). The association of *T. gondii* infection in this group is significant ($p<$ 0.05).

From our data analyzed, 33.33% of the women who partly cooked their meat in the study tested positive to *T. gondii* infection while 21.99% who cooked their meat to soft texture in the study were positive to *T. gondii* infection and only 5% of 20 women who eat tough meat in the study tested positive to *T. gondii* infection. Similarly the highest infection rate of 69.23% was observed among Women that taste their meat while cooking as against 30.00% in women who do not taste meat while cooking. From the results presented, 6(24.00%) of 25 women who do not consume suya in the study tested positive to *T. gondii* with the least infection while 84.62% or 33 of the women in this group tested positive to *T. gondii* infection. Women who consumed milk either pasteurized or unpasteurized had sero-positivity of 20.50% and 19.20% respectively lower than their counterparts who do not consume milk that accounted for *T. gondii* sero-positivity of 24.00% and 23.40% respectively.

On consumption of vegetables, 21.90% of vegetable consumers were positive to *T. gondii* with 0% recorded in non-vegetable consumers.

Women that use river water had the highest infection rate of 40.00% followed by those who use well water (31.25%) and those using packaged (19.15%). Our result demonstrate that, the consumption of beef, goat, chicken, fish, suya, and the form in which these meats are cooked were statistically not significant in this study similarly, the consumption of pasteurized and unpasteurized milk, vegetables and water sources were not significantly associated in this study **(Table 2)** .

The prevalence and risk factors associated with *T.gondii* infection in relation to the status of pregnancy and the number of pregnancies for women who enrolled in the study was assessed. Of the 100 non-pregnant women who enrolled in the study, 20(20.00%) tested positive to *T.gondii* infection. Nineteen (19) of their pregnant colleagues who account for 23.20% tested positive to *T. gondii* infection. The degree of the association in their *T. gondii* sero-positivity however, was not statistically significant ($p>0.05$).

With regard to the number or frequencies of the pregnancies, women that were pregnant for the third time or less than 3 times were more infected, with a sero-prevalence of 19(26.03%) followed by women who had never been pregnant. The least prevalence rate of 11(15.94%) was observed among women who had been pregnant for more than three times. However, these levels of IgG sero-positivity associated with the women and their pregnancy status are not significant as revealed by chi square (x^2) test ($p>0.05$).

On the assessment of *T. gondii* infection in relation to clinical factors such as their HIV status, 3(12.5%) out of the 24 of the women of child bearing age enrolled in the study that were HIV positive, tested positive to *T. gondii* infection while 36(22.78%) others that were free from HIV infection had *T. gondii.* Of the 14 women who had at least a stillbirth enrolled in this study, 4(28.60%) tested positive to *T. gondii* infection while 35(20.80%) who had not had any stillbirth were positive. One woman who had two series of stillbirths accounted for 100% seropositivity. The highest sero-prevalence rate of 23.14% was observed among women who had no miscarriage as against 11(18.03%) in women who had at least a miscarriage in this study. Women who enrolled in the study that haven't received blood transfusion were 143 out of which 15(10.50%) tested positive to *T. gondii* infection. Of the women that had received blood transfusion, the highest *T. gondii* sero-prevalence rate 5(12.80) % was recorded. Chi square (x^2) test showed that the association between *T. gondii* infection and number of miscarriages in the women are significant ($p<0.05$). However no significant difference was observed between the HIV status of women that had stillbirth and blood transfusion with IgG sero-positivity **(Table 3)**.

Our findings from the current studies also showed that 15(17.05%) of the women who had no cat nor even a cat in their neighbourhood were positive to *T. gondii* infection while 24(25.53%) of the 94 women who own a cat or have it in their neighbourhood tested positive with a higher sero-prositivity to *T. gondii* infection. 32(23.70%) women who were not cleaning their cat excrete and 7(14.89%) who clean their cat excrete were tested positive to *T. gondii* infection.

In terms of handling other animals such as goats, dogs and chicken, the level of infectivity of the women as revealed by the sero-positivity of *T. gondii* varied from 6.25% in women who handled dogs to 21.33% and 21.34% in those who handle goat and chicken respectively. Analysis of the level of variability by use of chi square (x^2) test showed that these difference in association of the pets and the women with regards to their *T. gondii* sero-positivities charted in **table (5)** are not significant statistically ($p>0.05$).

