Journal of Advances in Medicine and Medical Research

32(10): 1-10, 2020; Article no.JAMMR.57635
ISSN: 2456-8899
(Past name: British Journal of Medicine and Medical Research, Past ISSN: 2231-0614, NLM ID: 101570965)

Prevalence and Determinants of Toxoplasma Seropositivity among Women Who had Spontaneous Abortion in Gombe, North-Eastern Nigeria

H. U. Farouk[1*], M. M. Manga[2], U. R. Yahaya[3], C. H. Laima[1], A. I. Lawan[4], F. M. Ballah[5] and A. U. El-Nafaty[1]

[1]Department of Obstetrics and Gynaecology, Faculty of Clinical Sciences, College of Medical Sciences, Gombe State University, Gombe, Nigeria.
[2]Department of Medical Microbiology, Faculty of Basic Clinical Sciences, College of Medical Sciences, Gombe State University, Gombe, Nigeria.
[3]Department of Obstetrics and Gynaecology, Federal Teaching Hospital Gombe, Gombe, Nigeria.
[4]Department of Histopathology, Faculty of Basic Clinical Sciences, College of Medical Sciences, Gombe State University, Gombe, Nigeria.
[5]Department of Veterinary, Public Health and Preventive Medicine, Usmanu Dan Fodio University, Sokoto, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author HUF designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MMM and URY reviewed the study protocol, study design, data analyses and reviewed the manuscript. Authors CHL, AIL and FMB managed the literature searches, took part in data collection and analysis. Author AUEN reviewed the manuscripts, corrected and performed statistical analyses on the data. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMMR/2020/v32i1030509
Editor(s):
(1) Dr. Chan-Min Liu, Xuzhou Normal University, China.
Reviewers:
(1) Gopi Snehalkumar Patel, Gujarat Technological University, India.
(2) Gilbert Sterling Octavius, University of Pelita Harapan, Indonesia.
(3) Bouzebda Zoubir, University Mohamed-Chérif Messaadia, Algeria.
Complete Peer review History: http://www.sdiarticle4.com/review-history/57635

Original Research Article

Received 26 March 2020
Accepted 01 June 2020
Published 06 July 2020

**Corresponding author: E-mail: halimafarouk@yahoo.com;*

ABSTRACT

Aim: To determine the seroprevalence and determinants of Toxoplasma IgG and IgM seropositivity among women with spontaneous abortion in Gombe.
Materials and Methods: This was a cross-sectional study of 302 pregnant women with spontaneous abortion, presenting at the gynaecological emergency units of Federal Teaching Hospital Gombe and State Specialist Hospital Gombe. An interviewer-administered questionnaire was used to collect data, and a venous blood sample was drawn from each participant and tested for Toxoplasma IgG and IgM by ELISA technique.
Results: Toxoplasma seroprevalence was 62(20.5%) and was higher in women that owned cats (24% vs 20.1%, OR 1.3, 0.5-3.1) and ate grilled meat (suya) (21.0% vs 11.8%, OR 2.0, 0.4-9.0), but lower in those that washed fruits and vegetables before consumption (OR 0.6, 0.2-1.4).
Conclusion: Seroprevalence of Toxoplasmosis in Gombe is high and may be influenced by cat ownership cooking and eating habit.

Keywords: Toxoplasmosis; immunoglobulins; abortions; miscarriage.

1. INTRODUCTION

Toxoplasmosis is a zoonosis affecting both animals and humans [1]. It is caused by a protozoan *Toxoplasma gondii*, an obligate intracellular parasite [2,3]. *T.gondii* is seen to infect most warm-blooded animals including humans [1–3]. The disease affects a third of the world's population of humans causing abortions, stillbirths and congenital abnormalities in infants. Only 10-20% of patients with toxoplasmosis may present with symptoms that include lymphadenopathy, persistent myalgia, low grade fever, malaise, night sweats, sore throat and retinochoroiditis [1,4]. In immunocompromised individuals, symptoms can be severe with myocarditis, pneumonitis and CNS manifestations like seizures, encephalitis and visual disturbances [5,6]. The global annual incidence of congenital toxoplasmosis was estimated to be 190,100 cases, equivalent to a burden of 1.2 million Disability Adjusted Life Years (DALYs) [1,3,5]. Congenital infection can lead to severe disease in the developing fetus when the maternal infection is acquired in the first trimester, leading to fetal death and abortion [3,5].

The main source of infection is the cat, which passes the infective form of the parasite (the oocyst) in its faeces. This then contaminates soil, water and foods [1-3]. Other animals that feed on these foods, can also become infected. Ingestion of raw and undercooked meat of these infected animals by humans, can lead to transmission of bradyzoites encysted in such meat [3].*T.gondii* can be transmitted to humans through faeco-oral route by ingestion of fruits, vegetables and drinking water contaminated by the oocysts [6]. Through transfusion of blood and blood products, the parasite could also be transmitted. Vertical transmission from mother to child can also occur trans placentally [4,7,8].

