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ORIGINAL RESEARCH

Sero-Prevalence of *Toxoplasma gondii* in Pregnant Women Attending Ante Natal Care in Jos University Teaching Hospital (JUTH)

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Abstract

Toxoplasmosis caused by *Toxoplasma gondii* is an asymptomatic disease, but often takes a severe and life-threatening course during pregnancy, in foetuses, new bon babies and immune-compromised people. This study aimed at determining the prevalence of *Toxoplasma gondii* infection among pregnant women attending Ante Natal Clinic in Jos University Teaching Hospital (JUTH) and factors associated with it. 356 Pregnant women between 15 - 49 years were enrolled in the study. 5 ml of venous blood was collected aseptically using needle and syringe from each participant and were transported to Human Virology Laboratory, Plateau State Specialist Hospital, Jos, for analysis. ELISA was used to determine the sero-prevalence of *Toxoplasma* IgG antibody. A structured questionnaire was used to collect on socio-demographic characteristics and factors associated with the infection. Data was analyzed using Chi square and independent T-test. Out of the 356 pregnant women examined, 105 (29.49%) tested positive. *T. gondii* infection was significantly ($P < 0.05$) associated with the level of education, area of residence, occupation and cleaning of cat litter, but was not significantly ($P > 0.05$) associated with age, trimester, gravidity, eating meat and vegetables, HIV status, still birth and owning a cat. The high prevalence of Toxoplasmosis could probably be due to lack of knowledge about the disease as presented in these results. Therefore, health education on the disease and its transmission should be given to the public routinely which will help preventing *T. gondii* and other zoonotic infections.

Keywords

Sero-prevalence, Toxoplasma gondii, Pregnancy, Jos

Introduction

Toxoplasmosis is a protozoan infection caused by the obligate intracellular protozoan parasite *Toxoplasma gondii*. It is one of the most prevalent chronic infections affecting one third of the world's human population [1]. Infection due to *Toxoplasma gondii* is a worldwide zoonosis, the organism infects herbivorous, omnivorous and carnivorous animals, including birds [2,3]. Two main routes of transmission have been described in humans: By oral-ingestion of the parasite and through placental transmission to the foetus if it occurs during pregnancy [4]. Toxoplasmosis is usually an asymptomatic disease, but often takes a severe and life-threatening course during pregnancy, in foetuses, new born babies and in immunocompromised patients [5].

Congenital toxoplasmosis of newborn resulting from infection of the mother while she was pregnant is probably the most common form in man [6]. It is accompanied by various foetal complications based on gestational age at the time of infection [7].

Acute primary maternal toxoplasmosis if acquired during the first trimester of pregnancy can cause significant morbidity and mortality in developing foetuses [8,9]. Acute toxoplasmosis in patient resulted to severe disease with multi-organ involvement, including retinitis, myocarditis, and myositis [10]. Infection of the women before pregnancy causes immunity and therefore it is essential to estimate the time of infection as precisely as possible to properly estimate the risk of infection for the foetus [11].

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Although these infections are usually either asymptomatic or associated with self-limited symptoms in adults (e.g., fever, malaise and lymphadenopathy), infections in pregnant women can cause serious health problems in the foetus if the parasites are transmitted (i.e., congenital toxoplasmosis) and cause severe sequelae in the infant including mental retardation, blindness and epilepsy [12]. Women who acquired their infection prior to pregnancy are essentially not at risk of delivering an infected infant unless the woman is immunosuppressed [13].

Up to one third of the world's human population is estimated to be carrying a *Toxoplasma* infection [14]. In sub-Saharan Africa, toxoplasmosis often remains undetected and untreated due to insufficient diagnostic procedures [15]. Environmental contamination by oocysts shed in the faeces of infected cat on the soil, water and bedding of animals is important in the transmission process [16]. The incidence and the severity of the disease vary with the stage of pregnancy. The prevalence of Toxoplasmosis is diverse in pregnant women from different parts of the world. Many infected infants are asymptomatic at birth; however, most will develop learning and visual disabilities or severe life-threatening infections later in life if left untreated [17]. Infections acquired during pregnancy can lead to congenital toxoplasmosis [18]. Sero-prevalence varies considerably with high sero-prevalence occurring in countries where raw meat is commonly eaten and in tropical regions where cats are numerous and the climate is favourable to oocysts survival [1]. The global annual incidence of congenital Toxoplasmosis was estimated to be 190,100 cases. This was equivalent to a burden of 1.2 million DALYS (Disability Adjusted Life Years, [18]. Asero-prevalence of 45.8% has been reported among pregnant women in Colombia [19], 63.03% in Brazil [20], 24.1% in Saudi Arabia [21], 34.1% in Sudan [22], 70% in Cameroon, [23], 29.1% in Zaria [24], 32.8% in Lagos [7] and 48.9% was reported among pregnant women in Maiduguri [25].

