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Awareness and habits of Nigerians towards toxoplasmosis and risk factors

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Abstract

Introduction: *toxoplasmosis is a zoonotic protozoan disease caused by Toxoplasma gondii, which is a main cause of death related to foodborne diseases in the United States. In Nigeria, the prevalence of toxoplasmosis is 25.5% in food animals and 32% in humans. This study was designed to provide information on the awareness of toxoplasmosis and practices that expose people to the risk of the disease in Nigeria.* ***Methods:*** *a cross-sectional survey was carried out using a structured questionnaire to gather quantitative data on socio-demographic factors, awareness, attitudes towards toxoplasmosis and risk factors. Chi-square test was used to evaluate the statistical difference.* ***Results:*** *a moderate (53%) awareness of toxoplasmosis was recorded. Respondents within the ages of 45-54 years old showed the highest (58%) level of awareness compared to the other groups. The age group 35-44 despite showing high level of awareness, are also highly exposed to the disease risk factors. There was generally a high (64%) level of exposure to toxoplasmosis risk factors. Age group 55 years and above were highest (81%) exposed. Respondents who were previously exposed to toxoplasmosis risk factors who also manifested toxoplasmosis-related syndromes following stress and immunosuppression were significantly higher.* ***Conclusion:*** *this study suggests an association of exposure to toxoplasmosis risk factors with miscarriages, seizures, schizophrenia and bad vision in the immune compromised and immune-depressed individuals. We recommend an investigation of toxoplasmosis in humans and animals, and a need for public health education on toxoplasmosis in Nigeria in order to prevent and control toxoplasmosis.*

Introduction

Toxoplasmosis is a zoonotic protozoan disease caused by the parasite *Toxoplasma gondii* [1]. It is one of the most neglected tropical diseases [2] which continues to affect most vulnerable populations particularly in low socio-economic countries [3]. Toxoplasmosis is listed among the leading causes of death related to food borne diseases in the U.S [4], and the third highest burden of foodborne disease in the Europe [5]. *Toxoplasma gondii* is a ubiquitous obligate intracellular parasite of virtually all warm-blooded animals including humans [6]. Its world-wide distribution is due to the ease with which it can be transmitted between the intermediate hosts [7]. The parasite has a complex life cycle alternating between asexual reproduction and sexual reproduction. The sexual stages of this parasite take place in the cat and other felines (which are the definitive hosts) while the asexual stages take place in various vertebrates (intermediate hosts) including rats and other rodents, chickens, dogs, pigs, goat, sheep, horses, cattle, marsupials and humans; therefore its zoonotic potentials [8], and all these animals could be potential reservoirs [3]. Toxoplasmosis is one of the most prevalent diseases world-wide [9, 10]. It is reported that 30% to 65% of all persons world-wide are exposed to *Toxoplasma gondii* [11,12]. The prevalence of toxoplasmosis in food animals is 25.5% in West Africa and Nigeria [13]. Ohiolei and Isaac [14] reported a 32% seroprevalence of human toxoplasmosis in Nigeria. Similarly, a seroprevalence of 35.77% was reported for pregnant women attending ante-natal clinic in Cameroon, a neighbouring country to Nigeria located in central Africa [15]. In a report, 78% of pregnant women in Nigeria were seropositive to toxoplasmosis and this high seroprevalence may be due to lack of control measures and poor awareness of the disease [14]. Despite the huge public health importance of toxoplasmosis, there is no control programme for toxoplasmosis in any part of Nigeria [2].