High burdens are seen in South American, African and some middle eastern countries [1,9–11]. In France, seropositivity rates are up to 75%, and more than 50% in western Europe, Africa and South America [10] and 35% in Qatar [12]. In Africa, Evidence of *T. gondii* infection was found in 77.1% of pregnant women in Cameroun [13], 40.8% in Gabon, 53.6% in Benin Republic [14] and 83.6% in Ethiopian [15].

Lower annual prevalence 225,000 cases are seen in the United States, with toxoplasma seropositivity rates of 10-15% [1]. Prevalence of 15.1%-25.4% are seen in different provinces across China; with eating habits playing important role [9]. Inactive toxoplasmosis is seen to be prevalent with IgG seroprevalence of 25% in Saudi Arabia while congenital toxoplasmosis is rather low with IgM seroprevalence of 5% [16].

Contamination of the environment by oocyst shed in the feaces of the infected cat is important in the transmission process [2,5]. Active toxoplasmosis is related to the level of exposure [16]. Infections are particularly common in warm humid climate at lower altitude [16,17]. Some studies have shown higher risk of transmission among populations with shortage of clean water, raw meat handlers, and populations whose cultures and cooking practices encourage eating raw meat [9,18].

Toxoplasma seroprevalence of 22%-75% have been reported in various studies across Nigeria among various human populations [14,19–21].

Onadeko et al. [22] in Nigeria, reported prevalence rates of 75.4% in pregnant women and rate of 80.5% in postpartum women, using the Dye test.

In Lagos, Deji-Agboola et al. [14] found Toxoplasma IgG seroprevalence of 32.6% and Toxoplasma IgM seroprevalence of 7.6% among pregnant women using ELISA. IgM seroprevalence was higher in pregnant women in their first trimester (16.7%) compared to second (3.9%) and third (6.7%) trimesters. Toxoplasma IgG seroprevalence was associated with eating uncooked vegetables, farming and still birth [14]. Uttah et al. [19], showed toxoplasma seroprevalence if 31.5% in Abuja, Nigeria. Seropositivity was significantly higher in people living with cats/dogs (45.61%) than in those living without cats/dogs (15.69%). In Sokoto, the seroprevalence of Toxoplasma IgG is 44.4% while it is 22.2% in Maiduguri in a cross-sectional study of 90 pregnant women in 2014 [23]. Nasir et al. [20] in Maiduguri found Toxoplasma IgM seropositivity of 8.9% and that of IgG,40.0%. They also looked at IgG avidity and found 7.2% of those with IgM seropositivity had a primary infection while 1.7% had a reactivation of latent toxoplasmosis. Primary infection was significantly associated with employed status than unemployed [20].

In most parts of the world, routine screening for toxoplasmosis is not employed for reasons such as low prevalence of disease, high cost of testing, low sensitivity of screening test, false positive test and limitation of treatment effectiveness [4].

This study therefore, aimed to ascertain the prevalence and determinants of Toxoplasma seropositivity among women who had a spontaneous abortion in Gombe, North-Eastern Nigeria.

2. MATERIALS AND METHODS

This was a hospital-based, cross-sectional study. Consecutive patients presenting at the gynaecological emergency units of State Specialist Hospital Gombe (SSHG), and Federal Teaching Hospital Gombe (FTHG);from 1st August, 2017 to 31st January, 2018, with spontaneous abortion and met the inclusion criteria were recruited for the study, until the calculated minimal sample size of was reached.
The diagnosis of abortion was made by the attending gynaecologist based on history, physical examination, a positive bed-side dip stick urine pregnancy test, and a trans-abdominal pelvic ultrasound scan. Any woman in the reproductive age group (15-50 years) with a history of amenorrhea of less than 20 weeks, with or without vaginal bleeding, and/or drainage of liquor, with a positive urinary pregnancy test; and a trans-abdominal pelvic ultrasound scan showing features that include: (i) an empty intra uterine gestational sac of greater than 20 mm in diameter, (ii) absent fetal heart activity in an intra-uterine gestation with crown-rump length of at least 6 mm, or (iii) evidence of retained products of conception following history of expulsion of embryo, fetus or fetal parts. Those that had an induced abortion, threatened abortion, molar gestation, ectopic pregnancy, cervical incompetence, diabetes mellitus or Systemic Lupus Erythematosus and those whose samples were missing or lysed were excluded from the study.

2.1 Data Collection

Patients that met the inclusion and exclusion criteria were informed about the study using information sheet written in both English and Hausa languages that they understand. All patients were offered the required abortion care. Their consents were sought and obtained using an informed consent form. It was signed or thumb-printed by the participant. A coded interviewer-administered questionnaire was used to collect sociodemographic data such as age, parity, place of residence, occupation, and level of education, keeping of cats, eating improperly cooked meat, washing of fruits and vegetables before consumption, eating of 'suya' (a local delicacy of grilled beef prepared at the road side) and blood transfusion.