There is paucity of information on the disease distribution among women of child bearing age in the study area. With increase population world over and corresponding pressure this exerts on social amenities such as provision of clean and potable water, health facilities and environmental degradation poses a great risk to humans and animals. Stray cats constitute health hazards to pregnant women, as they are found both around the hospital environment as well as within houses, competing with individuals for what to eat [26].

The aim of this study is to determine the prevalence of *T. gondii* infection among pregnant women attending Ante Natal Clinic (ANC) at JUTH.

Materials and Methods

Study area

The study site was Jos University Teaching Hospital situated in Jos-North Local Government Area, Plateau State, Nigeria. It is located in the North Central geopolitical zone of Nigeria lying between latitude 08°24'N and longitude 008°32' and 010°38'east with an area of 26,899 square kilometres with an estimated population of 3,206,531 and of these 1,607,533 are females based on the 2006 census. The adjacent States are Bauchi to North East, Kaduna to North West, Nasarawa to South West and Taraba to South East. Routine screening tests and PMTCT services are available for pregnant women. The area is generally characterized by cold climate.

Study design

A cross-sectional study was conducted involving pregnant women attending ante natal care at JUTH using convenient sampling method. Blood from pregnant women who volunteered was collected and the sampling was done on a daily basis from Mondays-Thursday. An average of Sixty (60) samples was collected per week.

Study population

This consists of pregnant women in the reproductive age group (15-49) receiving ante natal care at JUTH, Jos-North Local Government Area, Plateau State. Pregnant women registered for their first visits were enrolled based on informed consent and invited to participate. Confidentiality was maintained by interviewing each study participant privately with their identifying number on the data.

Ethical consideration

Ethical approval was obtained from the ethical committee of Jos University Teaching Hospital. Consent was obtained from each study participant and confidentiality was maintained throughout.

Inclusion criteria

Pregnant women who had registered for Ante Natal Care at JUTH and volunteered to participate in the study were included.

Exclusion criteria

Pregnant women on admission in the health center were excluded from the study.

Sample collection

Venous blood (5 ml) was collected aseptically using needle and syringe from each of the 356 participants and transferred into a tube. All samples were transported to Plateau state Human Virology laboratory, Plateau State Specialist Hospital, Jos. Serum was obtained by Centrifugation at 30000 rpm for 5 minutes and was stored at -20 °C until use.

Data collection technique

A structured questionnaire was adopted, modified

and administered. The questionnaire was translated to illiterate participants and completed by them, where respondents could not read nor write they were completed by the researcher and a research assistant who was trained for this purpose so as to obtain a very reliable data.

Information on residential area, age, occupation, tribe, educational level, gestation period (in trimester), reproductive history (miscarriage, neonatal death, premature birth, still birth), ownership of cat at home or immediate neighborhood, type of meat consumed (boiled, roasted, undercooked, raw), consumption of vegetables (raw, par boiled, cooked), history of blood transfusion was obtained.

Laboratory analysis

Enzyme linked immunosorbent assay: *Toxoplasma gondii* IgG ELISA kit used for this study was a commercially prepared kit, sourced from Nova Tec Immunodiagnostica (Germany). The contents include; *Toxoplasma gondii* coated wells (IgG), IgG sample diluent, stop solution, washing buffer solution, *Toxoplasma gondii* anti-IgG conjugate, tetramethylbenzidine substrate, *Toxoplasma gondii* IgG standards (A,B,C,D), strip holder, cover foil and test protocol.