Toxoplasmosis is transmitted both horizontally (via ingestion of undercooked meat/contaminated food) and vertically from pregnant mother/dam to the foetus. The disease in humans is mostly contracted through eating raw or undercooked meat infected with *Toxoplasma gondii*. Undercooked meat has been reported to cause an estimated 50% of toxoplasmosis cases [16]. High

seroprevalence of antibodies against *Toxoplasma gondii* has been associated with the habit of eating rodents [12,17] and dog meat. Another major source of infection both to human and animals is ingestion of sporulated oocysts excreted by domestic cats [2]. Cockroaches and flies are also capable of contaminating food, dishes and drinking water when they make contact with feline faeces harbouring the oocysts which when ingested can lead to the transmission of the disease [3]. Neonates get infected transplacentally from infected mothers and the foetuses are either still-born or born alive but with severe nervous complications [18]. The definitive host (cats and other felines) get infected when they consume raw meat harbouring the cyst stages (bradyzoites) of the parasite [19]. This is most common in outdoor cats that hunt rats and other rodents as well as birds for food, thereby increasing the risk of the disease [4]. 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 [20] and the habit of eating rodents [17]. Others include eating raw vegetables and drinking unfiltered water [21].

The disease is asymptomatic in immune-competent individuals. It can, however, be severe in immune-compromised hosts (such as AIDS human patients), immunosuppressed hosts (patients receiving cancer treatment and organ transplant), in pregnancy and those receiving other immune depressing drugs such as steroids. This study assessed the level of awareness of Nigerians about toxoplasmosis and their attitudes towards toxoplasmosis risk factors. This will be valuable for effective control and possible elimination of toxoplasmosis, in line with the Sustainable Development Goal (SDG) 3.3 which aims at ending the epidemics of neglected tropical diseases by the year 2030 [22].

Methods

Study location: this study was carried out in Nigeria, a West African country located between longitude 3° and 15° east and between latitude 4° and 14° north. Nigeria is a multi-ethnic country with a population of over 206 million people [23]. The target population was made up of individuals across the six geopolitical zones of the country willing to provide consented information on their awareness, attitudes, and practices that are related to toxoplasmosis and its risk factor.

Study design: we used a cross-sectional survey in this study. A pre-tested questionnaire was developed to obtain information on the awareness and habits of Nigerians towards toxoplasmosis and its risk factors. The study was conducted from September 2020 to December 2020.

Sample size determination and sampling procedure: the sample size was determined based on 95% CI and 5% margin of error. An online survey sample size calculator [24] was used to obtain a minimum of 385 sample size. To achieve this sample size, 200 questionnaires were printed and distributed across the country, particularly among the population who may not have access to phone/computer with internet facilities. Google form was also designed for the questionnaire and the link sent across the country to contacts, who were also asked to send same to their contact lists and groups on social media.

Survey instrument: a structured questionnaire was used to obtain responses from the participants. We obtained socio-demographic data including gender, age group, level of education, ethnicity, geopolitical zone of residence and whether or not the respondent is a health worker. Awareness of the disease, its mode of transmission, clinical symptoms and risk factors were determined. Questions on attitude and practices that expose people to risk factors were also asked.

Validity and reliability of survey instrument: the content validity of the instrument was ensured by drawing questionnaire from reviewed literature, and was submitted to public health experts for scrutiny and necessary corrections. The reliability of the instrument was tested using a pre-test method. The questionnaire was administered to a few intended participants. Some of the questions were thereafter modified in order to improve clarity but ensuring the completeness of the content.

Statistical analysis: the data obtained were entered into Microsoft Excel spreadsheet and sorted according to each socio-demographic factors, and expressed as percentages. Descriptive statistics and chi square was also calculated using GraphPad Prism 5.0 (San Diego CA, USA) to evaluate the association between the demographic factors and awareness, attitudes and practices of the respondents. The percentage of respondents that answered "yes" to each group of questions on awareness, exposure/practice to risk factors, attitude towards risk factors were compared between the demographic factors. Data on the exposure to risk factors was also compared among those who have experienced syndromes similar to toxoplasmosis. The "yes" was compared with the "no", while the "maybe" and "not applicable" were regarded as no data. Values of $p \leq 0.05$ were considered significant.