Five millilitres of venous blood sample was obtained by venipuncture for serological testing from each participant by the researcher, assisted by laboratory technicians and medical doctors. Each sample was put into a plain sample bottle and allowed to clot naturally. It was labelled and paired with corresponding questionnaire. The samples were then transferred (maintained at 2-8^{0}C) to the immunology laboratory of Federal Teaching Hospital Gombe for processing. Serum was separated from clot by centrifugation at 3000 rpm for 10 minutes immediately on reception. Each serum sample was aliquoted into two separate plain micro vials and kept frozen at -20^{0}C in separate freezers until analysis. This provided back up samples. The samples were pooled until the required number for each ELISA test kit (96 wells) is reached. The sera were

analysed by the ELISA technique using "MELSIN® Toxoplasma IgM" and "MELSIN® Toxoplasma IgG Enzyme Immunoassay Test Kit" Cat. #: MTS-0001 China, with manufacturing date 22/06/2017, according to the manufacturers' instructions. Test were read using ELISA reader set at 450nm wavelength. Optical Density (OD) were read and recorded for corresponding samples.

2.1.1 Interpretation of test results

Mean Negative control OD≤0.1 and positive control OD ≥0.8 were considered for validating results. Cut off was calculated for each plate as = Mean negative control A x 2.1 (calculated by 0.09 when mean negative control OD was < 0.09, and calculated by actual value when Mean negative control was > 0.09).

Positive results: Results were considered reactive when the sample OD ≥cut off OD as calculated. All initially reactive samples were tested in duplicates using the same procedure. Positive samples after the re-run where considered truly positive.

Negative results: Results were considered negative when sample OD < cut-off OD.

2.2 Data Analysis

Data from the questionnaires and results of serological tests were entered into program database and analysed using Statistical Package for Social Sciences (SPSS version 23). Continuous data such as age and parity were analysed using mean and standard deviation. Comparison of means between seropositive and seronegative groups was done using student's T-test. Categorical data such as education, occupation, and risk factors were analysed against serological status in terms of proportions (percentages) and comparisons were made using chi-square. Fisher's exact was used when cells contained numbers less than 5. Level of significance was left at p=0.05. The odds were also calculated within 95% confidence intervals using the risk analysis.

3. RESULTS

Out of the 330 patients who were recruited for the study, 302 had complete data and samples analysed. The age range of the patients in the study was 15-50 years with a mean of 27.4 years ± 6.8 years and the median age is 26 years. The mean parity of the patients was 3.3 ±2.9.

Table 1. shows the sociodemographic characteristics of the women who had spontaneous abortion in Gombe. More than half of the patients, 162 (53.6%), were between the ages of 20-29 years, followed by those between 30-39 years, 90 (29.8%). More than half, 172 (57.0%) were unemployed housewives. Some 76 (25.2%) were traders. There were 31(10.3%) civil servants, 10 (3.3%) students, 9 (3.0%) petty traders and 4 (1.3%) farmers. About 2/3rd, 199 (65.9 %) of the patients had at least primary school education, while 104 (34.3%) had no formal education; and 211(69.9%) lived in urban areas. Only 29 (9.6%) kept pet cats and 49 (16.2%) practiced household gardening. Up to 74 (24.4%) of the patients had a blood transfusion. Only 15 (5.0%) ate undercooked meat, but 286 (94.4%) ate grilled meat ('suya'). Twenty-three (7.6%) patients did not usually wash their fruits and/or vegetables before consumption.

Table 1. Sociodemographic characteristics of women with spontaneous abortion in Gombe

Characteristic	Frequency	Percentage (%)
Age group		
<20 years	29	9.6
20-29 years	162	53.6
30-39 years	90	29.8
>40 years	21	7.0
Occupation		
Unemployed housewives	172	57.0
Artisan	76	25.1
Civil servants	31	10.3
Students	10	3.3
Traders	9	3.0
Farmers	4	1.3
Residence		
Rural	91	30.1
Urban	211	69.9
Educational status		
Non-formal education	103	34.1
Primary education	40	13.3
Secondary education	107	35.4
Tertiary education	52	17.2

Blood samples from 62 patients were positive for Toxoplasma antibodies while 240 were negative. The seroprevalence of Toxoplasma antibodies in the study population was therefore, 20.5% (62/302). The seroprevalence of Toxoplasma antibodies and the interpretation

Table 2. Seropositivity of Toxoplasma antibodies (IgG and IgM) and its interpretation