Toxoplasma IgG elisa test: All reagents including the *Toxoplasma gondii* coated microtiter plate were allowed to reach room temperature for 15 minutes before use. The microtiter plates were labeled accordingly (blank, negative control, positive control and samples). The wash buffer was diluted with distilled water at the rate of 1:40. Sample diluent (100 µl) was added into the corresponding well excluding the blank, negative control and positive control well. 10 µl of the serum samples was then added to the wells through the use of pipette after which it was mixed thoroughly. 100 µl of negative control and positive control was added to the negative control wells and positive control well. The plate was shaking for 30s to mix. The plate was incubated at 30 °C for 20 mins with the sealing plate membrane sealing plate. At the end of the incubation, the plate cover was removed and discarded. Wash buffer was added to each well for 20 seconds and repeated five times. After the final washing cycle, the plate was turned over onto a tissue paper and tapped to remove any remainders. 50 µl conjugate was added respectively and incubated at 37 °C for 20 minutes with the sealing plate membrane sealing plate. Wash buffer was added to each well and same process was repeated as explained earlier. After washing, the plate was turned over onto a tissue paper to remove any remainders. 50 µl substrate A and 50 µl substrate B was added into each well, a blue color change was noticed in some wells. The plate was incubated at 37 °C for 10 minutes with the sealing plate membrane sealing plate. 50 µl stop solution was added to each well to stop the reaction (Till this point, nothing was added to the blank well). The solution was mixed by shaking the plate gently. The plates were read for absorbance at a wavelength of 450 nm within 10 minutes after stopping the reaction using an ELISA plate reader.

Data analysis

Data was analyzed using SPSS statistical software version 23. Chi square method was used to analyze the data.

Results

Sero-prevalence of *T. gondii* in relation to age, trimester and socio-economic factors

A total of 356 pregnant were enrolled and participated in the study. Out of a total of 356 pregnant women tested, 105 (29.5%) were positive while 251 (70.5%) were negative. The prevalence of *Toxoplasma gondii* IgG antibody among the pregnant women in relation to age shows that the age range 10-20 years had the highest prevalence (38.24%) while the ages range 41-50 years had the least prevalence (25.0%) (Table 1). Age did not have significant (> 0.05) effect on the prevalence of the infection with the disease.

The prevalence of *Toxoplasma gondii* IgG antibody among the study participants in relation to trimester shows that those women who fall within the third trimester had the highest prevalence of infection 42.37%, followed by first trimester which had 27.78% while those in the second trimester had the least infection 26.57% (Table 2). Analysis showed that trimester had no significant ($p > 0.05$) influence on *T. gondii* infection.

The prevalence of *Toxoplasma gondii* IgG antibody among the study participants in relation to socio-economic factors shows that residence of the

Table 1: Prevalence of *Toxoplasma gondii* IgG Antibody among the study participants in relation to age.

	Antibody				
Age (years)	**No. tested**	**No. Positive (%)**	**χ^2**	**df**	**p-value**
10-20	34	13 (38.24)	1.497	3	0.68
21-30	195	57 (29.23)			
31-40	123	34 (27.64)			
41-50	4	1 (25.0)			
Total	356	105 (29.49)			

Table 2: Prevalence of *Toxoplasma gondii* IgG antibody among the study participants in relation to trimester.

Antibody					
Trimester	**No. tested**	**No. Positive (%)**	**χ^2**	**df**	**p-value**
First	90	25 (27.78)	5.684	2	0.06
Second	207	55 (26.57)			
Third	59	25 (42.37)			
Total	356	105 (29.49)			

Table 3: Prevalence of *Toxoplasma gondii* IgG antibody among the study participants in relation to socio economic factors.

Antibody					
Socio economic factors	**No. tested**	**No. Positive (%)**	**χ^2**	**df**	**p-value**
Residence					
Rural	87	16 (18.39)	6.826	1	**0.009**
Urban	269	89 (33.09)			
Total	356	105 (29.49)			
Level of education					
Primary	20	8 (40.00)	13.463	3	**0.004**
Secondary	174	59 (33.91)			
Tertiary	157	34 (21.66)			
None	5	4 (80.00)			
Total	356	105 (29.49)			
Occupation					
Civil servant	84	17 (20.24)	11.654	5	**0.04**
Students	13	1 (7.69)			
Self-employed	99	32 (32.32)			
Unemployed	126	47 (37.30)			
Meat/vegetable seller	32	8 (25.00)			
Farming	2	0 (0.0)			
Total	356	105 (29.49)			

participants was taken into consideration with those residing in the urban area with the highest population of 269 with the prevalence 33.1% while the rural area had the least number of participants (87) which had the least infection 18.4% (Table 3). Statistical analysis showed that area of residence had significant ($p < 0.05$) effect on the prevalence of the disease.