Results

Socio-demographic characteristics of the study participants: a total of 448 respondents completed the questionnaire. Of the participants, 51.8% were male while 48.2% were female. The age group of 18-24 years old were 34.8%, 25-34 years old were 29%, 35-44 were 24.6%, 45-54 were 8.5%, while 55 years and above were 3.1%. Those that obtained primary school education were 2.2%, those with secondary school education were 12.9%, and those with tertiary education were 83.9% while those without formal education were 0.9%. With regards to ethnicity, 10.5% of the respondents were Hausa speaking, 11.9% were Yoruba, and 11.2% were Igbo, while other ethnicities made up of 66.3%. The respondents residing within the North West geopolitical region of the country were 5.4%, those within North East were 6.5%, those in North Central were 73.2%, those in South West were 7.1%, and those in South East were 4%, while those in South South were 3.8%. Twenty-nine percent of the respondents were health workers, while 71% were not.

Awareness of toxoplasmosis and risk factors: the awareness of Nigerians about toxoplasmosis and its risk factors is shown on Table 1 and Table 2. Out of a total of 402 participants that responded to questions on awareness of toxoplasmosis, 53% were aware of the disease, while 47% were not. There was a statistical significant difference between those that were aware of the disease and those that were not (χ^2= 324.3, df = 5, $p \leq 0.0001$). Males that showed awareness of the disease were 53% while 42% of the females were aware of the disease. There was no statistical significant difference between the level of awareness of toxoplasmosis and its risk factors based on gender (χ^2= 4.529, df = 5, p = 0.476). The age group of 18-24 showed 38% awareness, 25-34 showed 53% awareness, 35-44 showed 52% awareness, 45-54 showed 58% awareness, while 55 years and above showed 38% awareness. There was a slight statistical significant difference between the level of awareness among the different age groups (χ^2= 31.43, df = 20, p = 0.0498). Respondents that obtained primary school education showed 13% awareness, those that obtained secondary school education were 41%, tertiary education was 49%, while those that didn´t have formal education showed 4% awareness. There was statistical significant difference in the awareness of toxoplasmosis among the different level of education (χ^2= 92.4, df = 15, $p \leq 0.0001$). The awareness of toxoplasmosis according to ethnicity was 35%, 56%, 50%, and 39% for Hausa, Yoruba, Igbo, and other ethnicities respectively. There was statistical significant difference between the percentage of awareness of toxoplasmosis among

the ethnicities (χ^2= 50.0, df = 5, p ≤ 0.0001). Residents in North West were 43% aware, while those in North East, North Central, South West, South East and South South were 39%, 47%, 19%, 43%, and 36% aware respectively. The differences with respect to geopolitical zone of resident were significant statistically (χ^2= 69.9, df = 25, p ≤ 0.0001). There was 75% awareness among the health workers, while non-health workers showed 36% awareness. The differences were significant statistically (χ^2= 11.56, df = 5, p = 0.0414).

Exposure to risk factors: the exposure of Nigerians to toxoplasmosis risk factors is shown on Table 1 and Table 3. The overall exposure to toxoplasmosis risk factors was 64%. The percentage of male respondents exposed to toxoplasmosis risk factors (71%) were more than that of the females (57%). There was, however, no statistical significant difference between their exposure (χ^2= 2.881, df = 6, p = 0.8236). The age group of 18-24 showed 51% exposure to toxoplasmosis risk factors, while 25-34, 35-44, 45-54, 55 years and above showed 69%, 72%, 68%, and 81% exposure respectively. There was statistical significant difference in their exposure to the disease risk factors (χ^2= 119.7, df = 24, p ≤ 0.0001). Exposure to toxoplasmosis risk factors based on ethnicity was 59% for Hausa, 50% for Yoruba, 42% for Igbo, and 71% for other ethnicities; with a statistical significant difference (χ^2= 40.49, df = 18, p = 0.0018). 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 statistical significant difference as far as geopolitical zone of residence is concerned (χ^2= 105.4, df = 30, p ≤ 0.0001). Health workers showed 62% exposure, while respondents that are non-health workers showed 64% exposure. There was no statistical significant difference between their exposure to the risk factors (χ^2= 1.060, df = 6, p = 0.9832).

