

SEROPREVALENCE OF TOXOPLASMOSIS AND ASSOCIATED RISK FACTORS AMONG PREGNANT WOMEN ATTENDING GENERAL HOSPITAL, MINNA, NIGERIA

IBRAHIM, M. A.,¹ OMALU, I. C. J.,¹ ADENIYI, K. A.² and UKUBUIWE, A. C.¹

¹Department of Biology, School of Life Sciences, Federal University of Technology Minna, Nigeria

²Department of Biology, Faculty of Natural Sciences, Federal University Dutse, Nigeria

Corresponding Author: maryamibrahimaudu@gmail.com, Tel.: +2348021139983

ABSTRACT

Infection with *Toxoplasma gondii* is one of the few known zoonotic diseases that have the ability to induce abortion and congenital transmission. Simple hygienic practices due to adequate knowledge about the parasite is one of the major keys to preventing this infection among pregnant women and women of child bearing age. The present cross sectional study was carried out to investigate the seroprevalence of *Toxoplasma* Immunoglobulin G (IgG) antibodies and exposure to associated risk factors of infection among pregnant women attending General Hospital, Minna, Nigeria. A total of 92 blood samples were collected from consenting pregnant women aged 15-40 years attending ante-natal clinic at General Hospital, Minna between December and February, 2022. The samples were screened for toxoplasmosis using specific Toxo IgG Indirect Enzyme-Linked Immunosorbent Assay (ELISA) kits by DiaSino. Information on respondents socio-demographic characteristics and exposure to associated risk factors were obtained from the study participants using a structured questionnaire. The results indicated an overall seroprevalence of 31.50% for *Toxoplasma* IgG antibodies. Seropositivity of *Toxoplasma* infection was found to be higher (80.00%) among pregnant women aged 15-20 years than other age groups. Seropositivity of *Toxoplasma* infection was also higher among women in their First Trimesters (57.10%), and among those who drink unfiltered water (50%). Hand washing and Backyard gardening were associated to *Toxoplasmosis* in this study. The results from this study indicated a high Seroprevalence of *Toxoplasma gondii* IgG antibodies among the pregnant women at General Hospital, Minna. Therefore, toxoplasmosis is a public health concern in Minna, Nigeria.

KEYWORDS: Seroprevalence, Toxoplasmosis, *Toxoplasma gondii*, Risk Factors, ELISA, Antibodies

INTRODUCTION

Toxoplasmosis is a broad-based zoonotic disease caused by *Toxoplasma gondii*, which is an obligate intracellular protozoan parasite that causes toxoplasmosis in human and other warm blooded animals (Bello *et al.*, 2017; Guemgne *et al.*, 2019). Cat family members are considered the main reservoirs of infection because they are the only known definitive hosts for the sexual stages of *T. gondii* (Dubey *et al.*, 2009). They excrete resistant oocysts in their faeces. Other mammals including humans, serve as intermediate host (Dubey and Jones, 2008). Cats become contaminated when they ingest animal flesh or food encysted with *T. gondii* and rarely by ingesting oocysts directly from faeces of other infected cats (Skariah *et al.*, 2010). Infected cats are usually asymptomatic and begin to shed unsporulated oocysts which are noninfectious in their faeces 7-14 days after exposure (Dubey *et al.*, 2009). Most cats shed

oocysts only once in their lifetime (Cook *et al.*, 2000).

Humans become infected with the parasite if it enters the food chain environment (that is, through the consumption of raw or undercooked meat containing cysts of the parasite and through ingestion of oocysts with fruits and vegetables soiled by the faeces of infested cat) or if it passes from an infected mother to her foetus leading to congenital toxoplasmosis (Assob *et al.*, 2011; Wallon *et al.*, 2013). Other rare causes of transmission included transfusion of infected blood and through organ transplantation (Jones *et al.*, 2001; Skariah *et al.*, 2010). Toxoplasmosis was once a leading infectious cause of food-borne death after salmonellosis and listeriosis in the USA (Jones *et al.*, 2001). Toxoplasmosis has been estimated to infect more than one third of the world population and to be responsible for 1.2 million

disability-adjusted life years ((DALYs) annually (Torgerson and Mastroiaco, 2013). It is one of the most prevalent and widespread parasitic infections, it is often neglected especially in developing countries (Bello *et al.*, 2017).