Level of education has significant effect ($p < 0.05$) on *T. gondii* infection with those who did not have formal educated having the highest prevalence (80%) while those with tertiary education had the least prevalence (21.66%).

Occupation of the participants was also taken into consideration. Unemployed women had the prevalence of 37.30%, followed by self-employed 32.32%, while those engaged in farming had no infection (Table 3). Statistical analysis showed that occupation of the study participants had significant effect ($p < 0.05$) on *T. gondii* infection.

Sero-prevalence of *T gondii* in relation to risk factors is shown in Table 4. The prevalence of *Toxoplasma gondii* IgG antibody among the study participants in relation to risk factors shows that primigravid participants had 26.8% prevalence while multigravid participants had 30.00%. Among those participants with knowledge of toxoplasmosis, 50.00% were infected while those which had no knowledge of the disease had 29.38%. Those who consume meat had 29.66% while those who don't eat meat had no infection. Those who taste meat while cooking it had 28.11% while those who don't had 29.91% infection for *Toxoplasma gondii* IgG antibody respectively.

The prevalence of *Toxoplasma gondii* IgG antibody among the study participants in relation to risk factors shows that participants who fry their meat before consumption had 29.0% infection while those who roast their meat before consumption had the highest infection of 33.3% for *T. gondii*. Those who consume suya had 29.85% while those who don't had 23.81%. Those who consume treated water had (3.87%) while those who used untreated water had 22.41% infection.

The prevalence of *Toxoplasma gondii* IgG antibody among the study participants in relation to risk factors. Those who consume vegetables had 29.58% infection

Table 4: Prevalence of *Toxoplasma gondii* IgG antibody among the study participants in relation to potential risk factors.

Antibody					
Risk factors	**No. tested**	**No. Positive (%)**	**χ^2**	**df**	**p-value**
Gravidity					
Primigravid	56	15 (26.79)	0.234	1	0.63
Multigravid	300	90 (30.0)			
Total	356	105 (29.49)			
Knowledge of *Toxoplasma gondii*					
Yes	2	1 (50.0)	0.407	1	0.52
No	354	104 (29.38)			
Total	356	105 (29.49)			
Eating meat					
Yes	354	105 (29.66)	0.841	1	0.36
No	2	0 (0.0)			
Total	356	105 (29.49)			
Tasting meat					
Yes	249	70 (28.11)	0.761	1	0.38
No	107	32 (29.91)			
Total	356	105 (29.49)			
Method of cooking					
Frying	231	67 (29.0)	0.131	2	0.94
Stewing	113	34 (30.09)			
Roasting	12	4 (33.33)			
Total	356	105 (29.49)			
Eating suya					
Yes	335	100 (29.85)	0.347	1	0.56
No	21	5 (23.81)			
Total	356	105 (29.49)			
Type of water					
Treated	298	92 (30.87)	1.670	1	0.20
Untreated	58	13 (22.41)			
Total	356	105 (29.49)			
Eating vegetables					
Yes	355	105 (29.58)	0.420	1	0.52
No	1	0 (0.0)			
Total	356	105 (29.49)			
Form vegetable is eaten					
Fresh & raw	84	30 (35.71)	2.051	2	0.36
Cooked	88	24 (27.27)			
Steamed	184	51 (27.72)			
Total	356	105 (29.49)			
HIV status					
Yes	232	63 (27.16)	1.753	1	0.19
No	124	42 (33.87)			
Total	356	105 (29.49)			
Miscarriage/still birth					
Yes	151	52 (34.44)	3.081	1	0.08
No	205	53 (25.85)			

Total	356	105 (29.49)			
Blood transfusion					
Yes	13	6 (46.15)	1.801	1	0.18
No	343	99 (28.86)			
Total	356	105 (29.49)			
Ownership of cats					
Yes	87	31 (35.63)	2.086	1	0.15
No	269	74 (27.51)			
Total	356	105 (29.49)			
Cleaning litters					
Yes	50	25 (50.0)	10.582	1	**0.001**
No	37	8 (21.62)			
Total	87	31 (35.63)			

Table 5: **Zoonotic disease awareness among study participants.**

Disease	Number aware (%)	Number Unaware (%)
	N = 356	
Lassa fever	75 (21.06)	268 (78.94)
Rabies	24 (6.74)	332 (93.26)
Tuberculosis	17 (4.77)	337 (95.23)
Ebola	7 (2.0)	349 (98.0)
Toxoplasmosis	2 (0.56)	354 (99.44)

while those who consume the vegetables by steaming had 27.72%. Those who know their HIV status had 27.16% infection while participants who didn't know their status had the highest prevalence 33.87.

