

Knowledge, Attitudes and Occupational Practices for Toxoplasmosis Prevention among Slaughterhouse and Meat Shop Workers in Benue North-West Senatorial District, Nigeria: A Cross-Sectional Study

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Abstract

Background

Slaughterhouse and meat shop workers are high-risk groups for toxoplasmosis due to their daily contact with raw meat. Evaluation of knowledge, attitudes and practices (KAP) is crucial to tailor intervention and preventive measures to decrease occupational exposure to toxoplasmosis.

Methods

The present study evaluated knowledge, attitudes and practices of slaughterhouse and meat shop workers for toxoplasmosis prevention in the Benue north-west senatorial district of Benue State, Nigeria. A cross-sectional study was designed which involved 400 respondents in Makurdi and Gboko towns. A pre-tested structured questionnaire was administered to the respondents via interviews to collect data regarding socio-demographic characteristics and KAP concerning toxoplasmosis. Data were presented as frequencies and percentages, and associations between demographic variables and KAP were investigated using chi-square tests of independence, and significant variables were subjected to multivariate binary logistic regression.

Results

Study participants were predominantly male (99.3%), with 55% being over 30 years, and 62.3% attained secondary education. Generally, 2.3%, 47.8% and 61% of the respondents had good knowledge, positive attitudes and good occupational practices, respectively. Only 4.75% (19/400) had previously heard of toxoplasmosis, and more than 95% had no knowledge of the aetiology, transmission, clinical features, or preventive measures for it. Level of education ($p = 0.001$) significantly influenced respondents' knowledge of toxoplasmosis. More than 80% had no idea that slaughterhouse and meat shop workers are at higher risk of toxoplasmosis compared to the general population and that proper meat handling and hygiene practices can reduce the risk of toxoplasmosis. Level of education ($p = 0.000$) and years of experience ($p = 0.005$) significantly influenced the attitudes of the respondents. Primary job role in the slaughterhouse ($p = 0.000$) and job type ($p = 0.003$) significantly influenced the occupational practices of the respondents.

Conclusion

The findings from the study indicate that slaughterhouse and meat shop workers in the study area exhibit poor knowledge and engage in risky behaviours. The study recommends awareness and health education campaigns on toxoplasmosis and other meat-borne diseases targeting the study population, as they are high-risk groups due to the nature of their jobs.

Background

Toxoplasmosis is a zoonotic parasitic disease caused by *Toxoplasma gondii*, an obligate intracellular protozoan capable of infecting nearly all warm-blooded animals, including humans. Cats are the definitive hosts of the parasite, while warm-blooded animals, including humans, serve as intermediate hosts [1]. Parasite transmission to humans occurs primarily through ingestion of tissue cysts in undercooked meat, consumption of food or water contaminated with oocysts shed by cats (the definitive hosts), or via congenital infection [1]. While often asymptomatic in immunocompetent individuals, toxoplasmosis can cause severe complications in immunocompromised individuals and pregnant women, such as encephalitis, miscarriage, and congenital abnormalities [2]. Several sero-epidemiological studies have reported varying seroprevalence of toxoplasmosis in different populations globally [3, 4] and locally [5, 6, 7]. The disease's preventive approaches concentrate on food safety and hygienic practices. These include cooking meat to safe internal temperatures, avoiding consumption of raw or undercooked meat or seafood, washing hands and utensils after handling raw meat, and controlling cat populations to reduce environmental contamination with oocysts [8]. Public health strategies emphasise occupational hygiene, surveillance, and awareness campaigns to reduce exposure risks among high-risk groups. Slaughterhouse and meat shop workers are considered high-risk occupational groups due to their frequent contact with raw meat and animal tissues, which may harbour *Toxoplasma gondii* cysts. Studies have shown that inadequate hygiene, poor slaughterhouse infrastructure, and lack of protective equipment increase the likelihood of exposure [9, 10]. In Nigeria, abattoirs/slaughterhouses or slabs often operate under poor sanitary conditions, with limited enforcement of meat safety regulations, further heightening the risk of zoonotic transmission. Several studies have reported seroprevalence of *Toxoplasma gondii* infection in slaughterhouse workers and in workers occupationally exposed to animals globally [11, 12, 13, 14] and in Nigeria [15, 16, 17].

The Knowledge, Attitudes, and Practices (KAP) model is extensively used in public health research to systematically assess a population's understanding (knowledge), feelings (attitudes), and behaviours (practices) regarding health-related issues. The surveys typically employ structured questionnaires to gather both quantitative and qualitative data, revealing critical insights such as knowledge gaps, misconceptions, cultural beliefs, and risky behaviours that may influence health outcomes [18]. There are several reports of KAP surveys on toxoplasmosis for different populations globally [19, 20, 21], but there is only one similar study reported in Nigeria [22], which targeted Nigerians in general. This study differs from the published one by focusing on slaughterhouse and meat shop workers who are at risk of *Toxoplasma gondii* infection due to their occupation.

In Benue State, the knowledge, attitudes, and practices of slaughterhouse and meat shop workers towards toxoplasmosis remain largely undocumented, posing a potential risk for disease transmission. The level of knowledge among these workers is crucial, as improper meat handling and hygiene practices can facilitate the transmission of *Toxoplasma gondii* to the workers and consumers. Additionally, the attitudes of these individuals toward disease prevention measures can significantly influence their compliance with safety protocols. Furthermore, inadequate education on occupational

safety and poor compliance with personal protective equipment (PPE) use can lead to a higher risk of infection. The evaluation of KAP is necessary to tailor intervention measures to decrease occupational exposure and enhance the safety of meat consumption. Therefore, the present study aimed to evaluate the KAP of slaughterhouse and meat shop workers towards toxoplasmosis in the Benue North-West Senatorial District of Benue State, Nigeria.