The status of the immune system plays an important role in the course of the parasite. Most immunocompetent individuals who contract *T. gondii* infection do not develop symptoms, or might experience nonspecific flu-like symptoms including fever, headache, muscle pain, and lymphadenopathy (Saadatnia and Golkar, 2012). Although toxoplasmosis is generally asymptomatic, it can be very dangerous in immunosuppressed individuals (Assob *et al.*, 2011) and in pregnant women who can transmit it to their unborn children, in which case it is called congenital toxoplasmosis (Montoya and Remington, 2008). In subjects with immunodeficiency, such as in patients with acquired immunodeficiency syndrome (AIDS), transplant recipients, and people on immunosuppressive therapy, the disease may provoke severe symptoms such as brain abscesses, encephalitis, pneumonia and disseminated infection (Montoya and Liesenfeld, 2004; Weiss and Dubey, 2009; Dubey *et al.*, 2012).

Congenital toxoplasmosis is the infection of the foetus by the protozoan parasite, *Toxoplasma gondii* transmitted by the mother; this implies that the mother has been in contact with the parasite during pregnancy without being previously immunized (Tenter *et al.*, 2000). Congenital toxoplasmosis may lead to myriad of health problems such as spontaneous miscarriage, stillbirth, or congenital abnormalities such as mental retardation, hydrocephalus, intracerebral calcifications, and chorioretinitis (Khan and Khan, 2018; Fanigliulo *et al.*, 2020). Mothers who acquired *T. gondii* at a distant time before pregnancy have a limited risk of congenital infection. On the other hand, women who become infected shortly before conception or during the first trimester are capable of transmitting the infection to their foetuses (Vogel *et al.*, 1996; Cook *et al.*, 2000). The degree of severity of congenital toxoplasmosis is inversely related to gestational age at the time of infection. During the first trimester, the transmission rate is low but the infection will result in severe congenital toxoplasmosis. Late infection is characterized by high transmission but less foetal morbidity (Lopez *et al.*, 2000; Martin, 2001). Most congenitally

infected babies appear normal at birth, however, serious sequel such as neurological impairment and chorioretinitis can manifest in the second or third decades of life (Dunn *et al.*, 1999). Seroconversion of susceptible women of childbearing age is preventable by simple precautions if such women are well informed. These precautions include consumption of well cooked meat, avoidance of ingesting fruits and vegetable contaminated with *T. gondii* oocyst and observance of improved personal hygiene in the handling of cat litters and in gardening (Adeniyi *et al.*, 2018).

In human infection, *T. gondii* elicit immune response which can be detected by several serological tests including enzyme linked immunosorbent assay (ELISA) (Bello *et al.*, 2017). Immunoglobulin G (IgG) antibodies usually appear within 1–2 weeks of acquisition of the infection, peak within 1–2 months, decline at various rates, and usually persist for life (Bello *et al.*, 2017). It has been observed that the functional affinity of specific IgG antibodies is initially low after primary antigenic challenge and that it increases during subsequent weeks and months by antigen-driven B cell selection. Protein-denaturing reagents including urea are used to dissociate the antibody-antigen complex. Immunoglobulin M (IgM) antibodies may appear earlier and decline more rapidly than IgG antibodies. An IgM test is still used by most laboratories to determine if a patient has been infected recently or in the distant past. In people with recently acquired primary infection, *T. gondii*- specific IgM antibodies are detected initially, and in most cases, these titers become negative within a few months. However, in some people, positive *T. gondii*-specific IgM titers can still be observed during the chronic phase of infection (Liesenfeld *et al.*, 1997).

Data on the burden of toxoplasmosis among pregnant women are sparse in Niger State. Toxoplasmosis is also not part of the routine screening done for pregnant women during anti-natal care despite its reported prevalence and complications in pregnant women. In view of the paucity of studies on toxoplasmosis in Niger State, this study is an attempt to bridge that gap. It is hope that the outcome will further sensitize the general public on the need to adopt effective control measures that will reduce the transmission of toxoplasmosis among pregnant women to limit associated complications. This study is designed to determine the prevalence of toxoplasmosis and

associated risk factors among pregnant women attending General Hospital, Minna, Nigeria.