The prevalence of *Toxoplasma gondii* IgG antibody among the study subjects in relation to risk factors shows that those who had one or more miscarriage(s)/ stillbirth(s) had highest prevalence 34.44%, those who had had no blood transfusion had 28.86%, those who didn't own cats had the least infection of 27.51%, and those who had come in contact with cat litters had recorded the highest prevalence of 50.00% infection for *T. gondii*. All the risk factors did not have significant effect ($p > 0.05$) on *T. gondii* infection except cleaning of cat litter which had significant ($p < 0.05$) effect on the prevalence of the disease.

Analysis revealed that 125 (34.63%) of the participants had awareness concerning zoonotic infections from cats, dogs and rats (Lassa fever, Tuberculosis, Rabies and Ebola) but only 2 (0.56%) had information on toxoplasmosis while 99.44% had no knowledge of toxoplasmosis (Table 5).

Discussion

Primary infection of *T. gondii* acquired during pregnancy can be transmitted to the foetus vertically which may cause serious complication including abortion, stillbirth, visual impairment and neurological disorders [27]. The overall sero-prevalence of *T. gondii* infection of 29.49% obtained in this study is consistent with 29.1% from pregnant women in Zaria [24] and 27.7% among pregnant women in Sokoto [4]. However, the result is at variance with high prevalence reported of 48.9% in Maiduguri [25], 63% in Brazil [20] and 70% in Cameroon [19].

The insignificant decline in sero-prevalence of *T. gondii* with age recorded in this study is contrary to the reported increase in sero-prevalence with increase in age [28]. Sero-prevalence rate increased from pregnant women in the age bracket 16-25 years to those in the age bracket 26-35 years for *Toxoplasma gondii* IgG antibody but declined at age 35 above. This could be due to behavioral differences and eating characteristics of the younger pregnant women compared to the older group and as such may get more exposed to some of the factors associated with toxoplasmosis in pregnant women. Infection in relation to trimester showed that women at their third trimester had higher but not significant prevalence followed by those at first and second trimester. This agrees with the report that women at third trimester had the highest IgG seropositivity [25]. This result is in contrast with [29,30], who separately reported higher prevalence in women at their first and first and second trimester respectively. *T. gondii* infections acquired by a mother during the second or third trimester had a higher (up to 68%) probability of infecting their unborn babies, with less severe repercussions [31]. The results of this study showed that pregnant women dwelling in urban areas had significantly higher sero-prevalence compared to the participants from the rural areas. This agrees with the high prevalence observed among urban pregnant