Attitude towards toxoplasmosis risk factors: the attitude/habit of eating undercooked meat and allowing pets to scavenge for food and hunt rodents was generally considered very good by 29 (6.5%), good by 90 (20%), bad by 133 (30%), very bad by 95 (21%), while 102 (23%) of the respondents were neutral. There was a statistical significant difference in the attitude of respondents towards the risk factors of toxoplasmosis (χ^2= 129.5, df = 4, p ≤ 0.0001). Majority of the male respondents (26%) and the females (34%) considered the habits bad. There was no statistical significant difference based on gender (χ^2= 1.337, df = 3, p = 0.7205). Higher proportion of those aged 18 - 24 (30%), 25 - 34 (42%) and 35 - 44 (31%) considered these habits as bad, while majority of respondents aged 45 - 54 (35%) and 55 and above (25%) considered these habits good with a statistical significant difference (χ^2= 45.48, df = 16, p = 0.0001). Thirty percent of respondents with primary level of education adjudged these habits as very bad, while 32% and 31% of those with secondary and tertiary levels of education respectively considered the habits bad. A higher percentage (63%) of those without formal education considered these habits good, and there was a statistical difference between their attitude towards these risk factors (χ^2= 134.3, df = 12, p ≤ 0.0001). Respondents of the different ethnic groups considered these habits bad with higher percentages (33% for Hausa and Yoruba, 36% for Igbo and 30% for "Others") but there was no statistical significant difference between their attitudes as far as ethnicity is concerned (χ^2= 11.78, df = 12, p = 0.4635). Majority of the six geopolitical zones considered the attitude of eating undercooked meat/contaminated food and allowing pets to hunt rodents bad. Forty percent for North West, 43% for North East, 27 % for North Central, 28% for South West, 33% for South East and 41% for South South. There was a significant difference statistically between their attitudes towards these risk factors (χ^2= 55.60, df = 20, p ≤ 0.0001). Majority of both the health workers (30%) and non-health workers (27%) considered these habits bad. There was no difference between their attitudes statistically (χ^2= 8.876, df = 4, p = 0.0643).

Exposure to toxoplasmosis risk factors and experiences of disease syndromes similar to toxoplasmosis: among the respondents who experienced miscarriage, 147 (73%) were exposed to toxoplasmosis risk factors, while 54 (27%) were not exposed to toxoplasmosis risk factors. There was a statistical significant difference between those exposed to risk factors and those not exposed (χ^2= 58.47, df = 7, p ≤ 0.0001). Respondents with experiences of mental derangement were 67 (73%) who were exposed to toxoplasmosis risk factors and 25 (27%) who were not exposed to the risk factors, with a statistical significant difference χ^2= 28.23, df = 7, p = 0.0002). Respondents with mental illness or bad sight following immunosuppression or immune-compromise were 52 (70%) who were also exposed to toxoplasmosis risk factors and 22 (30%) who were not exposed to the risk factors. There was a significant difference statistically between those exposed and those not exposed to the risk factors of toxoplasmosis (χ^2= 4.32, df = 7, p ≤ 0.0001). Respondents whose pets had abortion and who were also exposed to toxoplasmosis risk factors were 38 (86%), while those not exposed to risk factors were 6 (14%). The differences were not statistically significant (χ^2= 7.535, df = 7, p = 0.3753).

Discussion

Generally, the overall level of awareness of toxoplasmosis in this study was moderate (53%). This is, however, not good enough as almost one out of every two Nigerians is unaware of the disease according to this survey. The level of awareness in the male gender (53%) was not significantly higher than that of the female (42%). This suggests that gender may not be a factor when considering awareness to toxoplasmosis. There was, however, slight statistical difference (p = 0.0498) in the level of awareness to toxoplasmosis when comparing different age groups. Those 45-54 years old had the highest level of awareness (58%) which was similar to the findings from previous studies on seroprevalence of toxoplasmosis in some African countries where higher values were obtained in older people [15,25,26]. The low level of awareness in older people (55 years and above) reported in this study may lead to higher seroprevalence of toxoplasmosis in this age group. In relation to the level of education, the finding which showed that those with tertiary level of education were the most aware of toxoplasmosis, the least aware are those without formal education. This agrees with Bobic and co-workers [27] that lower educational level is associated with higher seroprevalence. It is worthy of note that many of those aware of toxoplasmosis are health workers, as they were significantly higher (75%, p = 0.00414) in awareness than the non-health workers (39%) who showed awareness to toxoplasmosis suggesting that they must have known about toxoplasmosis due to the privilege of their career and field of study. Ethnicity has been shown to play an important role in the awareness of Nigerians to toxoplasmosis and its risk factors. A high significant difference between the levels of awareness across different ethnicities is reported in this study, with the Yoruba speaking ethnicity showing the highest. This may be related to the general higher literacy level [28] of the Yoruba speaking ethnic group. However, respondents resident in the South West geopolitical zone showed the least awareness (19%) compared those residents in other geopolitical zones of the country. This is an important finding for concerned groups in choosing priority areas from where to start disease intervention and health education on toxoplasmosis.