MATERIALS AND METHODS

The study was carried out at Jummai Babangida Aliyu Maternal and Neonatal Hospital- a secondary health facility of the general hospital, Minna, Nigeria. Minna, Niger State was chosen for investigation of *Toxoplasma gondii* infection, Minna lies between latitude 9° 30' and 9° 45' North and longitude 6° 25' and 6° 40' East dispersed to both sides of the main road from Chanchaga in the South to Maikunkele in the North a distance of about 20 Kilometres. Bosso is a Local Government Area in Niger State, Nigeria with its headquarters in Maikunkele. It covers an area of 1,592km² and has a population of 147,359 at the 2006 Census.

Minna is a city located in North Central Nigeria having an estimated population of 304,113 as at 2007. It is the Capital of Niger State one of Nigeria's 36 Federal States and is the headquarters of Chanchaga Local government Area. Minna is located in the middle belt but has placed it at the advantage of moderate and favourable climate. It enjoys moist, dry equatorial and tropical climate with 7months rainfall (April to October) and 5months of dry season (October to March), The natural fresh water bodies includes streams, ponds and dams all serving as the main sources supplied for human population in Bosso village and Bosso Tudun Fulani Minna.

Study design: A descriptive cross-sectional study was employed.

Study Population: The study population was made up of ninety two pregnant women in different trimesters (first, second and third trimesters) registered at the antenatal clinic. Consent of each participant was sought after explaining the purpose and the benefit of the study to them. They were recruited progressively at the point of visit until sample size was realized.

Data collection, management and analysis: A well-structured questionnaire was administered to participants enrolled in the study to capture socio-demographic information such as age, educational status, occupation and also information regarding their stage of pregnancy, possession of cats at home, close contact with cats, main sources of drinking water, hygienic practices, habits of consuming undercooked meat, consuming raw

unwashed fruits/vegetables, history of miscarriage and stillbirth. Data was entered and analyzed using Microsoft Excel 2007 and statistical package for social sciences (SPSS) 20th version to determine frequency, proportions of descriptive variables. Chi square test was used to assess association. Level of significance was achieved at $p < 0.05$.

Sample Collection and Serological tests: Two millilitres (2ml) of blood sample was collected from each participant with the help of medical personnel of the secondary health facility using sterile syringe and needle by venipuncture. Samples collected from each participant were immediately transferred into plain sterile specimen bottles and each sample was labeled with a code given to each participant. Sera obtained were tested for anti-*Toxoplasma gondii* IgG antibodies using Enzyme Linked Immunosorbent Assay (ELISA) test kits for anti-T. gondii- specific IgG antibody only. Samples were analysed at the centre for Genetic Engineering and Biotechnology (Step-B) Federal University of Technology Minna, Nigeria (Dairo *et al.*, 2018).

Ethical Considerations

Ethical approval was obtained from Jummai Babangida Aliyu Maternal and Neonatal Hospital, Minna. Informed consent was sought from each pregnant woman before their involvement in the study. Information collected from each study participant was kept confidential.

RESULTS

A total of 92 pregnant women at general hospital, Minna participated in this study. Most (36) of the women were between ages 26-30years and a few (5) were between 15-20years (table 2). Majority (54) of the pregnant women examined were in their third trimester, 31 were in their second trimester while 7 were in their first trimester (Table 3). Out of the 92 pregnant women examined, 29 (31.50%) were seropositive for *Toxoplasma gondii* (IgG) antibodies while 63 (68.50%) were Seronegative for *Toxoplasma gondii* (IgG) antibody (See table 1). The result therefore showed a relatively high prevalence of *Toxoplasma gondii* infection among pregnant women attending General Hospital, Minna, Nigeria. In this study, participants in their first trimester recorded a higher prevalence (57.10%) compared to participants in their second and third trimesters, participants who wash their hands less often and who engage in backyard gardening recorded higher prevalence compared to their counterparts who wash their hands often and

who do not engage in backyard gardening (see table 3).