Antibody positive	Frequency	Percentage	Interpretation
IgG only	57	18.9%	Previous exposure
IgM only	4	1.3%	Primary infection
IgG & IgM	1	0.3%	Chronic/recent infection
None (Negative)	240	79.5%	Non-exposed/Susceptible
Total	302	100%	

Table 3. Associations between sociodemographic characteristics of patients with spontaneous abortion and toxoplasma seropositivity

Characteristic	Number n= 302	IgM positive (count/%) n=5	OR, 95% CI	*p-value*	Seropositive (IgG/IgM) (count/%) n=62	OR, 95% CI	*p-value*
Age group(years)							
<30	188	5(2.7%)	0	0.16	38(20.2%)	1.0, 0.5-1.7	0.89
≥30	159	0(0%)			24(20.9%)		
Residence							
Urban	211	2 (0.9%)	0.3, 0.1-1.71	0.17	45(21.3%)	1.2, 0.6-2.2	0.57
Rural	92	3(3.3%)			17(18.5%)		
Formal Education							
Educated	199	3(1.5%)	0.8,0.1-4.7	1.0	44(22.1%)	1.3, 0.7-2.5	0.33
Not educated	104	2(1.9%)			18(17.3%)		
Employment							
Employed	130	2(1.5%)	0.9, 0.1-5.3	1.0	24(18.5%)	0.8, 0.5-1.4	0.45
Unemployed	173	3(1.7%)			38(22.0%)		
Keep cat							
Yes	29	1(3.4%)	2.4, 0.2-22.2	1.0	7(24.1%)	1.3, 0.5-3.1	0.61
No	273	4(1.5%)			55(20.1%)		
Usually, wash fruits and vegetables							
Yes	279	5(2.0%)	0	1.0	55(18.4%)	0.6, 0.2-1.4	0.22
No	23	0(0)			7(30.4%)		
Eat undercooked meat							
Yes	15	0	0	1.0	3(20.0%)	1.0, 0.3-3.5	1.0
No	287	5(1.7%)			59(20.5%)		
Eat "SUYA"							
Yes	285	5(1.7%)	0	1.0	60(21.0%)	2.0, 0.4-9.0	0.54
No	17	0			2(11.8%)		
Blood transfusion							
Yes	74	0	0	0.34	15(20.3%)	1.0, 0.5-1.9	0.95
No	228	5(2.2%)			47(20.5%)		

of the results is as shown in Table 2. Fifty-seven (18.9%) women tested positive for Toxoplasma IgG alone, while 4 (1.3%) tested positive for Toxoplasma IgM alone. Only one patient was seropositive for both IgG and IgM (0.3%). Two hundred and forty patients

tested negative for both Toxoplasma IgG and IgM (79.5%).

As shown in Table 3, IgM seropositivity was higher among women <30 years of age, 5(2.7%) vs 0(0%) *p>0.05*, while the IgG seropositivity rate was higher among women ≥30 years, 24(20.9%) vs 34(18.1%) *p>0.05*. Thus, women <30 years of age are less likely to test positive for Toxoplasma IgG than older women (OR=0.8, 95% CI 0.5-1.5).

There was modest difference between overall toxoplasma seropositivity among women leaving in the urban areas, compared to those in the rural areas (21.3% vs 18.5% respectively) *p>0.05*. However, IgM seropositivity among rural residents was 3.6-fold higher than that among urban residents. So, the odds of acute toxoplasmosis are 0.3 times lower among urban residents compared to rural [3(3.3%) vs 2(0.9%), *p>0.05.* (OR 0.3, 95% CI 0.1-1.7)]. Overall seropositivity rate was higher in educated women compared to women that were not educated [44(22.1%) vs 18(17.3%), *p>0.05.* (OR= 1.3, 95% CI 0.7-2.5)]. Unemployed women were more seropositive compared to those that were employed women (38(22.0%) vs 24(18.5%), *p>0.05.*

There overall seropositivity rate was higher in women that kept cats compared to those that did not 7(24.1%) vs 55(20.1%) *p>0.05.* However, IgM seropositivity in those that kept catswas 2.4 times more than in women that did not keep cats at home, 1(3.4%) vs 4(1.5%), *p>0.05.* (OR= 2.4; 95% CI 0.26-22.24).

Overall seropositivity rate was also 1.8 times higher in women who did not usually wash fruits and vegetables before consumption compared to those that did, 7(30.4%) vs 55(19.6%), *p>0.05.* (OR=1.8; 95% CI 0.22-1.43).

The overall seropositivity was 2 times higher among women that ate 'suya' compared to those that did not, 60(21.1%) vs 2(11.8%) *p>0.05.* (OR=2; 95% CI 0.45-8.99). In fact, all 5(1.7%) of those that tested positive for IgM were among those that ate suya; compared to none, 0(0%) of those that did not eat "suya", *p>0.05.* There was no statistically significant difference in seropositivity between those that ate undercooked meat and those that did not, 3(20.0%) vs 59(20.5%)*p>0.05*,(OR= 1, 95% CI, 0.26-3.54, and between those that had a blood transfusion and those that did not,15(20.3%) vs 47(20.5%)*p>0.05*, (OR=1, 95% CI 0.51-1.88).