women in Maiduguri [25]. However, this does not agree the report that women of childbearing age who reside in rural community shows higher risk of contracting *T. gondii* infection than those who reside in peri-urban communities in Osun [32]. The high rate in urban women could probably be due to lifestyles, eating habits and environmental conditions of those dwelling in urban areas as such more prone to factors that are associated with toxoplasmosis. *T. gondii* sero-prevalence was found to be significantly highest among the pregnant women with no formal education and lowest among the participants with formal education agrees the with reported high prevalence amongst participants with low level of formal education [28]. The occupation of the study participants showed that pregnant women who were unemployed had significantly higher prevalence compared with the employed. This is in accord with [29] who found more prevalence among the unemployed women in Jos with the students having the highest prevalence (66.7%), while civil servants had the highest prevalence (50%) among the employed women. This varies with the findings that pregnant women who were employed were more IgG seronegative (susceptible) than the employed and are at higher risk of contracting primary *T. gondii* infections [25]. Factors associated with *T. gondii* seropositivity among abattoir workers in Uyo were being a butcher/raw meat seller when compared with livestock seller, working in the abattoir for more than 5 years, and working with birds as against other livestock such as cows, sheep, and goat [33]. There was no significant difference between the pregnant women who were primigravid or multigravid but the pregnant women in their second and above pregnancies (multigavid) had higher sero-prevalence which is period where risk of foetal transmission is highest following infection without any intervention [34]. Cooking practices and habits including the type of meat preference by a pregnant woman are important factors for *T. gondii* transmission. The cooking of meat and meat products at high temperature rapidly destroys *T. gondii* cyst found in muscles of infected animals. However, this study did not find any significant association in the sero-prevalence to *T. gondii* infection in the pregnant women who tasted their meat during cooking as compared to those who did not. It was observed that those who tasted meat during cooking had lower sero-prevalence which was statistically significant in comparison to those who did not. This is in accordance with the that tasting of meat while cooking and the consumption of lightly cooked meat showed no significant association with seropositivity among women in Port Harcourt [35]. Seroprevalence was higher in individuals who did not taste meat while cooking than in those who did [30]. Low prevalence among women who tasted their meat may probably be because most women tasted their food when it was almost done to avoid the dangers of contracting zoonotic disease. Considering the custom of backyard cooking and fondness for rare beef, many cases of toxoplasmosis may be acquired every day [36]. There was no significant association between the types of water the study participants drank and sero-prevalence to *T. gondii* infection. The pregnant women who reported drinking treated water recorded significantly higher sero-prevalence compared to those who drank untreated water. This does not agree with findings that more prevalence was recorded among women who drank untreated water [28]. The reason could be that the seropositive participants who drank treated water have in one way contacted the oocysts through other ways such as consumption of undercooked meat/vegetables, contaminated snacks. Other factors assessed in this study that demonstrated high *T. gondii* sero-positivity but there was no significant association includes cooking method, form vegetable was eaten, and HIV status. The risk factors associated with toxoplasmosis include ingestion of raw ground beef, rare lamb, locally produced cured, dried or smoked meat, raw oyster, drinking unpasteurized goat milk, having cats as pets [37], living at elevations of ≤ 200 m, compared with > 200 m, daily contact with raw meat, drinking unfiltered and water density of cats [38] and eating of wild boar sausage [10]. There was no significant difference in the sero-positivity of those who ate stick meat (suya) and owing cat(s) and those who did not. The none significant association between *T. gondii* infection and ownership of cat is consistent with [28,29] who observed no significant association between sero-prevalence of *T. gondii* antibodies and cat ownership and contact with cats respectively. Contact with cats does not translate to zoonosis, but more pertinent in causing zoonosis is the improper handling of cats' fecal matter [39]. The mere presence of cats in the home is not enough to confirm zoonosis but rather the handling of cat litter is of more importance [40]. None of the risk factors (environmental factors) show a significant association with *T. gondii* infection including contact with cats, consumption of raw and frozen meat, drinking unboiled water, consumption of raw vegetable, handling raw meat and miscarriage [32]. The sero-positivity of those who clean cat litters was higher which explains that cleaning of cat litter was associated with *T. gondii* infection. The low awareness of zoonotic diseases including toxoplasmosis among pregnant women in this study is consistent with the report that 96.6% of the women in Port Harcourt had no knowledge of toxoplasmosis [35]. This would increase the risk of infection with this disease and other zoonotic infections. However, the low awareness in this study varies with the reported moderate (53%) awareness of Nigerians about toxoplasmosis and overall exposure to toxoplasmosis risk factors of 64% where North West residents showed 53% exposure, North East 54%, North Central 62%, South West 23%, South East 39%, and South South 52% exposure to toxoplasmosis risk factors with a statistically significant difference as

far as geopolitical zone of residence is concerned [41]. The variation in the level of awareness may probably be from the origin, occupation, educational background of the targeted study groups. Some women who visited the hospital were referral from other localities where there might be non or little knowledge about zoonotic infection.

Conclusion

The Knowledge of the sero-prevalence of *Toxoplasma gondii* infection among ante natal attendees in this health facility in Plateau State is significant in prevention of toxoplasmosis transmission. Though educational level, residence, occupation and cleaning of litters by participants were found to be significantly associated with *T. gondii* infection, all other factors considered that were not significant, are important since they served as sources of infection with the disease. Health education on preventive measures against *T. gondii* infection and other zoonotic diseases by avoiding risks factors that could predispose the pregnant women to the infection during antenatal care by the care givers. However, the study was limited to pregnant women who had registered for Ante Natal Care at JUTH and volunteered to participate in the study were included. Other pregnant women not in this category were excluded. Further studies should be carried out to consider the acute effects of the infection in infected persons and also the effects of the infection on foetuses of infected pregnant women.

Competing Interests

The authors declare that there are no competing interests.

Authors' Contributions

AD, KY and DPY conceived the idea, designed and carrying out the study. All authors contributed significantly in collection of the literatures, drafting the manuscript and reading and approval of the manuscript.

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