Table 1: Overall Seroprevalence of *Toxoplasma gondii* IgG antibodies among pregnant women attending General Hospital, Minna, Nigeria.

Result	Frequency	Percent
Positive	29	31.50 ^P
Negative	63	68.50
Total	92	100

^PPrevalence of *Toxoplasma gondii* IgG antibodies by ELISA

Table 2: Seroprevalence of *T. gondii* infection in relation to age of the pregnant women attending General Hospital, Minna, Nigeria.

Age groups (years)	No. Examined	No. Infected	Prevalence (%)
15-20	5	4	80.0
21-25	24	6	25.0
26-30	36	10	27.8
31-35	17	7	41.2
36 and above	10	2	20.0
Total	92	29	31.5

$X^2=7.50$ $df=4$ $P>0.05$

Table 3: Seroprevalence of Toxoplasmosis in relation to risk factors among pregnant women attending General Hospital, Minna, Nigeria

Parameter	No. Examined	No. Infected	Prevalence (%)	P-Value
Level of Education				
Non-formal	4	0	0.00	0.587
Primary	6	2	33.3	
Secondary	43	14	32.6	
Tertiary	39	13	33.3	
Occupation				
Artisan	10	4	40.00	0.837
Housewife	34	10	29.40	
Civil Servant	11	4	36.40	
Trader	35	11	31.40	
Student	2	0	0.00	
Miscarriage History				
YES	28	5	17.90	0.088
NO	64	24	37.50	
Stillbirth History				
YES	19	4	21.10	0.406
NO	73	25	34.20	
Gestation				

First Trimester	7	4	57.10	0.315
Second Trimester	31	9	29.00	
Third Trimester	54	16	29.60	
Cat Ownership				
YES	11	0	0.00	0.015
NO	81	29	35.80	
Close Contact with cat				
Often	8	0	0.00	0.093
Rarely	9	2	22.20	
Never	75	27	36.00	
Consumption of Undercooked meat				
Sometimes	74	22	29.70	0.573
Never	18	7	38.90	
Consumption of Raw Fruits/vegetables				
Sometimes	6	1	16.70	0.661
Never	86	28	32.60	
Sources of Drinking Water				
Borehole	14	7	50.00	0.218
Mineral (bottle) water	10	1	10.00	
Tap water	18	6	33.00	
Sachet Water	50	15	30.00	
Hand washing				
Always	83	26	31.30	0.585
Less Often	9	3	33.30	
Backyard Gardening				
YES	22	8	36.40	0.585
NO	70	21	30.00	

DISCUSSION

Toxoplasmosis is a zoonotic disease caused by *Toxoplasma gondii*; a protozoan parasite transmitted to humans when the parasite is ingested accidentally in drinking water, contaminated raw fruits/vegetables, contaminated soil and consumption of infected meat. It can also be transmitted congenitally during pregnancy (Dubey, 2010). While it is known that *T. gondii* rarely cause acute disease in healthy individuals, different studies have recorded its high prevalence rates and this proves it as a serious threat to human health. The most serious form of *Toxoplasma* infection is Congenital Toxoplasmosis which is accompanied by serious foetal complication based on gestational age at the time of infection (Deji-Agboola *et al.*, 2011).

In this study, the overall seroprevalence of anti-*Toxoplasma* IgG antibody among pregnant women attending General Hospital Minna, is 31.50%. This is in line with the 35.80%, 32.60% and 30.44%

prevalence reported by Dairo *et al.* (2018), Deji-agboola *et al.* 2011 and Adeniyi *et al.* 2018 in Ibadan, Lagos and Osogbo respectively. The prevalence in this study is higher when compared to the findings of Oyinloye *et al.* (2014) who reported 22.20% prevalence for *T. gondii* IgG antibodies among pregnant women in Maiduguri. Higher prevalence of (46.20%) and (42.40%) were reported respectively among pregnant women in Jos by Okojokwu *et al.* (2021) and among pregnant women in Port Harcourt by Oboro *et al.* (2016). The varied prevalence rates been reported might be due to differences in geographical location, levels of exposure, methodology, sample size and behavioural attitudes of the study populations (Yusuf *et al.*, 2016).