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In Benue state, the knowledge, attitudes, and practices of slaughterhouse workers and meat shop workers towards toxoplasmosis remain largely undocumented, posing a potential risk for disease transmission. The level of knowledge among these workers is crucial, as improper meat handling and hygiene practices can facilitate the transmission of *Toxoplasma gondii* to the workers and consumers. Additionally, the attitudes of these individuals toward disease prevention measures can significantly influence their compliance with safety protocols. Furthermore, inadequate education on occupational safety and poor compliance with personal protective equipment (PPE) use can lead to a higher risk of infection. The evaluation of KAP is necessary to tailor intervention measures to decrease occupational exposure and enhance the safety of meat consumption. Therefore, the present study aimed to evaluate the KAP of slaughterhouse and meat shop workers towards toxoplasmosis in the Benue north-west senatorial district of Benue state, Nigeria.

Methods

The present study was carried out according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects. Ethical approval was obtained from the research ethics committee (Animal Ethics and Welfare Committee) of the College of Veterinary Medicine, Joseph Sarwuan Tarka University, Makurdi, Nigeria (reference number: JOSTUM/CVM/ETHICS/2025/21). Before the commencement of the study, preliminary visits were made to the slaughterhouse management and meat shops to discuss the study, and their permission and cooperation were sought. Participants were informed about the objectives of the study and that participation was voluntary and that they could withdraw from the study at any stage without any consequences. Only those who agreed (via verbal consent) to participate were involved in the study. Each participant was assigned an identity number, and the information of each participant was anonymised and securely stored on a computer.

Study area

The study was conducted in Benue State, Nigeria, which is located in the north-central geopolitical zone of the country. Benue State (Latitude 6° 25' N to 8° 8' N and Longitude 7° 47' E to 10° 0' E) shares boundaries with five other states, namely, Nasarawa State to the north, Taraba State to the east, Cross-River State to the south, Enugu State to the south-west, Kogi State to the west and the Republic of Cameroon to the south-east. Benue State is divided into three senatorial districts, namely, Benue north-east (zone A), Benue north-west (zone B) and Benue south (zone C) (Fig. 1). Study locations were Makurdi and Gboko towns, which are within the Benue north-west senatorial district (Zone B). There is no modern abattoir in the state, but there are slaughterhouses and slaughter slabs in the different local government areas of the state. Various slaughter slabs and markets within the study locations were visited, during which a questionnaire was administered to the workers of both slaughterhouses and meat shops. Inhabitants of the state commonly engage in farming, fishing and animal husbandry.

Study population

The study population included slaughterhouse and meat shop workers of both sexes. Other socio-demographic characteristics such as level of education, type of work, years of experience, primary job role in the slaughterhouse, and species of animal slaughtered/retailed were obtained.

Study design and study period

A cross-sectional study design was conducted from March 2025 to August 2025 to assess slaughterhouse and meat shop workers' knowledge, attitudes, and occupational practices that could influence toxoplasmosis transmission.

Sample size determination and sampling strategy

An expected prevalence of 50% was assumed since there were no reported studies in a similar target population in the country. Using the formula for calculating sample size for a cross-sectional study [23] and adopting a 95% confidence interval and 5% absolute error, the sample size was made up to 400 to account for any sampling errors. Using the purposive sampling method, slaughterhouse and meat shop workers who consented to the study were included in the study. This method of sampling was adopted because some individuals were not interested and cooperative in being included in the study, stating that it was a waste of their time. Hence, only individuals who cooperated were recruited. Those who did not consent to the study and those who were absent on the day of questionnaire administration were excluded from the study.

Method of data collection

Data collection

A validated structured questionnaire (Supplementary material 1) was used to collect data. The questionnaire was developed in the English language after a thorough review of literature. Afterwards, it was forwarded to public health experts who reviewed the items for content validity. Based on their feedback, modifications were made, and the questionnaire was subjected to reliability testing. Some of the questions were thereafter modified, ensuring completeness of the content. A final Cronbach's alpha value of 0.725 was achieved. Questions for KAP were closed-ended, and a face-to-face interview was employed to complete the questionnaire.

Measurement tools

Socio-demographic data

The socio-demographic data consisted of seven questions, which covered age, gender, type of work, level of education, years of experience, primary job role in the slaughterhouse and species of animal slaughtered/retailed.

Knowledge about toxoplasmosis

Seven questions were administered to assess the knowledge of slaughterhouse and meat shop workers regarding it. Questions included knowledge of toxoplasmosis aetiology, transmission, symptoms, prevention and control measures, and complications. Each correct response scored 1 point, while an incorrect and "I don't know" answer scored 0 points. Scores ≤ 3 were classified as poor knowledge, while scores of 4–7 were considered good knowledge.

Attitudes towards toxoplasmosis

Seven questions were administered to assess the attitudes of slaughterhouse and meat shop workers toward toxoplasmosis. Questions included attitudes towards risk of contracting toxoplasmosis, hand hygiene, eating or drinking while processing a carcass, interest in receiving training on toxoplasmosis prevention, screening for toxoplasmosis and willingness to inform employer if diagnosed with toxoplasmosis. Each correct response scored 1 point, while an incorrect and 'I don't know' answer scored 0 points. Scores ≤ 3 were classified as negative attitudes, while scores of 4–7 were considered positive attitudes.

Occupational practices towards toxoplasmosis prevention

Six questions were administered to assess the practices of slaughterhouse and meat shop workers that may influence the transmission/prevention of toxoplasmosis. Questions assessed practices while at work, including the use of personal protective equipment, hand hygiene, cleaning of work surfaces, eating or drinking while working and consumption of raw meat. Each correct response scored 1 point,

while an incorrect and 'I don't know' answer scored 0 points. Scores ≤ 3 were classified as poor practices, while scores of 4–6 were considered good practices. The proportion of each category for KAP was expressed as a percentage.

Other questions

Questions assessing participants' involvement in regular health checkups, participation in training on meat-borne diseases and willingness to be trained on hygienic practices during carcass processing were included in the survey instrument.

Data analysis

Data was collected using FormsApp and exported to IBM SPSS® Statistics vs 25.0 (IBM Corporation, NY, USA) for analysis. Descriptive statistics were performed, expressing the data in frequencies and percentages. Chi-square test of independence was used to assess significant association between socio-demographic variables and KAP. Variables assessed to be statistically significant at $p < 0.05$ were subjected to multivariate binary logistic regression using a backward elimination method to determine covariates that were significantly associated with KAP. P values < 0.05 were considered statistically significant, adopting a 95% confidence interval.