The practices that lead to exposure to risk factors of toxoplasmosis varied across the different socio-demographic factors. Sixty-four percent of all respondents were exposed to the risk factors of toxoplasmosis. The implication is that, despite the awareness of the disease, the exposure rate to the risk factors is still very high. This highlights the need for public health education through various means to ensure both people in the rural and urban areas are educated on the disease, the risk factors and the consequences of their practices. There was appreciably high exposure in males (71%) compared to the females (57%) though not

statistically significant. Such high level of exposure warrants investigation of the disease. The exposure to risk factors was also highly different ($p \leq 0.0001$) among the different age groups, with those 55 years and above having the highest (81%) exposure. This can lead to high seroprevalence in older age groups, particularly that there is also low awareness (39%) among this same age group. More worrisome is the high (72%) exposure of the 35-44 years age group despite their relative good awareness (52%). Many who are aware of the disease, the risk factors and the consequences still expose themselves to the risk factors. This could imply that they knew about the disease but do not believe they can contract it.

Respondents who did not have any formal education had a very high (89%, $p \leq 0.0001$) exposure to risk factors. The higher the level of education, the less the exposure. However, it is worthy of note that respondents who are health workers had a similar ($p = 0.9832$) level of risk factor exposure compared to non-health workers, and the level of exposure is as high as 62% and 64% respectively. This implies that more than half of health workers are at risk of the disease despite having a significantly higher knowledge of the disease than the non-health workers. It should, however, be noted that the questions on the exposure to risk factors was not designed to identify the timeline of the exposure to the risk factors, and so they may be exposed before knowing about the disease. Other Nigerian ethnicities apart from the Hausa, Yoruba, and Igbo had the highest (71%, $p = 0.0018$) exposure to toxoplasmosis risk factors, while the least exposed were those of the Igbo ethnicity (42%). Over 62% of those resident in the North Central are exposed to the disease risk factors, and this is very significant ($p \leq 0.0001$). In an earlier report, Olusi and co-workers [17] associated high seroprevalence of toxoplasmosis in the region with the habit of eating rodents and dog meat. In our survey, these and other factors were widely practiced in the North Central, which is the reason for the high exposure rate compared to other ethnic groups and geopolitical zones. It is interesting, however, that the responses to questions on attitudes of the respondents towards eating undercooked meat and other risk factors showed that most respondents opined that it is bad (38%), and very bad (27%), although a large number (29%) were neutral. Because these group of respondents are undecided, they could change their attitude anytime to practise such eating habits that expose them to the risk of toxoplasmosis.

Respondents who (or their relatives) have experienced any disease syndrome similar to toxoplasmosis were sorted to compare those who, also, were exposed to the risk factors with those not exposed. Among those who experienced miscarriages, those exposed to toxoplasmosis risk factors were significantly higher ($p \leq 0.0001$) than those not exposed to the risk factors. This is similar to those with mental illness ($p = 0.0002$), and those who experienced bad sight or mental derangements like epileptic seizures, schizophrenia and so on after immune compromise, immune depression or stress ($p \leq 0.0001$). This may suggest an association of these syndromes with exposure to toxoplasmosis risk factors as earlier reported by several researchers [29,30]. However, pets that experienced abortion did not differ significantly in their exposure to toxoplasmosis risk factors.