4. DISCUSSION

In this study, the overall seroprevalence of Toxoplasma antibodies (IgG and IgM) among women who had spontaneous abortions was comparable with the studies by Oyinloye *et al*, Jones et al, Carmen et al. Ballah et al. and Shalangwa et al. which found rates of 22.2%, 22.5%, 24.2%, 28% and 29.9%) respectively[24–28]. It waslower than that found by Onadeko *et al* in Southern Nigeria (76%) [22] and also lower than that by Elvis *et al*, Tamman et al. Zemene et al. Amin et al. and Vado-Solis et al. (54.5%, 46.1%, 83.6%, 45.8% and 55% respectively [11, 15,29–31]. This difference could be attributable to the lower population density in Gombe and the climatic variation [32]. The hot & dry climate of North-Eastern Nigeria, may not favour replication of the organism [3,5]. The higher sensitivity (92%-97%) and specificity (92%-100%) of ELISA technique, used in the current study, as compared to that of other diagnostic techniques (80% and 52% for dye test, and 61% and 80% for haemagglutination test, respectively), used in other studies may also explain some of the differences [33]. Another important factor is the difference in the socio-cultural practices [34]. The culture of the people in Gombe does not encourage eating of raw or undercooked meat, as only 5% of the study population ate improperly cooked meat and 9.6% kept cats. This might have contributed to the lower prevalence in the study.

The seroprevalence was higher than 12.3% and 17.5% by Xiao et al. and Lamichhane et al. respectively, who used direct agglutination test [35,36]. The difference in the population studied, and diagnostic technique, may account for the difference in seroprevalence.

The IgM seroprevalence in the current study is comparable to 1/352 (0.3%) found by Onadeko et al. [22]. It is, however, lower than 7.6%, 8.9%, 11.7% by Deji-Agboola et al. Nasir et al. and Lamichhane et al. respectively [14,20,35]. This difference may be attributable to the different population studied. The current study on abortions, limited the study to first and second trimesters of pregnancy, while most studies mentioned, study spanned through to third trimester of pregnancy. Patients who were seronegative for both IgG and IgM in the study have never been exposed to Toxoplasma

infection and so remain susceptible. This is similar to 85% among women of reproductive age, found in the US by Jones et al. [25].

None of the sociodemographic characteristics in the current study showed any significant association to Toxoplasma seropositivity in the current study. This may be explained by the demographic evolution seen in Gombe in the last decade [37]. The population of Gombe has become more heterogeneous now due to the relative peace in the state, compared to the other parts of the North-East region battered by the insurgency. Thus, there has been an influx of people from neighbouring states which has contributed to the heterogenicity and expansion of urban and rural areas in the state [32]. This is similar to the findings by Xiao et al [36].

IgG seropositivity rates increased with increasing age in the current study. Again, those younger than 30 years were more seropositive to IgM than older women. The younger women are probably socially active, and are more likely to eat out, especially unwashed fruits and vegetables or have less time to observe hand washing hygiene [38]. And once exposed to *Toxoplasma gondii* at a young age, IgG persists for a life time, and so older women are likely going to test positive to IgG, increasing the seroprevalence in that age group[39]. It is similar to the finding of Jones et al. that found seropositivity rate significantly higher in older women aged over 40 years [25]. However, this did not agree with the finding by Tammam *et al* and Ballah *et al* who found IgG seropositivity rates to be higher among pregnant women less than 20 years of age (52.86%) [28,30].

IgM seropositivity was 3.7 times more in rural (3.3%) residents than urban (0.9%) residents. This agrees with the finding by Tammam in Egypt of *T.gondii* infection being 3.8 times greater among rural dwellers than urban and to Siddiqui in India [30,38]. This could be as a result of higher tendency to eat unwashed fruits and vegetables and close contact with livestock and vast contaminated farmlands [40]. The higher seropositivity rate among those that were educated in the current study was probably due to tendency for more outdoor interaction among urban residents, and also the likelihood of eating meals prepared on road-side or by hawkers with questionable sanitary habits.

In the current study, IgM seropositivity was 2.3 times higher in those that kept pet cats (3.4%) than in those that did not (1.5%) and it agrees with the finding of Wam *et al*, Ballah *et al* and Siddiqui et al. [28,29,38]. In the population studied, only 29 (9.6%) kept cats. Similarly, only 5.6% of pregnant women studied by Wam et al, in Cameroun kept cats [29]. It was lower than 59(29.4%) who kept cats in Ethiopia, with seropositivity rate of 95% [15]. Perhaps a look at other forms of livestock rearing could bring out a more significant association with Toxoplasma seropositivity in this population [25,39]. Seroprevalence of *T. gondii* infection in humans and animals including chickens, has been used as an indicator of the endemicity of the parasite [25,36].