Variations in the prevalence of toxoplasmosis across countries have been well documented, and indeed contrasting data are observed: 80.3% in the Democratic Republic of Congo (Doudou *et al.*, 2014); 6.2% in México (Alvarado-Esquivel *et al.*, 2016) and 44.5% in Tanzania (Paul *et al.*, 2018).

The differences in prevalence rates in the worldwide population may be associated with various factors related to each region/country and the diagnostic methods used as well as the specific characteristics of the population.

The result obtained from this study suggest that considerable number of pregnant women 63 of 92 (68.4%) sampled at General Hospital Minna, Nigeria are seronegative that is, they have not been exposed to *T.gondii*. This group is at risk of becoming infected later in life if they come in contact with the parasite. The findings from this study showed that there was no definite age-related pattern of increase in seroprevalence of *Toxoplasma gondii* IgG antibodies among the study participants (table 2). This is in disparity with the work of Uttah *et al.* (2013) who reported that seroprevalence was found to increase with age. In this study (see table 2), pregnant women in age group 15-20 had the highest prevalence 4 of 5 (80.00%) of toxoplasma IgG antibody among the age categories (this rate is higher than the overall seroprevalence of 31.5%), this actively reproducing age group are more at risk of giving birth to infants who are exposed to the teratogenic effects of toxoplasmosis and should therefore take appropriate precautions to protect themselves against this infection. This finding is in line with the report of Okojokwu *et al.* (2021) in which pregnant women 11-20 years had the highest prevalence among the age categories and it is contrary to the report of Adeniyi *et al.* (2018) who found the least prevalence of toxoplasmosis among the age categories in pregnant women ≤ 20 years of age. Older pregnant women age 36 years and above in this study were observed to have the least prevalence of *T.gondii* as compared to their younger counterparts. This might be explained by difference in behavioural pattern and hygiene practices of the women. Younger women tend to have more preference for outings and gatherings than older women. During those outings, the women are exposed to grilled meat which might be undercooked. Fruits and salads which may be contaminated with the oocysts are also often eaten in such outings hence increasing the risk of infections.

The findings from this study also showed that high level of education didn't amount to decrease in prevalence. In this study, none among the 4 pregnant women who had no formal education was positive for *Toxoplasma* IgG antibody. More so, pregnant women at primary level and tertiary level

of education in this study were seen to have the same rates of prevalence (33.30%) while those at secondary level had prevalence of 33.20%. This is in disparity with the findings of Okojokwu *et al.* (2021) who found low level of education to be associated with higher rate of toxoplasmosis infection among pregnant women. Pregnant women that were artisan and civil servant recorded a non-significantly higher prevalence to *Toxoplasma* IgG antibodies while lower seropositivity of *T. gondii* antibodies was observed among pregnant women that were housewives. This is in consonance with the report of Adeniyi *et al.* (2018) who recorded higher seropositivity to *T. gondii* antibodies among employed pregnant women. The explanation for this might be that employed pregnant women are stable with incomes that enable them buy meat compared to housewives and students who are essentially dependent financially on husbands, parents or guardians.

The relatively high seroprevalence (57.10%) of *Toxoplasma gondii* antibodies found in pregnant women in their first trimester of gestation period in the present study is in agreement with a study in Jos by (Okojokwu *et al.*, 2021) that studied Anti-*Toxoplasma gondii* antibodies: Prevalence and risk factors among Pregnant women accessing antenatal care in some primary health centers in Jos Metropolis, Nigeria and reported women in their first trimester to have the highest prevalence of *Toxoplasma* Infection. This finding is also in agreement with the report of Adeniyi *et al.* (2018) who recorded highest prevalence of *T. gondii* in pregnant women in their first trimester. The findings in the present study is contrary to the report by (Ballah *et al.*, 2017) in which the highest prevalence of *Toxoplasma* antibodies in pregnant women was recorded among pregnant women in their second trimester. Although, the gravidity of the pregnant women was not established in this study, Mandour *et al.* (2017) reported an increased percentage of multigravid women, in whom complicated pregnancy outcomes have been reported compared with primigravid females. In view of that finding, it is likely that the majority of the women in their first trimester of pregnancy in this study were multigravid females.