Results

Socio-demographic characteristics of the study participants

A total of four hundred individuals were recruited into the study, 200 each from Makurdi and Gboko towns. Slaughterhouse workers constituted 49% of the population, while meat shop workers were 51%. Most participants were male (99.3%) and were more than 30 years of age (62.3%). Most individuals had formal education (88.8%) and attained primary school education (47.8%). About half of the study participants had worked for more than ten (10) years in their facilities. For participants who worked in slaughterhouses, the primary roles of most participants were carcass processing (49.5%) and slaughtering (22.8%), while beef (46.8%) was mostly slaughtered/retailed by the participants, followed by pork (28.0%) (Table 1).

Table 1
Sociodemographic characteristics of study participants

Variable	Category	Frequency	(%)
Town	Makurdi	200	50.00
	Gboko	200	50.00
Gender	Male	397	99.30
	Female	3	0.70
*Age	< 20	16	4.00
	21–30	133	33.00
	>=31	249	62.25
Level of education	No formal education	45	11.25
	Primary	124	31.00
	Secondary	191	47.75
	Tertiary	40	10.00
Type of work	Slaughterhouse	196	49.00
	Meat shop	204	51.00
*Years of work experience	< 1	11	2.75
	1–5	87	21.75
	6–10	101	25.25
	11+	200	50.00
Primary job role in the slaughterhouse	Slaughtering	91	22.75
	Carcass processing	198	49.50
	Clean intestines	25	6.25
	Cleans slaughterhouse	22	5.50
	Meat retailer	64	16.00
Type of animal slaughtered/retailed	Cattle	187	46.75
	Goat	78	19.50
	Sheep	6	1.50
	Pig	112	28.00
	chicken	17	4.25

*Missing values were present in these two variables; age (2) and years of work experience (1) which were excluded from analysis. Hence, the total number of cases for the 2 variables was not 400.

Respondents' knowledge about toxoplasmosis

Results indicated that 2.3% (9/400) had good knowledge about toxoplasmosis, while 97.8% (391/400) had poor knowledge (Fig. 2). About 4.75% (19/400) reportedly have heard about toxoplasmosis. Out of this, 9 (47.4%) had good knowledge of toxoplasmosis. Results showed that 1.5% (6/400) of the respondents knew the causative agent of toxoplasmosis. Eight out of 400 respondents (2%) and 2.75% (11/400) stated at least one correct means of transmission and symptom of toxoplasmosis, respectively. About 97.8% (391/400) of the respondents had no knowledge of preventive measures against toxoplasmosis. About 1.75% (7/400) indicated that toxoplasmosis affects pregnant women and their unborn babies, while 2% (8/400) stated at least one complication of toxoplasmosis (Table 2).

Table 2
Knowledge about toxoplasmosis among study participants

Knowledge questions	Responses	N	%
Heard of toxoplasmosis	yes	19	4.75
	no	381	95.25
Causative agent of toxoplasmosis	Virus	1	0.25
	Bacteria	5	1.25
	Parasite	6	1.50
	I don't know	388	97.00
Transmission to humans	Contaminated water	1	0.25
	Consuming undercooked or raw meat	7	1.75
	Contact with infected cat faeces	0	0
	Mosquito bites	1	0.25
	Airborne transmission	1	0.25
	I don't know	390	97.50
Symptoms	Fever	9	2.25
	Muscle pain	2	0.50
	I don't know	389	97.25
Prevention and control	Cook meat properly	5	1.25
	Wash hands after handling raw meat	2	0.50
	All of the above	2	0.50
	I don't know	391	97.75
Toxoplasmosis affects pregnant women and their unborn babies	Yes	2	0.50
	No	5	1.25
	I don't know	393	98.25
Possible complications of toxoplasmosis	Flu-like condition	5	1.25
	Miscarriage/birth defects	2	0.50
	Skin rash	1	0.25

Knowledge questions	Responses	N	%
	I don't know	392	98.00
Toxoplasmosis treated with medication	Yes	9	2.25
	No	3	0.75
	I don't know	388	97.0

Respondents' attitudes towards toxoplasmosis

Results indicated that 47.8% (191/400) of the respondents had positive attitudes towards toxoplasmosis, while 52.3% (209/400) had negative attitudes (Fig. 2). About 13% (52/400) think that slaughterhouse and meat shop workers are at a higher risk of toxoplasmosis compared to the general population. Three hundred and thirty-four respondents did not know that proper meat handling can reduce the risk of toxoplasmosis infection, while 37% (148/400) suggested that it is safe to eat or drink when processing carcasses. About 84.75% (339/400) indicated interest in receiving training on toxoplasmosis prevention, and 75.25% (301/400) agreed that slaughterhouse and meat shop workers should undergo routine screening. While 16.25% (65/400) are very concerned about contracting toxoplasmosis at work, 39% (156/400) indicated that they would inform their employers or colleagues if diagnosed with toxoplasmosis (Table 3).

Table 3
Attitudes towards toxoplasmosis among study participants

Attitude questions	Responses	N	%
Do you think slaughterhouse and meat shop workers are at higher risk of toxoplasmosis compared to the general population?	Yes	52	13.00
	No	18	4.50
	I don't know	330	82.50
Do you believe that proper meat handling and hygiene practices can reduce the risk of toxoplasmosis infection?	Yes	66	16.50
	No	12	3.00
	I don't know	322	80.50
Do you believe it is safe to eat or drink when processing carcasses/selling meat?	Yes	148	37.00
	No	148	37.00
	I don't know	104	26.00
Would you be interested in receiving training on toxoplasmosis prevention	Yes	339	84.75
	No	61	15.25
Do you think slaughterhouse and meat shop workers should undergo routine screening for toxoplasmosis?	Yes	301	75.25
	No	22	5.50
	I don't know	77	19.25
How concerned are you about contracting toxoplasmosis at work?	Very concerned	65	16.25
	Somewhat concerned	231	57.75
	Not concerned	104	26.00
If diagnosed with toxoplasmosis, would you inform your employer or colleagues?	Yes	156	39.00
	No	179	44.75
	Not sure	65	16.25

Respondents' occupational practices that may influence toxoplasmosis transmission/prevention

Conversely, results showed that 61% (244/400) had good practices while 39% (156/400) had poor practices (Fig. 2). While 91% (364/400) do not wear protective gloves while handling raw meat, 91.75% (367/400) have never consumed raw meat. While 60.75% (243/400) reportedly do not wash their hands with soap and water after handling raw meat, 95.25% (381/400) clean and wash their work surfaces after handling raw meat. Sixty-two percent (248/400) stated that they eat or drink while working, while 70.5% (282/400) clean their work tools daily (Table 4).