Figure 2 shows that of the 2(1.1%) women that had prior knowledge of the zoonotic transmission of *T. gondii,* none tested positive to *T. gondii* infection. There were 180(98.9%) others who had no prior knowledge on the transmission of toxoplasmosis from which 39(21.43%) tested positive to *T. gondii* infection. Subjecting the data to Chi square (x^2) test revealed that these differences are not statistically significant ($p>0.05$).

Table 1. Risk factors associated with *T. gondii* in women of child bearing age in two health centres in gombe in relation to their demographic characteristics.

Characteristics	**No examined**	**Igg positive**	**Odd ratio**	**(c.i) lower 95% – upper 95%**	**X2value**	***p*-value**
Educational Status Primary	34	10(29.41)	0.316	0.096– 1.037		
Secondary	78	16(20.51)	0.510	0.173-1.505	9.278	**0.032***
Tertiary	43	5(11.63)	1	1		
Non	23	5(21.74)	0.474	0.122-1.847		
Others	4	3(75.00)	0.044	0.004-0.507		
Age						
15-25	65	14(21.54)	0.662	0.282-1.555		
26-35	39	13(33.33)	1	1	4.774	0.09
36 and above	78	12(15.38)	0.364	0.147-0.900		
Marital status						
Single	29	5(17.24)	4.80	0.255 – 90.29		
Married	150	32(21.33)	3.68	0.224 – 60.59	4.190	0.2416
Widow	2	1(50.00)	1	1		
Divorced	1	1(100.00)	1.195	0.010-14.33		
Occupation						
Student	27	5(18.52)	4.40	0.233 – 82.98		
Teacher	2	1(50.00)	3.68	0.224 – 60.59		
Tailor	3	1(33.33)	2.00	0.051-78.25	12.755	0.238
Farmer	2	0(0.00)	0	0-0		
Corper	3	0(0.00)	0	0-0		
Business	27	8(29.60)	2.22	0.125-39.64		
Applicant	1	0(0.00)	0	0-0		
Housewife	96	22(22.92)	3.364	0.202-56.00		
Others	3	2(66.70)	1	1		
Cleaner	2	0(0.00)	0	0-0		
C/S Settlement	16	0(0.00)	0	0-0		
Rural	25	9	0.48	0.17-1.04	0.419	0.2275
Urban	157	30	1	1		
Income						
<10,000	64	15(23.44)	0.860	0.274– 2.694		
>10,000	2	1(50.00)	0.263	0.014-4.986	1.591	0.810
10,000-30,000	24	5(20.83)	1	1		
>30,000	14	2(14.29)	1.579	0.263-9.476		
No income	78					
Tribe						
Hausa Fulani	112	29(25.89)	.86	0.385 – 21.26		
Yoruba	4	2(50.00)	1	0.224 – 60.59	6.717	**0.035***
Others	66	8(12.12)	7.25	0.893– 58.89		

Where IgG = immunoglobulin G, CI=Confidence interval, *p* value <0.05 is considered significant. $\chi 2$=Chi-square, p=probability, df=degree of freedom

Table 2. Risk factors associated with *T.gondii* infection in relation to food consumption and water source in health centres in Gombe metropolis.