Conclusion

This study revealed a moderate awareness of Nigerians about toxoplasmosis and its risk factors. But despite their knowledge, there appears to be a high level of exposure to the disease risk factors. There may be an association of the high exposure with high seroprevalence of the disease, as we also report an association between exposure to toxoplasmosis risk factors and syndromes similar to those of toxoplasmosis. We, therefore, recommend an investigation of the disease in both humans, food animals, pets, game animals and rodents. We also suggest an urgent need for public health education on toxoplasmosis to prevent the disease,

as there appear to be no control programme of toxoplasmosis in any geopolitical zone of Nigeria.

What is known about this topic

- *Toxoplasmosis is a zoonotic disease which can be transmitted by consumption of undercooked meat;*
- *Prevalence rate of toxoplasmosis in Nigeria is high;*
- *There is no established control programme of the disease in the study area.*

What this study adds

- *There is moderate awareness of toxoplasmosis in the study area;*
- *The awareness of the disease is higher in those that have formal education;*
- *Despite the level of toxoplasmosis awareness, there is high exposure to practices that facilitate the transmission of toxoplasmosis.*

Competing interests

The authors declare no competing interest.

Authors' contributions

All authors (SAO, AJJ, BOE) contributed to the study design. SAO drafted the manuscript, AJJ and BOE critically revised the manuscript and provided valuable inputs. All authors (SAO, AJJ, BOE) read and approved the final version of the manuscript.

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Tables

Table 1: summary of toxoplasmosis awareness, exposure to risk factors and its clinical syndromes

Table 2: relationship between demographic factors and toxoplasmosis awareness

Table 3: relationship between demographic factors and exposure to toxoplasmosis risk factors

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Table 1: summary of toxoplasmosis awareness, exposure to risk factors and its clinical syndromes

Demographic factors	**Frequencies (%)**					**P-value***
Awareness of toxoplasmosis and risk factors	Yes		No			0.0001
	52		47			
Exposure to toxoplasmosis risk factors	Yes		No			0.0001
	64		36			
Attitude towards habits leading to risk factors exposure	VG	G	B	VB	N	0.0001
	6.5	20	30	21	23	
Experiences of syndromes suggestive of toxoplasmosis following exposure to risk factors	Yes		No			0.0001
	73		27			
VG = very good, G = good, B = bad, VB = very bad, N = neutral *Chi-square test, p-value ≤ 0.05 is significant						

Table 2: relationship between demographic factors and toxoplasmosis awareness												
Demographic factors	**Frequencies (%)**											**P-value***
Gender	Male						Female					0.476
	53						42					
Age	18-24		25-34		35-44		45-54		55+			0.0498
	38		53		52		58		38			
Level of education	Primary		Secondary				Tertiary				None	0.0001
	13		41				49				4	
Ethnicity	Hausa		Yoruba			Igbo				Others		0.0001
	35		56			50				39		
Geopolitical zone of residence	NW		NE		NC		SW		SE		SS	0.0001
	43		39		47		19		43		36	
Medical knowledge	Health worker						Non-health worker					0.0414
	75						36					
NW = North West NE = North East NC = North Central SW = South West SE = South East SS = South South *Chi-square test, p-value ≤ 0.05 is significant												

Table 3: relationship between demographic factors and exposure to toxoplasmosis risk factors												
Demographic factors	**Frequencies (%)**											**P-value***
Gender	Male						Female					0.8236
	71						57					
Age	18 - 24		25-34		35-44		45-54		55+			0.0001
	51		69		72		68		81			
Level of education	Primary		Secondary			Tertiary				None		0.0001
	73		67			59				89		
Ethnicity	Hausa		Yoruba			Igbo				Others		0.0018
	59		50			42				71		
Geopolitical zone of residence	NW		NE		NC		SW		SE		SS	0.0001
	53		54		62		23		39		52	
Medical knowledge	Health worker						Non-health worker					0.9832
	62						64					
NW = North West NE = North East NC = North Central SW = South West SE = South East SS = South South *Chi-square test, p-value ≤ 0.05 is significant0												