Table 4
Occupational practices among study participants

Practice questions	Responses	N	%
Wear protective gloves while handling raw meat	Always	4	1.00
	Sometimes	32	8.00
	Never	364	91.00
Wash hands with soap after handling raw meat	Always	7	1.75
	Sometimes	150	37.50
	Never	243	60.75
Consumed raw meat	Frequently	7	1.75
	Occasionally	26	6.50
	Never	367	91.75
Clean and wash work surfaces after handling raw meat	Yes	381	95.25
	No	19	4.75
Frequency of cleaning work tools	After every use	85	21.25
	Daily	282	70.50
	Weekly	19	4.75
	Rarely	14	3.50
Eat or drink while working	Yes	248	62.00
	No	152	38.00

Respondents' views on health checkups and meat hygiene trainings

About 94.75% (379/400) and 97.75% (391/400) stated that they do not receive regular health checkups related to occupational hazards and have not received training on foodborne diseases, including

toxoplasmosis, respectively. Three hundred and fifty-three respondents indicated interest in receiving training on hygienic practices during carcass processing (Table 5).

Table 5 Responses regarding health checkups and meat hygiene training among the study participants			
Questions	Responses	N	%
Do you receive regular health checkups related to occupational hazards?	Yes	21	5.25
	No	379	94.75
Have you ever received training on foodborne diseases, including toxoplasmosis?	Yes	9	2.25
	No	391	97.75
Would you be interested in receiving training on hygienic practices during carcass processing?	Yes	353	88.25
	No	47	11.75

Association between socio-demographic characteristics of the study population and knowledge about toxoplasmosis

Results showed that level of education ($p = 0.000$) and the type of work ($p = 0.004$) had a significant association with the knowledge of toxoplasmosis (Table 6). When subjected to multivariate binary logistic regression, only level of education remained significant. Results indicated that individuals that had primary level of education were less likely to have good knowledge of toxoplasmosis compared to individuals with tertiary education ($p = 0.001$, OR = 0.033, 95% CI = 0.004–0.270) (Table 7).

Table 6 **should be placed here.**

Table 6 Association between socio-demographic characteristics of the study participants and their knowledge about toxoplasmosis

Variable	Category	Total	Knowledge		P value
			Good (%)	Poor (%)	
Town	Makurdi	200	4 (2.00)	196 (98.00)	0.736
	Gboko	200	5 (2.50)	195 (97.50)	
Gender	Male	397	9 (2.30)	388 (97.70)	1.000
	Female	3	0 (0)	3 (100.00)	
*Age	<20	16	(0)	16 (100.00)	0.590
	21-30	133	2 (1.50)	131 (98.50)	
	>=31	249	7 (2.80)	242 (97.20)	
Education level	NFE	45	0 (0)	45 (100.00)	0.000
	primary	124	1 (0.80)	123 (99.20)	
	Secondary	191	0 (0)	191 (100.00)	
	Tertiary	40	8 (20.00)	32 (80.00)	
Work type	Slaughterhouse	196	0	196 (100.00)	0.004
	Meat shop	204	9 (4.40)	195 (95.60)	
*Years of work experience	<1	11	0 (0)	11 (100.00)	0.908
	1-5	87	2 (2.30)	85 (97.70)	
	6-10	101	3 (3.00)	98 (97.00)	
	11+	200	4 (2.00)	196 (98.00)	
Primary job role in the slaughterhouse	Slaughtering	91	0	91	0.244
	Carcass processing	198	6(3.00)	192(97.00)	
	Clean intestines	25	0	25(100.00)	
	Cleans slaughterhouse	22	0	22(100.00)	
	Retails meat	64	3(4.70)	61(95.30)	
Animal slaughtered/meat retailed	Cattle	187	3(1.60)	184(98.40)	0.106
	Goat	78	2(2.60)	76(97.40)	

Sheep	6	0	6(100.00)
Pig	112	2(1.80)	110(98.20)
chicken	17	2(11.8)	15(88.20)

NFE = no formal education, *Missing values were present in these two variables; age (2) and years of work experience (1) which were excluded from analysis. Hence, the total number of cases for the 2 variables was not 400.

Table 7
Binary logistic regression result of association between level of education and respondents' knowledge of toxoplasmosis.

	Category Comparisons	P value	OR	95%CI
	*NFE	0.018		
1	Primary vs NFE	0.998	1.3133939×10^7	0.000
2	Secondary vs NFE	1.000	1.000	0.000
3	Tertiary vs NFE	0.997	4.03868625×10^8	0.000
4	**Primary vs Tertiary	0.001	0.033	0.004–0.270

*Reference category = NFE (no formal education), **Tertiary is the reference category in this comparison.

Association between socio-demographic characteristics of the study population and attitudes towards toxoplasmosis transmission

Results showed that age ($p = 0.000$), level of education ($p = 0.000$), work type ($p = 0.003$), years of experience ($p = 0.000$) and the primary job role in the slaughterhouse ($p = 0.000$) significantly influenced the attitudes of the respondents (Table 8). When subjected to multivariate binary logistic regression, only level of education and years of work experience remained highly significant (Table 9). Individuals with secondary ($p = 0.001$, OR = 3.788, 95%CI = 1.749–8.204) and tertiary ($p = 0.000$, OR = 9.641, 95%CI = 3.487–26.656) education were more likely to have positive attitudes towards toxoplasmosis prevention compared to individuals with no formal education (Table 9). Conversely, individuals who had worked for 10 years or less were less likely to have positive attitudes compared to those who had worked for more than 10 years ($p < 0.05$) (Table 9).