Food Consumption	**No examined**	**IgG Positive**	**Odd ratio**	**(C.I)lower95% -upper 95%**	**χ2value**	***p*-value**
Beef						
No	10	2(20.00)	1	1	0.013	0.9091
Yes	172	37(21.51)	1.09	0.22 – 5.38		
Goat						
No	32	7(21.88)	1	1	0.005	0.9461
Yes	150	32(21.33)	0.97	0.38 – 2.44		
Chicken						
No	18	4(22.22)	1	1	0.0007	0.9314
Yes	164	35(21.34)	0.95	0.29 – 3.07		
Fish						
No	17	2 (11.80)	1	1	1.178	0.2779
Yes	165	37(94.87)	2.17	0.47 – 9.91		
Others (dog, pork and rat)						
No			1	1	8.422	**0.032***
Yes			3.64	0.60-12.28		
Meat form						
Mildly	21	7(33.33)	0.105	0.012-0.956		
Soft	141	31(21.99)	0.187	0.024-1.451	5.915	0.05*
Tough	20	1(5.00)	1	1		
Taste meat						
No	64	12(30.80)	1	1	0.421	0.5134
Yes	118	27(69.23)	1.29	0.60 – 2.75		
Suya						
No	24	6(15.40)	1	1	0.209	0.6524
Yes	158	33(84.62)	0.79	0.29 – 2.15		
Cow milk						
No	25	6(24.00)	1	1		
Yes	156	32(20.50)	0.82	0.30 – 2.21	0.154	0.6951
Unpasteurized milk						
No	77	18(23.40)	1	1	0.456	0.499
Yes	104	20(19.20)	0.78	0.38 – 1.60		
Wash vegetable						
No	4	0 (0)	1	1	1.115	0.291
Yes	178	39(21.90)	0	0		
Water source						
Packaged	47	9(19.15)	1.250	0.263-5.935	1.971	0.5785
Piped	114	23(20.18)	1.427	0.339-6.012		
River	5	2(40.00)	0.649	0.038-11.043		
Well	16	5(31.25)	1			

Figures in parenthesis are percentage infection rate

Where CI=Confidence interval, p value <0.05 is considered significant. χ2=Chi-square, p=probability, df=degree of freedom,* = Calculated x^2 is significant (p<0.05)

Table 3. Prevalence of *T.gondii* infection in women of childbearing age at two health centres in Gombe in relation to pregnancy status and number of pregnancy.

Pregnancy and Pregnancy Number	**No examined**	**IgG Positive**	**Odd ratio**	**(C.I) lower 95% – upper 95%**	**χ2value**	***p*-value**
Pregnancy Status						
Non pregnant	100	20(20.00)	1	1	0.269	0.605
Pregnant	82	19(23.20)	1.21	0.59 – 2.45		
Pregnancy Number						
<3 pregnancies	73	19(26.03)	1.855	0.809-4.25	2.224	0.329
>3 pregnancies	69	11(15.94)	1.212	0.489-3.00		
Never pregnant	40	9(22.50)	1			

Figures in parenthesis are percentage infection rate

Where IgG = immunoglobulin G, CI=Confidence interval, *p* value <0.05 is considered significant. χ2=Chi-square, p=probability, df=degree of freedom.

Table 4. Prevalence of *T. gondii* infection of women of childbearing age in two health centres in Gombe in relation to clinical features of some disease ailment and nature of feotus at birth.

Clinical Features	**No examined**	**IgG Positive**	**Odd ratio**	**95%(C.I)**	**χ2value**	***p*-value**
HIV Status						
No	158	36(22.78)	1	1	1.457	0.228
Yes	24	3(12.50)	0.48	0.13 – 1.72		
Stillbirth						
No	168	35(20.80)	1	1		
Yes	14	4(28.60)	1.52	0.45 – 5.14	0.460	0.100
Stillbirth Number						
One	3	13(23.08)	1	1		
Two	1	1(100.0)	0	0	2.706	0.498
Miscarriage						
No miscarriage	121	28(23.14)	1	1		
Had miscarriage	61	11(18.03)	0.73	0.34-1.59	0.642	0.423
Miscarriage Number						
One miscarriage	47	12(25.53)	1	1		
Two miscarriages	11	0(0)	0	0	6.196	0.045*
Three miscarriages	1	0(0)	0	0		
Blood Transfusion						
No	143	15(10.50)	1	1		
Yes	39	5(12.80)	1.27	0.43 – 3.76	0.447	0.800

Figures in parenthesis are percentage infection rate

Where CI=Confidence interval, *p* value <0.05 is considered significant. χ2=Chi-square, p=probability, df=degree of freedom

* = Calculated x^2 is significant (p<0.05)

Table 5. Prevalence of *T. gondii* infection of women of childbearing age in two health centres in Gombe in relation to presence of pets in the houses.