Although cats are the definitive and reservoir hosts of *T. gondii* and probably the major source of contamination, cat ownership and contact with cats were not found to be associated with *T. gondii* infection in this study. This is similar to the report

of Wam *et al.* (2016) in Cameroon. An explanation to our findings could be because the cat owners among our study participants are few and maybe practiced good hygiene and their cats probably do not use litter box. There was no association found between history of miscarriage or history of stillbirth and prevalence of toxoplasmosis in this study. This is similar to the report of Deji-Agboola *et al.* (2011). More so, no association was found between consumption of undercooked meat, consumption of raw unwashed fruits/ vegetables and *Toxoplasma* IgG seropositivity. This is similar to the findings of Deji-Agboola (2011) but in disparity to the findings of Guemgne *et al.* (2019) who reported *T. gondii* seropositivity to be associated with consumption of undercooked meat and raw unwashed fruits/Vegetables. A possible explanation for our results has to do with eating habits and food preparation practices in the studied population.

Hand washing practices was associated with seropositivity of toxoplasmosis. A non-significantly higher prevalence was seen among pregnant women who wash their hands less often as compared to those who often wash their hands. This is consistent with the report of Guemgne *et al.* (2019). Backyard gardening was also associated with seropositivity of *Toxoplasma gondii* infection in this study this is contrary to the reports of Paul *et al.* (2018) .

Sources of drinking water were assessed in this study. Findings showed that pregnant women who consume borehole and tap water have relatively higher prevalence of *Toxoplasma gondii* IgG antibodies. This is similar to the report of Guemgne *et al.* (2019).

Toxoplasmosis appears to be a public health concern in Minna, with an overall seroprevalence of 31.50% of *Toxoplasma* IgG antibodies among pregnant women attending General hospital, Minna. There is need for the inclusion of mandatory screening for toxoplasmosis to all pregnant women during ante-natal care to prevent maternal and congenital infections. Education on toxoplasmosis during antenatal care may be a strategy for primary prevention of toxoplasmosis and its devastating outcomes in pregnancy. Follow up studies on *Toxoplasma gondii* IgM antibodies is very important to detect recent exposure.

REFERENCES

- Adeniyi, O. T., Adekola, S. S., & Oladipo, O. M. (2018). Seroepidemiology of Toxoplasmosis among Pregnant Women in Osogbo, Southwestern, Nigeria. *Journal of Infectious Diseases and Immunity*, 10(2),8-16.
- Alvarado-Esquivel, C., Rascon-Careaga, A., Hernandez-Tinoco, J., Corella-Madueno, M. A. G., Sanchez-Anguiano, L. F., Aldana-Madrid, M. L., ... & Liesenfeld, O. (2016). Seroprevalence and correlates of *Toxoplasma gondii* infection in Yoremes (Mayos) in Mexico: a cross-sectional study. *British Medical Journal Open*, 6(5), e010218.
- Assob, J. C. N., Njunda, A. L., Nsagha, D. S., Kamga, H. L., Weledji, P. E., & Che, V. B. (2011). *Toxoplasma* Antibodies amongst HIV/AIDS patients attending the University Teaching Hospital Yaoundé, in Cameroon. *African Journal of Clinical and Experimental Microbiology*, 12(3),1119–23.
- Ballah, F.M., Maikai, B.V., Magaji, A. A., Shuaibu, A. B., El-Nafaty, A. U., Sambo, Y.T., Auwah, A. A., Faruk, H. U. & Suleiman, F., (2017). Seroprevalence and Risk of *Toxoplasma gondii* Infection among Pregnant Women at Federal Teaching Hospital Gombe, Nigeria. *Asian Journal of Medicine and Health* 3(2), 1-5
- Bello, S. H., Umar, Y. A., Abdulsalami, M. S., & Amusan, V. O. (2017). Seroprevalence and Risk Factors of Toxoplasmosis among Pregnant Women Attending Antenatal Clinic in Kaduna Metropolis and Environs. *International Journal of Tropical Disease and Health*, 23(3),1-11
- Cook, A. J. C., Gilbert, R. E., Buffolano, W., Zufferey, J., Petersen, E., Jenum, P. A..., & Dunn, D. T. (2000). Sources of *Toxoplasma* infection in pregnant women: European multicentre case-control study. *British Medical Journal*, 321,142-147.
- Dairo, M. D., Ogunjimi, T., & Ayinmode, A. B. (2018). Knowledge, Risk Factors and Prevalence of Toxoplasmosis Among Pregnant Women at Primary Health Care Level in Ibadan, Southwestern Nigeria. *African Journal of Biomedical Research*, 21,(3),267-271