Table 8 **should be placed here.**

Table 8 Association of socio-demographic characteristics of study participants and their attitudes towards toxoplasmosis

Variable	Category	Total	Attitude		P value
			Positive (%)	Negative (%)	
Town	Makurdi	200	103(51.50)	97(48.50)	0.110
	Gboko	200	88(44.00)	113(56.00)	
Gender	Male	397	190(47.90)	207(52.10)	1.000
	Female	3	1(33.30)	2(66.70)	
*Age	<20	16	2(12.50)	14(87.50)	0.000
	21-30	133	52(39.10)	81(60.9)	
	>=31	249	136(54.60)	113(45.40)	
Education level	NFE	45	10(22.20)	35(77.80)	0.000
	primary	124	44(35.50)	80(64.50)	
	Secondary	191	107(56.00)	84(44.00)	
	Tertiary	40	30(75.00)	10(25.00)	
Work type	Slaughterhouse	196	79(40.30)	117(59.70)	0.003
	Meat shop	204	112(54.90)	92(45.10)	
*Years of work experience	<1	11	4(36.40)	7(63.60)	0.000
	1-5	87	37(42.50)	50(57.50)	
	6-10	101	33(32.70)	68(67.30)	
	11+	200	116(58.0)	84(42.00)	
Primary job role in the slaughterhouse	Slaughtering	91	41(54.10)	50(54.90)	0.000
	Carcass processing	198	104(52.5)	94(47.50)	
	Clean intestines	25	7(28.00)	18(72.00)	
	Cleans slaughterhouse	22	2(9.10)	20(90.90)	
	Retails meat	64	37(57.80)	27(42.20)	
Animal slaughtered /meat retailed	Cattle	187	93(49.70)	94(50.30)	0.724
	Goat	78	40(51.30)	38(48.70)	
	Sheep	6	3(50.00)	3(50.00)	

Pig	112	48(42.90)	64(57.10)
chicken	17	7(41.20)	10(58.80)

NFE = no formal education, *Missing values were present in these two variables; age (2) and years of work experience (1) which were excluded from analysis. Hence, the total number of cases for the 2 variables was not 400.

Table 9
Binary logistic regression result for significant variables that influenced attitudes of respondents towards toxoplasmosis transmission

Variable Comparisons	P value	Adjusted OR	95%CI
Level of education	0.000		
Primary vs *NFE	0.147	1.819	0.810–4.088
Secondary vs *NFE	0.001^	3.788	1.749–8.204
Tertiary vs *NFE	0.000^	9.641	3.487–26.656
Years of work experience	0.005		
< 1 vs *11+	0.154	0.378	0.099–1.438
1–5 vs *11+	0.030^	0.549	0.319–0.943
6–10 vs *11+	0.001^	0.424	0.251–0.715
*Reference category = NFE (no formal education) and 11+, ^significant association, OR = odds ratio, CI = confidence interval			

Association between socio-demographic characteristics of the study population and occupational practices towards toxoplasmosis prevention

At univariate analysis, age ($p = 0.010$), work type ($p = 0.030$), years of work experience ($p = 0.000$), primary job role in the slaughterhouse ($p = 0.001$) and the type of animal carcass processed or retailed ($p = 0.015$) significantly influenced the practices of the respondents (Table 10). When subjected to multivariate binary logistic regression, primary job role in the slaughterhouse and type of work remained significant ($p < 0.05$) (Table 11). Individuals that clean intestines ($p = 0.038$, OR = 0.383, 95% CI = 0.154–0.950) and sell meat in the slaughterhouse ($p = 0.000$, OR = 0.196, 95% CI = 0.080–0.481) were less likely to have good practices when compared to those who are engaged in slaughtering (Table 11). Meat shop workers are 2.5 times more likely to exhibit good occupational practices than slaughterhouse workers ($p = 0.003$, OR = 2.520, 95%CI = 1.357–4.678) (Table 11).

Table 10 **should be placed here.**

Table 10 Association of socio-demographic characteristics of the study participants and their practices towards toxoplasmosis prevention

Variable	Category	Total	Practices		P value
			Good (%)	Poor (%)	
Town	Makurdi	200	117(58.50)	83(41.50)	0.305
	Gboko	200	127(63.50)	73(36.50)	
Gender	Male	397	241(60.70)	156(39.30)	0.285
	Female	3	3(100.00)	0(0)	
*Age	<20	16	5(31.30)	11(68.80)	0.010
	21-30	133	75(56.40)	58(43.60)	
	>=31	249	163(65.50)	86(34.50)	
Education level	NFE	45	20(44.40)	25(55.60)	0.116
	primary	124	78(62.90)	46(37.10)	
	Secondary	191	120(62.80)	71(37.20)	
	Tertiary	40	26(65.00)	14(35.00)	
Work type	Slaughterhouse	196	109(55.60)	87(44.40)	0.030
	Meat shop	204	135(66.20)	69(33.80)	
*Years of work experience	<1	11	2(18.2)	9(81.80)	0.000
	1-5	87	40(46.00)	47(54.00)	
	6-10	101	62(61.40)	39(38.60)	
	11+	200	139(69.50)	61(30.50)	
Primary job role in the slaughterhouse	Slaughtering	91	57(62.60)	34(37.40)	0.001
	Carcass processing	198	138(69.70)	60(30.30)	
	Clean intestines	25	10(40.0)	15(60.00)	
	Cleans slaughterhouse	22	10(45.50)	12(54.50)	
	Retails meat	64	29(45.30)	35(54.70)	
Animal slaughtered /meat retailed	Cattle	187	107(57.20)	80(42.80)	0.015
	Goat	78	49(62.80)	29(37.20)	
	Sheep	6	3(50.00)	3(50.00)	

Pig	112	68(60.70)	44(39.30)
chicken	17	17(100.00)	0(0)

NFE = no formal education, *Missing values were present in these two variables; age (2) and years of work experience (1) which were excluded from analysis. Hence, the total number of cases for the 2 variables was not 400.

Table 11

Multivariate binary logistic regression results for significant variables that influence respondents' occupational practices.