Pets	No examined	IgG Positive	Odd ratio	(C.I) lower 95% – upper 95%	χ2value	*p*-value
Cat ownership						
No	88	15(17.05)	1	1		
Yes	94	24(25.53)	1.67	0.81 – 3.44	1.961	0.161
Clean cat excretes						
No	135	32(23.70)	1	1		
Yes	47	7(14.89)	0.56	0.23 – 1.38	1.703	0.192
Handling animals						
Goat						
No	32	7(21.88)	1	1		
Yes	150	32(21.33)	0.97	0.38 – 2.44	0.005	0.946
Dog						
No	166	38(22.89)	1	1		
Yes	16	1(6.25)	0.22	0.03 – 1.76	3.042	0.081
Chicken						
No	18	4(22.22)	1	1		
Yes	164	35(21.34)	0.95	0.29 – 3.07	0.0007	0.931
Cow						
No	25	6(24.00)	1	1		
Yes	156	32(20.50)	0.82	0.30 – 2.21	0.154	0.695

Where IgG = immunoglobulin G, CI=Confidence interval, p value <0.05 is considered significant, χ2=Chi-square, p=probability, df=degree of freedom.

Figure 1. Seroprevalence of IgG and IgM antibodies to *Toxoplasma gondii* among women attending Gombe state Women and Children Hospital, Nigeria.

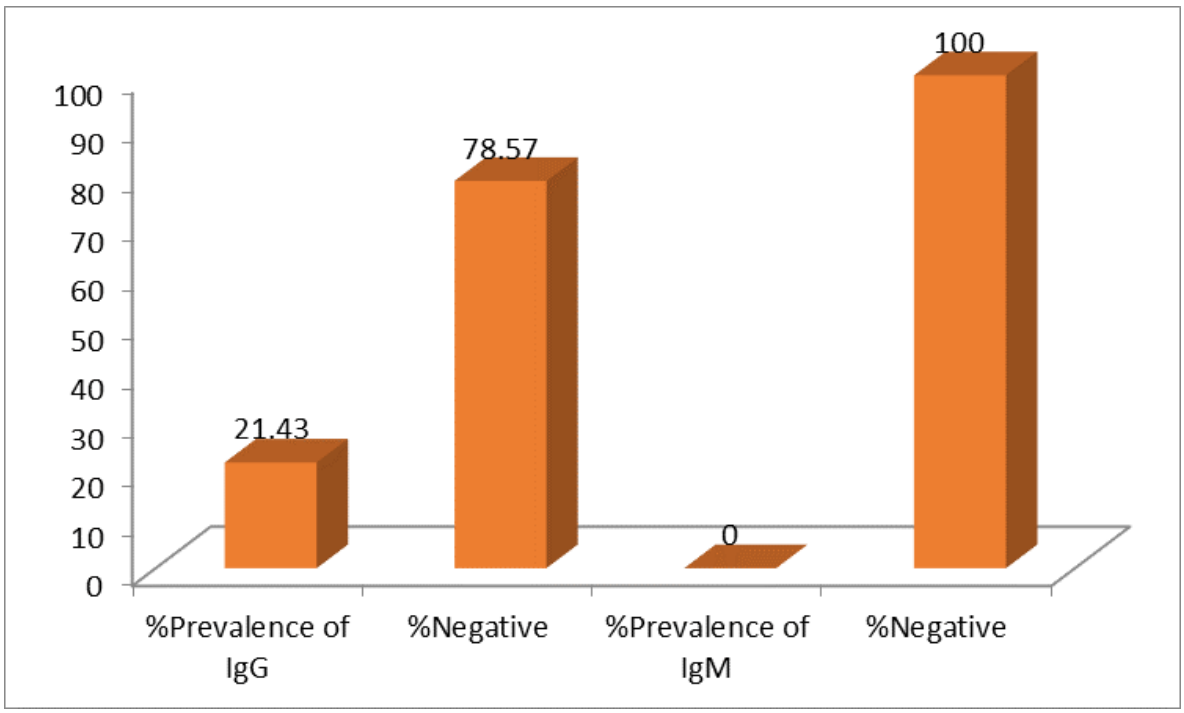

Figure 2. Risk factors associated with *T. gondii* sero-positivity of women of childbearing age in two health centres in Gombe in relation to information on the zoonotic transmission of toxoplasmosis.