In the current study, women that did not usually wash fruits and vegetables before consumption had highseropositivity rates compared to those that did. This is comparable to the findings by Deji-Agboola, Siddiqui et al., Wam et al. who found eating unwashed vegetables and fruits, and poor hygiene significantly associated with Toxoplasma seropositivity [14,34,38].

Only 5% of the women in the current study ate undercooked meat with no difference in seropositivity rates between those that ate and those that did not. This is lower than 52.2% by Zemene and Wam [15,29]. Higher rates have been reported in meat handlers and cooks [9,41]. It is not a regular cultural practice in the area of study, to eat raw meat or undercooked meat as it were [6,42]. But the population in this area commonly ate ‘suya’, a form of grilled meat usually prepared, by men at the road-side in most of Northern Nigeria [20]. It is a delicacy enjoyed by a large proportion of the population studied, with 286 (94.4%) of the patients consuming it. This may be an important source of infection; where the cooking temperature and duration of grilling may not be enough to eliminate meat parasites [24]. In the current study, toxoplasma seropositivity rate was 1.8 times higher among women that ate suya, 21.0% vs 11.8%. This agrees with the assertion made by Oyinloye et al. in Maiduguri [24]. Perhaps a look at this factor in a properly designed study may avail a more significant association. There was no difference in the current study between seropositivity rates among women who had blood transfusion and those that did not. This is in contrast to the difference found by Oyinloye (33.3% vs 20.9%) [24]. Higher in those that had blood transfusion than those did not [24].

The findings from this study showed that the seroprevalence of toxoplasmosis among women of reproductive age is high and that there are no

statistically significant associations between sociodemographic factors with seroprevalence of Toxoplasmosis [43]. However, certain factors were found to show some increased relation to likelihood of infection with *T. gondii*. These include keeping of cats, eating of "suya", poor sanitary habit such as not washing fruits and vegetables before consumption.

5. CONCLUSION

The seroprevalence of *Toxoplasma gondii* infection is high in our environment. Yet, a larger proportion of the population still remains susceptible to the infection.

Toxoplasma seropositivity was not significantly associated with patients' age, place of residence, or keeping of pets. However, factors like rural residence, keeping of cats, eating of unwashed fruits and vegetables and eating 'Suya' showed higher seropositivity rates and need further investigation to establish their significance.

6. LIMITATIONS

The study did not specify the cooking temperature of meat to define it as improperly cooked. Meaningful comparisons between IgM seropositive and seronegative could not be done due to very few cases with IgM.

7. RECOMMENDATIONS

A well-designed analytic study on individual risk factors is necessary for conclusive inferences to the disease. The study may open up opportunities for further study in the immediate area that will fill the dearth of literature.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT AND ETHICAL APPROVAL

The study was approved by the Research and ethical review committee of the Federal Teaching Hospital Gombe (NHRC 25/10/2013). Patients were informed about the study using information sheet written in both English and Hausa languages that they understand. All patients were offered the required abortion care. Their consents were sought and obtained using an informed consent form. It was signed or thumb-printed by the participant. Storage, handling and disposal of all specimens/ data was based on sound ethical principle.

ACKNOWLEDGEMENT

I acknowledge the huge intellectual contribution of Prof. Mohammed Bukar to the work from conception to conclusion.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Toxoplasmosis: Background, Etiology and Pathophysiology, Epidemiology. 2015 Oct 20
[Cited 2015 Dec 3]
Available:http://emedicine.medscape.com/article/229969-overview
2. Ramsewak S, Gooding R, Ganta K, Seepersadsingh N, Adesiyun AA. Seroprevalence and risk factors of *Toxoplasma gondii* infection among pregnant women in Trinidad and Tobago. Rev Panam Salud Pública Pan Am J Public Health. 2008 Mar;23(3):164–70.
3. Remington JS. The tragedy of Toxoplasmosis. Paediat Infec J. 1990;762-3.
4. Chaudhry SA, Gad N, Koren G. Toxoplasmosis and pregnancy. Can Fam Physician. 2014;60(4):334–6.
5. Lindsay DS, Dubey JP. *Toxoplasma gondii*: The changing paradigm of congenital toxoplasmosis. Parasitology. 2011;138(14):1829–31.
6. Montoya GJ, Liensenfeld O. Toxoplasmosis. Lancet. 2004;363(9425): 1965–75.
7. Jenum PA, Stray-Pedersen B, Melby KK, Kapperud G, Whitelaw A, Eskild A, et al. Incidence of *Toxoplasma gondii* Infection in 35,940 Pregnant Women in Norway and Pregnancy Outcome for Infected Women. J Clin Microbiol. 1998;36(10):2900–6.
8. Juma AS, Salman S. Correlation between apoptosis and Toxoplasma in abortion induction: Relevance of caspase 8. Int J Med Sci. 2011;3(6):181–192.