- Deji-Agboola, A. M., Busari, O. S., Osinupebi, O. A., & Amoo, A. O. J. (2011). Seroprevalence of *Toxoplasma gondii* antibodies among pregnant women attending antenatal clinic of Federal Medical Center, Lagos, Nigeria. *International Journal of Biological Medical Research*, 2(4), 1135-1139.
- Doudou, Y., Renaud, P., Jacqueline, F., Hypolite, S., Hypolite, M., Patrick, M., ... & Pascal, L. (2014). Toxoplasmosis among pregnant women: high seroprevalence and risk factors in Kinshasa, Democratic Republic of Congo. *Asian Pacific Journal of Tropical Biomedicine*, 4(1), 69-74.
- Dubey, J. P., & Jones, J. L. (2008). *Toxoplasma gondii* infection in Humans and Animals in the United States. *International Journal for Parasitology*, 38, 1257-1278
- Dubey, J. P., Lago, E. G., Gennari, S. M., Su, C., & Jones, J. L. (2012). Toxoplasmosis in humans and animals in Brazil: high prevalence, high burden of disease, and epidemiology. *Parasitology* 139,1375-1424
- Dubey, J. P., Lindsay, D. S., & Lappin, M. R. (2009). Toxoplasmosis and other intestinal coccidial infections in cats and dogs, *Veterinary Clinics of North America: Small Animal Practice*, 39,1009-1034.
- Dunn, D., Wallon, M., Peyron, F., Petersen, E., Peckham, C., & Gilbert, R. (1999). Mother-to-child transmission of toxoplasmosis: risk estimates for clinical counseling. *Lancet*, 353, 1829-1833
- Fanigliulo, D., Marchi, S., Montomoli, E., & Trombetta, C. M. (2020). *Toxoplasma gondii* in women of childbearing age and during pregnancy: Seroprevalence study in Central and Southern Italy from 2013 to 2017. *Parasite*, 27,2.
- Guemgne, T. F., Mekou, T. E., Gamago, G. A., & Vignoles, P. (2019). Seroprevalence of toxoplasmosis and associated risk factors in pregnant women at the Protestant Hospital, Mbouo-Bandjoun, Cameroon. *African Journal of Clinical and Experimental Microbiology*, 20(3),221.
- Jones, J. L., Kruszon-Moran, D., Wilson, M., McQuillan, G., Navin, T., & McAuley, J. B. (2001). *Toxoplasma gondii* infection in the United States: seroprevalence and risk factors. *American Journal of Epidemiology*, 154, 357-365
- Khan, K., & Khan, W. (2018). Congenital toxoplasmosis: An overview of the neurological and ocular manifestations. *Parasitology International*, 67(6),715-21.
- Liesenfeld, O., Press, C., Montoya, J. G., Gill, R., Isaac-Renton, J. L., Hedman, K., & Remington, J. S. (1997). False-positive results in immunoglobulin M (IgM) toxoplasma antibody tests and importance of confirmatory testing: The Platelia ToxoIgM test. *Journal of Clinical Microbiology*, 35(1),174-8.
- Lopez, A., Dietz, V. J, Wilson, M., Navin, T. R., Jones, J. L. (2000). Preventing congenital toxoplasmosis. *Morbidity and Mortality Weekly Report: Recommendations and Reports*, 49,59-68
- Mandour, A. M., Mounib, M. E., Eldeek, H. M., Ahmad, A. R., & Abdelkader, A. M. (2017). Prevalence of congenital toxoplasmosis in pregnant women with complicated pregnancy outcomes in Assiut Governorate, Egypt. *Journal of Advances in Parasitology*, 4(1),1-8
- Martin, S. (2001). Congenital toxoplasmosis. *Neonatal Network*, 20,23-30
- Montoya, J. G., & Liesenfeld, O. (2004). Toxoplasmosis. *Lancet*, 363, 1965-1976
- Montoya, J. G., & Remington, J. S. (2008). Management of *Toxoplasma gondii* infection during pregnancy. *Clinical Infectious Diseases*, 47(4),554-66.
- Oboro, I. L., Obunge, O. K. & Wariso, K. T., (2016).Sero-epidemiology of Toxoplasmosis among Pregnant Women in the University of Port Harcourt Teaching Hospital, Nigeria.*The Nigerian Health Journal*, 16(1), 1597-4292.
- Okojokwu O. J., Onaji, I. A., Entonu, E. E., Abubakar, B. S., Adebayo, M. B., Adamu, N. A..., & Anejo-Okopi, J. A. (2021).Anti-*Toxoplasma gondii* Antibodies: Prevalence and Risk Factors among Pregnant Women Accessing Antenatal Care in Some Primary Health Centers in Jos Metropolis, Nigeria. *Journal of Health Science Research*, 6(1), 9-17.