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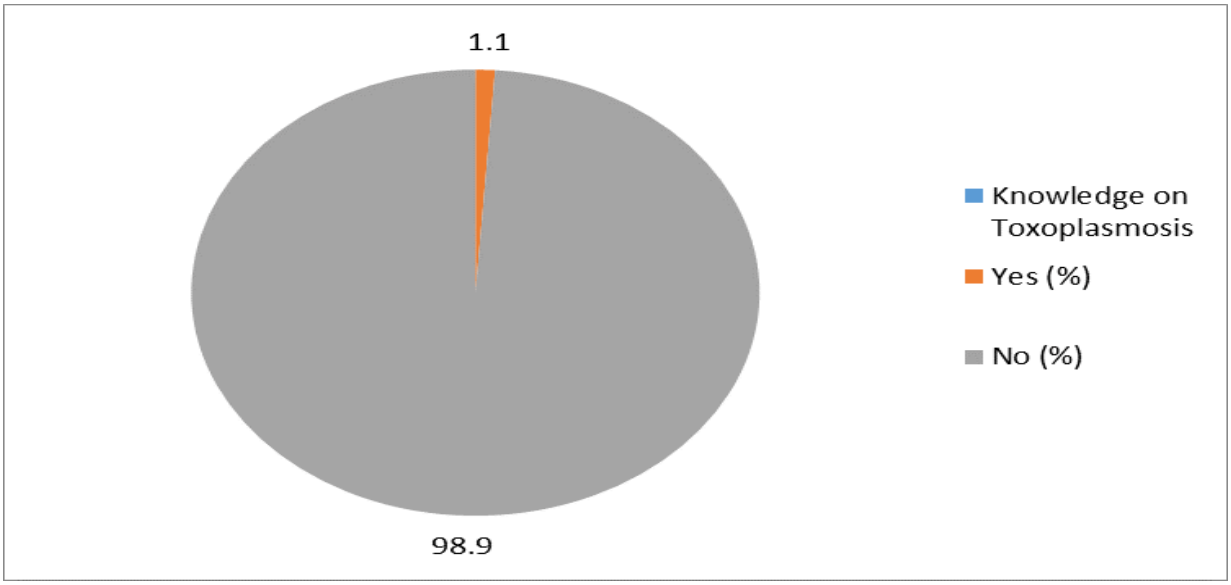

Discussion

The current study in Gombe metropolis recorded *T. gondii* sero-prevalence rate of 21.43% among women of child bearing age. The overall prevalence of *T. gondii* antibodies in the women however, is lower than the 49% reported in Maiduguri, North East Nigeria [12]; 48% in Benue, North Central Nigeria [13]; 56% in Akwa Ibom, Southern Nigeria [14] and 20% in South Africa, 54% in Kenya and 35% in Tanzania [15] as well as 81.4% reported also in women of child bearing age in Central Ethiopia [16]. The current report of 21% sero-prevalence of *T. gondii* is however, higher than the 11.5% reported in Port Harcourt, Sourthern Nigeria [17] and11% in Botswana [18]. These differences in sero-prevalence of *T. gondii* infection in women of child bearing age in the different studies could be attributed to differences from where the two sets of data were drawn or possible differences in the research methodology adopted [18]. Another possibility may be due to the sampled populations, the serological tests carried out, the genetic back ground of the parasite and the type of immune response elicited by the parasite in the host elicited by the parasite. Other factors such as the living standards of the people in the defined areas, culture of the society and different feeding habits are some factors contributing to the variation of sero-prevalence of anti-*T. gondii* antibodies across the globe as separately documented [19,20]. The decrease in prevalence with age of women in this study however, is at variance with the result reported [21]. The gradual increase in trend of the sero-positivity of toxoplasmosis with age suggests that adults may be less prone to infection with *T. gondii* due to previous exposure to the sources of infection. A similar trend was earlier documented [22]. The comparatively high prevalence of 33.33% in the age group 26–35 years of age of the child bearing women in Gombe is suggestive of adults engaging in risky behaviours such as not washing of hands after coming in contact with infested vegetables from gardens, consumption of roasted fish and meat (suya) which are mostly undercooked as previously reported by **Jones et al.** [23] in United State, or prepared and consumed under unhygienic conditions such as handling meat without washing of hands which is common in this current study area and can serve as a source of infection among the women.