9. Zhou P, Chen Z, Li H-L, Zheng H, He S, Lin R-Q, et al. *Toxoplasma gondii* infection in humans in China. Parasit Vectors. 2011; 4:165.
10. Paquet C, Yudin MH, Allen VM, Bouchard C, Boucher M, Caddy S, et al. Toxoplasmosis in pregnancy: Prevention, screening and treatment. J Obstet Gynaecol Can. 2013;35(1):78–79.
11. Amin A, Mazloomzadeh S, Haniloo A, Mohammadian F, Fazaeli A. Evaluation of Anti-Toxoplasma IgG, IgM and IgA in Mothers with Spontaneous Abortion in Zanjan, Northwest Iran. Korean J Parasitol. 2012;50(4):371–4.
12. Ndir I, Gaye A, Faye B, Gaye O, Ndir O. Seroprevalence of toxoplasmosis amomg women having spontaneous abortion and pregnant womenfollowing in a center of health up-town in Dakar. Dakar Med. 2004; 49(1):5–9.
13. Ndumbe PM, Andela A, Nkemnkeng-Asong J, Watonsi E, Nyambi P. Prevalence of infections affecting the child among pregnant women in Yaounde, Cameroon. Med Microbiol Immunol (Berl). 1992;181(3):127–30.
14. Deji-Agboola AM, Busari OS, Osinupebi OA, Amoo AOJ. Seroprevalence of *Toxoplasma gondii* antibodies among pregnant women attending antenatal clinic of Federal Medical Center, Lagos, Nigeria. Int J Biol Med Res. 2011;2(4):1135–1139.
15. Zemene E, Yewhalaw D, Abera S, Belay T, Samuel A, Zeynudin A. Seroprevalence of *Toxoplasma gondii* and associated risk factors among pregnant women in Jimma town, Southwestern Ethiopia. BMC Infect Dis. 2012;12(1):337.
16. Razzak AH, Wais SA, Saeid AY. Toxoplasmosis: the innocent suspect of pregnancy wastage in Duhok, Iraq. East Mediterr Health J Rev Santé Méditerranée Orient Al-Majallah Al-Ṣiḥḥīyah Li-Sharq Al-Mutawassiṭ. 2005;11(4):625–32.
17. Al-Qurashi AR, Ghandour AM, Obeid OE, Al-Mulhim A, Makki SM. Seroepidemiological study of *Toxoplasma gondii* infection in the human population in the Eastern Region. Research Gate. 2001; 22(1):13–8.
18. Guerina NG, Hsu H-W, Meissner HC, Maguire JH, Lynfield R, Stechenberg B, et al. Neonatal Serologic Screening and Early Treatment for Congenital *Toxoplasma gondii* Infection. N Engl J Med. 1994;330 (26):1858–63.
19. Uttah EC, Ajang R, Ogbeche J, Etta H, Etim L. Comparative seroprevalence and risk factors of toxoplasmosis among three subgroups in Nigeria. J Nat Sci Res. 2013; 3(8):23–8.
20. Nasir I, Aderinsayo A, Mele H, Aliyu M. Prevalence and associated risk factors of *Toxoplasma gondii* antibodies among pregnant women attending Maiduguri Teaching Hospital, Nigeria [Internet]; 2015. [Cited 2016 Aug 19]
Available:http://search.proquest.com/openview/3bd686fb868738b30e96e86b6fac5d48/1?pq-origsite=gscholar
21. Acharya D. Serological Screening of TORCH Agents as an etiology of spontaneous abortion in Dhulikhel Hospital, Nepal. Am J Biomed Life Sci. 2014;2(2):34.
22. Onadeko MO, Joynson DH, Payne RA, Francis J. The prevalence of toxoplasma antibodies in pregnant Nigerian women and the occurrence of stillbirth and congenital malformation. Afr J Med Med Sci. 1996;25(4):331–4.
23. Oyinloye OI, Okoyomo AA. Longitudinal evaluation of foetal transverse lie using ultrasonography: Original research article. Afr J Reprod Health. 2010;14(1):129–33.
24. Oyinloye SO, Igila-Atsibee M, Ajayi B, Lawan MA. Serological Screening for Ante-Natal Toxoplasmosis in Maiduguri Municipal Council, Borno State, Nigeria. Afr J Clin Exp Microbiol. 2014;15(2):91–6.
25. Jones JL, Kruszon-Moran D, Wilson M, McQuillan G, Navin T, McAuley JB. *Toxoplasma gondii* infection in the United States: Seroprevalence and risk factors. Am J Epidemiol. 2001;154(4):357–65.
26. Shalangwa I, Ajogi I, Udoudoh Umoh J, Lawal I, Randawa A. Seroprevalence and risk factors for *Toxoplasma gondii* Infection among antenatal women in Zaria. 2009; 4:483.
27. Studeničová C, Benčaiová G, Holková R. Seroprevalence of *Toxoplasma gondii* antibodies in a healthy population from Slovakia. Eur J Intern Med. 2006;1;17(7): 470–3.
28. Ballah FM, Maikai BV, Magaji AA, Shuaibu AB, El-Nafaty AU, Sambo YT, et al. Seroprevalence and risk of *Toxoplasma gondii* infection among pregnant women at Federal Teaching Hospital Gombe, Nigeria.
[Cited 2017 Jul 17]