Variable Comparisons	P value	Adjusted OR	95%CI
Primary role in the SH	0.000		
Carcass processing vs *slaughtering	0.383	0.748	0.390–1.436
Cleans intestine vs *slaughtering	0.038^	0.383	0.154–0.950
Cleans SH vs *slaughtering	0.106	0.458	0.177–1.181
Retails meat vs *slaughtering	0.000^	0.196	0.080–0.481
Work type			
Meat shop vs slaughterhouse worker	0.003^	2.520	1.357 – 4.678
*Reference category = slaughtering, ^significant association, SH = slaughterhouse, OR = odds ratio, CI = confidence interval			

Association between awareness, knowledge, attitudes and occupational practices of slaughterhouse and meat shop workers towards toxoplasmosis prevention

Results indicated a statistically significant association between awareness of toxoplasmosis and practices ($p = 0.009$). Individuals who reportedly indicated that they have heard of toxoplasmosis were 5.8 times more likely to have good occupational practices than those who have not heard about the disease ($OR = 5.767$; 95% CI = 1.313–25.316) (Table 12). Conversely, knowledge of toxoplasmosis did not significantly influence the occupational practices of the respondents ($p = 0.097$). The association between the attitudes of the respondents and their occupational practices was highly significant ($p = 0.000$). Individuals that had positive attitudes were 2.9 times more likely to have good occupational practices (Table 12). Similarly, the respondents' knowledge of toxoplasmosis significantly influenced their attitudes towards its transmission ($p = 0.016$). Individuals who had good knowledge of toxoplasmosis were 9 times more likely to have good attitudes towards toxoplasmosis than those who had poor knowledge (Table 12).

Table 12

Association between awareness, knowledge, attitudes and occupational practices of study participants towards toxoplasmosis

Variable	Occupational Practices					
	Category	Good (%)	Poor (%)	P value	OR	95%CI
Heard of toxoplasmosis	Yes	17(89.50)	2(10.50)	0.009	5.767	1.313–25.316
	No	227(59.60)	154(40.40)			
	Total	244(61.00)	156(39.00)			
Knowledge of toxoplasmosis	Good	8(88.90)	1(11.10)	0.097	5.254	0.651–42.425
	Poor	236(60.40)	155(39.6)			
	Total	244(61.00)	156(39.00)			
Attitude towards toxoplasmosis	Positive	141(73.80)	50(26.20)	0.000	2.902	1.904–4.423
	Negative	103(49.30)	106(50.70)			
	Total	244(61.00)	156(39.00)			
Attitude of Respondents						
	Category	Positive (%)	Negative (%)	P value	OR	95%CI
Knowledge of toxoplasmosis	Good	8(88.90)	1(11.10)	0.016	9.093	1.127–73.392
	Poor	183(46.80)	208(53.20)			
	Total	191(47.80)	209(52.30)			

Discussion

The knowledge, attitudes and practices framework is a widely used tool to understand how people think, feel and behave regarding specific topics [24]. Results from the current study indicated that slaughterhouse and meat shop workers in the Benue north-west senatorial district of Benue State, Nigeria, had overall poor knowledge and poor attitudes but indicated good occupational practices towards toxoplasmosis prevention. As of the time of this study, there is no published report on the KAP of slaughterhouse and meat shop workers towards toxoplasmosis in Nigeria. But there is a report on KAP of Nigerians towards toxoplasmosis [22] and KAP of abattoir workers towards meat safety [25]. These studies indicated moderate knowledge of toxoplasmosis and poor knowledge of meat safety,

respectively. Two recent studies reported on the occupational risk factors for *T. gondii* among abattoir workers and meat handlers in Jos [26] and attitudes and practices of workers in slaughter facilities in Kaduna [27].

The poor knowledge and attitude recorded in the current study are a result of a lack of awareness and education on meat-borne diseases, including toxoplasmosis, as 97.75% of respondents stated that they have not received training on meat-borne diseases prior to the study. Greater knowledge of toxoplasmosis is expected to shape the perception, leading to more informed, proactive and positive attitudes towards the disease. This rationale is validated, as there was a significant association between knowledge of toxoplasmosis and attitudes towards the disease among the study population, as individuals who had good knowledge were 9 times more likely to exhibit positive attitudes towards the disease. Compared with previous studies [21, 22, 28], this study recorded a higher proportion of individuals with poor knowledge of toxoplasmosis. This difference could be due to the educational level of the study population, as previous studies included health workers. The current study reflects that the disease is not known among this high-risk population. Since the disease is not given priority in health education programmes, high-risk groups such as slaughterhouse and meat shop workers might subject themselves to risky practices.

The evidence shows that insufficient knowledge or health education regarding toxoplasmosis among slaughterhouse and meat shop workers influenced their attitudes towards the disease, as only 13% of respondents perceived themselves to be at a higher risk of infection. The majority were unaware that proper meat handling could mitigate the risk of toxoplasmosis infection, and only a small number expressed concern about the possibility of being infected at work.

Contrastingly, the majority (61%) of the respondents exhibited good occupational practices that would not predispose them to toxoplasmosis. Some of the favourable practices recorded in the study included not consuming raw meat, cleaning of work surfaces after handling raw meat, and daily cleaning of work tools after use. Based on food habits, Nigerians typically do not eat raw meat (by cultural norm). This good practice excludes individuals from contracting infectious diseases that can be got through eating raw meat. But at the same time, poor hand hygiene can predispose such individuals to various infections. Cleaning work surfaces and tools after use significantly reduces the risk of contracting toxoplasmosis by eliminating the parasite before it can be ingested or transferred. These good practices help protect vulnerable populations such as immunocompromised individuals and pregnant women, as they are at high-risk for severe toxoplasmosis with resulting grave consequences [1]. Additionally, cleaning surfaces doesn't just target *Toxoplasma*; it also reduces the spread of other harmful pathogens like *Salmonella*, *Listeria* and *Escherichia coli*.

On the other hand, most respondents exhibited unfavourable practices such as not wearing protective gloves and not washing hands with soap and water after handling meat and eating or drinking while at work. These are risky behaviours that are likely to influence toxoplasmosis transmission [11, 26]. Previous studies reported similar work behaviours among slaughterhouse workers [25, 29].