The significant association between educational attainment of women in the current studies and *T. gondii* sero-positivity agrees with the report of other earlier studies in Northern Ethiopia who reported that pregnant women who were unable to read and write were 5.8 times more likely to be infected with toxoplasmosis as compared to those who had at least college education [24] However, the inverse association of *T. gondii* infection with level of schooling with the less educated being more infected was maintained, which is in agreement with other data in the literature [25]. This reinforces the notion of higher risk of toxoplasmosis among people

of low level of education as well as those with worse socioeconomic status. The significant association between the educational status and *T. gondii* sero-positivity in the current study may be due to the fact that the individuals enrolled in the study are coming into contact with *T. gondii* oocyst in either one or more of the transmission routes such as non-regular washing of hands, eating unwashed fruits and vegetables or eating food prepared under poor hygienic conditions. This might have increased their chance of infection coupled with lack of knowledge of the source of infection of *T. gondii* to the patient's poor hygienic areas.

Most of the study participants in the current investigation were married women which is in agreement with the culture of the people where the study was carried out and had higher prevalence of 32 (21.33%) compare to the unmarried women who had 5 (17.24%). This variation could be as a result of the married participants being housewives. They are always in direct contact with vegetables, fruits, raw meats that might have been either contaminated or infested with *T. gondii* cysts. Another possible root may be from cyst from infected tissue of the infected hosts. Such cysts are not easily destroyed by washing and they may end up serving as a source of infection when consumed with food or water. As a result, the hosts have been exposed and therefore more susceptible to primary infection. Vegetables could be a main source of re-infection with different strains of *T. gondii* [26]. More so, cleaning of the environment may lead to high rate of their contamination by oocysts from faecal matter of the parentenic hosts such as cats.

There was a significant association between *T. gondii* infection among the different ethnic groups engaged in the current study with calculated $x^2 = 6.661$, *p* value of 0.035. The highest sero-prevalence was observed among the Yoruba ethnic group who had sero-prevalence rate of 50 % followed by 25.89 % in the Hausa/Fulani ethnic group and 12.12 % that was recorded from the other tribes comprising of Bolawa, Dadiya, Tangale, Tera, Tula and Waja. This result is in agreement with a study carried out in Asia [27] who reported *T.gondii* infection to be more common among Malays than other ethnic groups. However, this contrasts the study carried out in the Nigerian Federal Capital Territory [28] who reported no case of association between *T. gondii* and the different ethnic groups. These differences in ethnic susceptibility may be due to the lifestyle, climatic conditions, cultural practices, and dietary habits between these different ethnic groups.

The occupation of the women enrolled in the current study and *T. gondii* sero-positivity was not significant statistically though those women of child bearing age that were either cooks or street cleaners had the highest sero-prevalence compare to other groups. This could be explained from the fact that the cooks are always in contact with vegetables, fruits, raw meat that might have been infested with *T. gondii* oocysts. The street cleaners on the other hand might have come in contact with faecal matters contaminated with the oocytes of the parenthenic hosts while sweeping. If their hands are not properly washed it can serve as a source of infection when they ingest the oocyst from their hands with either food or water.

High sero-prevalence was recorded among low-income earners in the study though not significantly associated with *T. gondii* infection. The higher risk among people with poor socioeconomic status may be due to the fact that, they don't have enough money to afford good food that will improve the standard of their living and hence predispose them to factors associated to *T. gondii* infection.

The area of residence of the women was associated with high sero-prevalence of *T. gondii* though such levels of associations were not significant. Women of child bearing age dwelling in the rural areas were more infected compared to those in urban areas. This may be due to the lifestyle as well as poor living standards of the women. Rural women are used to living closely with pet animals, lack of good hygienic practices and non-regular washing of hands. These along with poor dietary habits such as eating unwashed fruits and vegetables or eating food prepared under poor hygienic conditions might have been the source of *T. gondii* transmission. A similar situation was observed among the women in the rural areas of Fortaleza, Northern Brazil that made them more prone to factors that are associated with transmission of toxoplasmosis [29].