Available:http://www.journalrepository.org/media/journals/AJMAH_48/2017/Mar/Shuaibu322017AJMAH31528.pdf

29. Wam EC, Sama LF, Ali IM, Ebile WA, Aghangu LA, Tume CB. Seroprevalence of *Toxoplasma gondii* IgG and IgM antibodies and associated risk factors in women of child-bearing age in Njinikom, NW Cameroon. BMC Res Notes [Internet]; 2016;9(1).
[Cited 2018 Jan 29]
Available:http://bmcresnotes.biomedcentral.com/articles/10.1186/s13104-016-2206-0
30. Tammam AE, Haridy MAM, Abdellah AH, Ahmed SR, Fayed HM, Alsammani MA. Seroepidemiology of *Toxoplasma gondii* infection in women with first trimester spontaneous miscarriage in qena governorate, egypt. J Clin Diagn Res JCDR. 2013;12:2870–3.
31. Vado-Solís IA, Suárez-Solís V, Jiménez-Delgadillo B, Zavala-Velázquez JE, Segura-Correa JC. *Toxoplasma gondii* presence in women with spontaneous abortion in Yucatan, Mexico. J Parasitol. 2013;99(2):383–5.
32. National population Commision, ICF international. Nigeria Demographic and Health Survey 2013 {FR293] - FR293.pdf [Internet]. Nigeria, maryland, USA: NPC,; 2013.
[Cited 2016 Oct 16]
Available:https://dhsprogram.com/pubs/pdf/FR293/FR293.pdf
33. Gharavi M, Oormazdi H, Roointan E. Conventional and Unconventional IgG and IgM Assays for Diagnosis of Toxoplasmosis; 2008.
34. Mwambe B, Mshana SE, Kidenya BR, Massinde AN, Mazigo HD, Michael D, et al. Sero-prevalence and factors associated with *Toxoplasma gondii* infection among pregnant women attending antenatal care in Mwanza, Tanzania. Parasit Vectors. 2013;6:222.
35. Lamichhane S, Subedi S, Ghimire SP, Chetri M, Banerjee B. Relationship of torch profile in first trimester spontaneous miscarriage. J Nobel Med Coll. 2016;5(2): 17–21.
36. Xiao Y, Yin J, Jiang N, Xiang M, Hao L, Lu H, et al. Seroepidemiology of human *Toxoplasma gondii* infection in China. BMC Infect Dis. 2010;10:4.
37. Gombe State. In: Wikipedia, the free encyclopedia [Internet]; 2015.
[Cited 2015 Dec 14]
Available:https://en.wikipedia.org/w/index.php?title=Gombe_State&oldid=690951542
38. Siddiqui N, Shujatullah F, Khan HM, Rabbani T, Khan PA. IgG avidity antibodies against *Toxoplasma gondii* in high risk females of reproductive age group in India. Korean J Parasitol. 2014;52 (5):487–91.
39. kamani J, Mani A, Egwu G, Kumshe H. Seroprevalence of human infection with *Toxoplasma gondii* and the associated risk factors, in Maiduguri, Borno state, Nigeria: Annals of Tropical Medicine & Parasitology: [Internet].
[Cited 2016 Aug 19].
Available:http://www.tandfonline.com/doi/abs/10.1179/136485909X435094
40. Wellington AO, Oladipo OO, Chimere OA, Oladele TO, Anunobi CC, K Soyebi. Congenital toxoplasmosis: A review of its pathology, immune response and current treatment options. Sierra Leone J Biomed Res. 2009;1(1):9–20.
41. Saki J, Mohammadpour N, Moramezi F, Khademvatan S. Seroprevalence of *Toxoplasma gondii* in women who have aborted in comparison with the women with normal delivery in Ahvaz, southwest of Iran. The Scientific World Journal Sci World J. 2015;764369–764369.
42. Wang SY, Remington JS. Toxoplasmosis in pregnancy. Clin Infect Dis Off Publ Infect Dis Soc Am. 1994;18(6):853–61.
43. Araoye MO. Research methodology with statistics for health and social sciences. First. Ilorin: Nathadex Publishers. 2004. 115–129.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/57635