The present study demonstrated a statistically significant association between attitudes and occupational practices towards toxoplasmosis among the study population. This finding suggests that workers' perceptions, beliefs, and dispositions towards toxoplasmosis prevention may influence the extent to which they adopt protective behaviours during slaughtering, meat processing, and meat sales. In practical terms, workers who regard toxoplasmosis as a serious occupational and public-health risk are more likely to support and practise preventive measures such as consistent handwashing, appropriate use of gloves and other personal protective equipment (PPE), safe handling of offal and animal tissues, cleaning and disinfection of work surfaces, and avoidance of eating or drinking while handling raw meat. This result is consistent with a recent study [27]. This outcome aligns with the behavioural foundation of the knowledge–attitude–practice model, where attitude serves as the motivational connection between recognising a health risk and engaging in preventive actions [30]. A favourable attitude may increase workers' perceived susceptibility to infection and the perceived benefits of protective measures. Conversely, workers who consider toxoplasmosis unimportant, unavoidable, or unrelated to their occupation may be less motivated to comply with recommended safety procedures. The significant association observed in this study therefore indicates that improving occupational practices should not depend solely on providing information; it should also address workers' perceptions of risk and the practical value of prevention.

However, the observed association may not necessarily mean a positive attitude automatically guarantees safe practice. Workplace conditions and structural constraints also shape occupational behaviour. Even when workers possess favourable attitudes towards occupational hygiene, inadequate infrastructure; limited access to water and handwashing facilities; insufficient PPE; and weak institutional support may restrict their ability to practise recommended preventive measures [10]. Workers may understand the importance of PPE but fail to use it consistently because gloves or protective clothing are unavailable, uncomfortable, damaged, or unsuitable for the work environment. In addition, limited access to water, soap, handwashing facilities, waste-disposal systems, sanitation infrastructure, supervision, and periodic training can prevent workers from translating favourable attitudes into routine practices.

Results from the current study agree with previous reports that level of education has a significant association with the knowledge of toxoplasmosis [21, 22]. There are seroepidemiological studies that demonstrated a significant association between level of education and *T. gondii* seropositivity [27, 31], indicating that lower education levels are correlated with higher *T. gondii* seroprevalence. The current study showed that with a higher level of education, an individual becomes more aware of the dangers of exposure to toxoplasmosis. It is expected that individuals at various educational levels exhibit differing awareness of health issues, hygiene practices, and lifestyle factors that influence disease exposure risk. Although meat shop workers significantly had more knowledge of toxoplasmosis than slaughterhouse workers, this variable was not significant in multivariate analysis.

Similarly, the level of education had a significant influence on attitudes, as individuals with higher education were more likely to have positive attitudes towards toxoplasmosis. Educated workers tend to

adopt positive attitudes towards preventive measures of a disease such as hand washing, use of protective wears, cleaning and disinfection of work tools, etc. Those with lower education levels may view such practices as unnecessary or burdensome, leading to risky behaviours.

Results from this study indicated that individuals with fewer years on the job (10 years or less) were less likely to have positive attitudes towards toxoplasmosis. This could be explained by various factors such as a knowledge gap in disease transmission, attitude formation over time, lower practical experience with zoonotic risks, and limited exposure to safety training. Years of work experience were not a significant factor in an earlier study [25], as the range considered in the study was 1 to 3 years, which is less than in the current study (1 to > 10 years).

The primary job role in the slaughterhouse and type of work were two highly significant socio-demographic factors that influenced the occupational practices of the respondents. Results indicated that individuals who cleaned intestines were less likely to have good practices compared to those who engaged in animal slaughter. This is most likely due to the exposure of these individuals to animal gut content and heavily contaminated environments. Poor hygiene and lack of awareness may expose these individuals to toxoplasmosis. Meat shop workers were shown to be more likely to exhibit good practices when compared to slaughterhouse workers. This is so because the work environment of meat shop workers is less hazardous, more customer-facing, and requires stricter hygiene standards to maintain consumer trust. Slaughterhouse workers handle freshly slaughtered animals, increasing direct contact with tissues that may contain *T. gondii* cysts. Meat shop workers deal with already processed meat, reducing direct exposure to infected tissues.

The current study has shown that respondents that were aware of toxoplasmosis were more likely to have good occupational practices, stressing the need for public education and awareness campaigns about the dangers of toxoplasmosis exposure. It is worrying to note that the majority of these high-risk groups for toxoplasmosis do not receive regular health checkups and have not received training on foodborne or meat-borne diseases. Adequate knowledge about the disease will positively influence the attitudes of workers, thereby reducing risky behaviours at work.

Limitation of the study

The study assessed knowledge, attitudes, and practices without conducting serological tests to confirm actual infection status. This prevented the ability to compare reported KAP with true infection risk. The study relied on self-reported responses, which are subject to recall bias and social desirability bias. Some workers may have overstated or understated their hygiene practices or attitudes. Participants were selected based on willingness to participate, which may not accurately represent all slaughterhouse and meat shop workers in the study locations.

Conclusion and recommendation

The findings of this study indicate that slaughterhouse and meat shop workers in the North Central senatorial district of Benue State, Nigeria, have poor knowledge and poor attitudes but reportedly showed good occupational practices towards toxoplasmosis prevention. The level of education significantly influenced the knowledge and attitudes of the respondents, while their primary job role in the slaughterhouse and the type of work they performed significantly affected their occupational practices. The authors recommend a One Health approach in mitigating the risk of toxoplasmosis transmission in Benue State. Awareness campaigns, proper training and continuing education for slaughterhouse workers and meat shop workers on the risks, prevention, and safe handling of meat are essential. Addressing poor environmental hygiene, inadequate hygiene facilities, and implementing effective standard operating procedures within slaughterhouses/abattoirs are crucial steps to prevent exposure to toxoplasmosis.