Previous separate related reports [30], revealed that regular contact with domestic animals such as cats and their litters were linked to *T. gondii* transmission in Accra, Ghana and Hebron, Palestine respectively. Our studies however, has shown non-significant association with such cases which is in consonance with other studies in Kolkata, India [31] and Mwanza, Tanzania [32] respectively. Except for

the high prevalence of 25.53% of *T. gondii* sero-positivity observed among those that owned either a cat or had a cat in their neighborhood as against those that had no cat.

The consumption of beef, fish, goat and chicken seems not to be significant in enhancing the susceptibility of the women in this study to *T. gondii.* A significant association was however, observed between meat form and *T. gondii* sero-positivity ($p<0.05$). The highest sero-prevalence of 33.33% was observed among women who partly cook their meat followed by 21.99% among women who cook their meat till soft and the least infection rate of 5% was reported among women who eat tough meat. Other factors predisposing transmission of toxoplasmosis such as consumption of suya, cow milk, unpasteurized milk, washing of vegetables and water source were not significantly associated with *T. gondii* sero-positivity ($p>0.05$) in this study. This finding is in agreement with a study done in Sudan [33]. The odd ratio for having *T. gondii* infection was high among the study subjects that consume fish with OR=2.17, (0.47 – 9.91) which is in agreement with previous studies in the Mediterranean basin where fish can harbour and effectively transmit *T. gondi* to the human consumers of fishery products [34].

In this study, the number of miscarriages was statistically significant with having sero-positive anti *T. gondii* immunoglobulins ($p<0.05$). This is in agreement with previous studies in Huicholes, Mexico [35] and other studies done in Iran [36]. Other clinical features assessed in this study demonstrated high *T. gondii* sero-positivity in the study population though there was no significant association including those cases with stillbirth and blood transfusion.

High prevalence of *T. gondii* was observed in HIV positive women enrolled in the study though the association of the level of infectivity was not significantly associated. The reason for this may be due to few number of HIV positive women of child bearing age that were enrolled in the study. More so, all the HIV positive women involved were on anti-retroviral drugs which might improve the immune status.

Sero-prevalence to *T. gondii* infectivity was higher among pregnant women who had infection rate of 23.20% as against 20.0% reported in the non-pregnant women. The difference was however, not significant ($p>0.05$). In relation to pregnancy status and numbers, no significant association was observed with IgG sero-positivity and *T. gondii* of women of the study population. A high risk of having *T. gondii* infection was observed among pregnant women as revealed by the OR=1.21 (0.59 – 2.45) and those whose pregnancy number was less than 3 who had OR=1.855 (0.809-4.2l5). These OR values are in agreement with other studies that reported high sero-prevalence among pregnant women especially younger women. It can be speculated therefore, that behavioral patterns, lack of good personal hygiene and uncontrolled eating habits compare to the older pregnant women who had more than three pregnancies might have accounted for this sero-positivity.

Only 1.1% of the women had some prior information on toxoplasmosis with 98.9% that constituted majority of the women not aware of the zoonotic nature of toxoplasmosis as a disease. Those who had no knowledge of toxoplasmosis and tested positive with anti-specific IgG antibodies were 21.70%. This result is in agreement with reviews reported in Nigeria [36] and Africa [37] where researchers had noted that knowledge on toxoplasmosis is lacking among many communities in spite of the fact that detailed knowledge on the prevalence and risk factors associated with *T.gondii* infection are required especially for women of childbearing age.

Conclusion

The sero-prevalence of *T. gondii* infection was high among women of child bearing age in this study with an infection rate of 21.70%. Serological screening for *T. gondii* antibodies in women of child bearing age should be conducted as this will allow for identification of women that are at risk of acquiring the infection. It will also form part of strategic approach for prevention of congenital toxoplasmosis among the women of childbearing age

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Conflict of interest

None to be declared.

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