- Oyinloye, S. O., Igila-Atsibee, M., Ajayi, B. & Lawan, M. A. (2014). Serological screening for ante-natal toxoplasmosis in Maiduguri Municipal Council, Borno State, Nigeria. *African Journal of Clinical and Experimental Microbiology*, 15(2), 91-96.
- Paul, E., Kiwelu, I., Mmbaga, B., Nazareth, R., Sabuni, E., Maro, A., ... & Chilangola, J. (2018). *Toxoplasma gondii* seroprevalence among pregnant women attending antenatal clinic in Northern Tanzania. *Tropical Medicine and Health*, 46(1), 1-8.
- Saadatnia, G., & Golkar, M. (2012). A review on human toxoplasmosis. *Scandinavian Journal of Infectious Diseases*, 44(11), 805-14.
- Skariah, S., McIntyre, M. K., & Mordue, D. G. (2010). *Toxoplasma gondii*: Determinants of tachyzoite to bradyzoite conversion. *Parasitology Research*, 107, 253-260.
- Tenter, A. M., Heckeroth, A. R., & Weiss, L. M. (2000). *Toxoplasma gondii*: from animals to humans. *International Journal of Parasitology*, 30(12), 1217-1258.
- Torgerson, P. R., & Mastroiacovo, P. (2013). The global burden of congenital toxoplasmosis: a systematic review. *Bull World Health Organization*, 91:501–8.
- Uttah, E., Ogban, E., & Okonofua, C. (2013). Toxoplasmosis: A global infection, so widespread, so neglected. *International Journal of Scientific and Research Publications*, 3(6), 2250-3153
- Vogel, N., Kirisits, M., Michael, E., Bach, H., Hostetter, M., ... & Boyer, K. (1996). Congenital toxoplasmosis transmitted from an immunologically competent mother infected before conception. *Clinical Infectious Diseases*, 23(5), 1055-60.
- Wallon, M., Peyron, F., Cornu, C., Vinault, S., Abrahamowicz, M., Kopp, C. B., & Binquet, C. (2013). Congenital *Toxoplasma* infection: monthly prenatal screening decreases transmission rate and improves clinical outcome at age 3 years. *Clinical Infectious Diseases*, 56(9), 1223–1231.
- Wam, E. C., Sama, L. F., Ali, I. M., Ebile, W. A., Aghangu, L. A., Tume, C. B. (2016). Seroprevalence *Toxoplasma gondii* IgG and IgM antibodies and associated risk factors in women of child-bearing age in Njinikom, NW Cameroon. *BioMed Central Research Notes*, 9, 406
- Weiss, L. M., Dubey J. P. (2009) Toxoplasmosis: a history of clinical observations. *International Journal of Parasitology*, 39, 895–901
- Yusuf, A. M., Yahaya, S. & Azeez-Akande, O. (2016). Seroprevalence and risk factors of *Toxoplasma gondii* infection (toxoplasmosis) among HIV seropositive pregnant women in a tertiary healthcare Centre, Kano, Northern Nigeria. *Journal of Medicine and Medical Sciences*, 7(1), 001-005