Table 6

Association between socio-demographic characteristics of the study participants and their knowledge about toxoplasmosis

Variable	Knowledge				
	Category	Total	Good (%)	Poor (%)	P value
Town	Makurdi	200	4 (2.00)	196 (98.00)	0.736
	Gboko	200	5 (2.50)	195 (97.50)	
Gender	Male	397	9 (2.30)	388 (97.70)	1.000
	Female	3	0 (0)	3 (100.00)	
*Age	< 20	16	(0)	16 (100.00)	0.590
	21–30	133	2 (1.50)	131 (98.50)	
	>=31	249	7 (2.80)	242 (97.20)	
Education level	NFE	45	0 (0)	45 (100.00)	0.000
	primary	124	1 (0.80)	123 (99.20)	
	Secondary	191	0 (0)	191 (100.00)	
	Tertiary	40	8 (20.00)	32 (80.00)	
Work type	Slaughterhouse	196	0	196 (100.00)	0.004
	Meat shop	204	9 (4.40)	195 (95.60)	
*Years of work experience	< 1	11	0 (0)	11 (100.00)	0.908
	1–5	87	2 (2.30)	85 (97.70)	
	6–10	101	3 (3.00)	98 (97.00)	
	11+	200	4 (2.00)	196 (98.00)	
Primary job role in the slaughterhouse	Slaughtering	91	0	91	0.244
	Carcass processing	198	6(3.00)	192(97.00)	
	Clean intestines	25	0	25(100.00)	
	Cleans slaughterhouse	22	0	22(100.00)	
	Retails meat	64	3(4.70)	61(95.30)	

Variable	Knowledge				
	Category	Total	Good (%)	Poor (%)	P value
Animal slaughtered/meat retailed	Cattle	187	3(1.60)	184(98.40)	0.106
	Goat	78	2(2.60)	76(97.40)	
	Sheep	6	0	6(100.00)	
	Pig	112	2(1.80)	110(98.20)	
	chicken	17	2(11.8)	15(88.20)	

NFE = no formal education, *Missing values were present in these two variables; age (2) and years of work experience (1) which were excluded from analysis. Hence, the total number of cases for the 2 variables was not 400.

Table 8

Association of socio-demographic characteristics of study participants and their attitudes towards toxoplasmosis

Variable	Attitude				
	Category	Total	Positive (%)	Negative (%)	P value
Town	Makurdi	200	103(51.50)	97(48.50)	0.110
	Gboko	200	88(44.00)	113(56.00)	
Gender	Male	397	190(47.90)	207(52.10)	1.000
	Female	3	1(33.30)	2(66.70)	
*Age	< 20	16	2(12.50)	14(87.50)	0.000
	21–30	133	52(39.10)	81(60.9)	
	>=31	249	136(54.60)	113(45.40)	
Education level	NFE	45	10(22.20)	35(77.80)	0.000
	primary	124	44(35.50)	80(64.50)	
	Secondary	191	107(56.00)	84(44.00)	
	Tertiary	40	30(75.00)	10(25.00)	
Work type	Slaughterhouse	196	79(40.30)	117(59.70)	0.003
	Meat shop	204	112(54.90)	92(45.10)	
*Years of work experience	< 1	11	4(36.40)	7(63.60)	0.000
	1–5	87	37(42.50)	50(57.50)	
	6–10	101	33(32.70)	68(67.30)	
	11+	200	116(58.0)	84(42.00)	
Primary job role in the slaughterhouse	Slaughtering	91	41(54.10)	50(54.90)	0.000
	Carcass processing	198	104(52.5)	94(47.50)	
	Clean intestines	25	7(28.00)	18(72.00)	
	Cleans slaughterhouse	22	2(9.10)	20(90.90)	
	Retails meat	64	37(57.80)	27(42.20)	
Animal slaughtered /meat retailed	Cattle	187	93(49.70)	94(50.30)	0.724

Variable	Attitude				
	Category	Total	Positive (%)	Negative (%)	P value
	Goat	78	40(51.30)	38(48.70)	
	Sheep	6	3(50.00)	3(50.00)	
	Pig	112	48(42.90)	64(57.10)	
	chicken	17	7(41.20)	10(58.80)	

NFE = no formal education, *Missing values were present in these two variables; age (2) and years of work experience (1) which were excluded from analysis. Hence, the total number of cases for the 2 variables was not 400.

Table 10

Association of socio-demographic characteristics of the study participants and their practices towards toxoplasmosis prevention

Variable	Practices				
	Category	Total	Good (%)	Poor (%)	P value
Town	Makurdi	200	117(58.50)	83(41.50)	0.305
	Gboko	200	127(63.50)	73(36.50)	
Gender	Male	397	241(60.70)	156(39.30)	0.285
	Female	3	3(100.00)	0(0)	
*Age	< 20	16	5(31.30)	11(68.80)	0.010
	21–30	133	75(56.40)	58(43.60)	
	>=31	249	163(65.50)	86(34.50)	
Education level	NFE	45	20(44.40)	25(55.60)	0.116
	primary	124	78(62.90)	46(37.10)	
	Secondary	191	120(62.80)	71(37.20)	
	Tertiary	40	26(65.00)	14(35.00)	
Work type	Slaughterhouse	196	109(55.60)	87(44.40)	0.030
	Meat shop	204	135(66.20)	69(33.80)	
*Years of work experience	< 1	11	2(18.2)	9(81.80)	0.000
	1–5	87	40(46.00)	47(54.00)	
	6–10	101	62(61.40)	39(38.60)	
	11+	200	139(69.50)	61(30.50)	
Primary job role in the slaughterhouse	Slaughtering	91	57(62.60)	34(37.40)	0.001
	Carcass processing	198	138(69.70)	60(30.30)	
	Clean intestines	25	10(40.0)	15(60.00)	
	Cleans slaughterhouse	22	10(45.50)	12(54.50)	
	Retails meat	64	29(45.30)	35(54.70)	
Animal slaughtered /meat retailed	Cattle	187	107(57.20)	80(42.80)	0.015

Variable	Practices				
	Category	Total	Good (%)	Poor (%)	P value
	Goat	78	49(62.80)	29(37.20)	
	Sheep	6	3(50.00)	3(50.00)	
	Pig	112	68(60.70)	44(39.30)	
	chicken	17	17(100.00)	0(0)	

NFE = no formal education, *Missing values were present in these two variables; age (2) and years of work experience (1) which were excluded from analysis. Hence, the total number of cases for the 2 variables was not 400.

Abbreviations

KAP Knowledge Attitude and Practices

PPE Personal Protective Equipment

NFE No Formal Education

Declarations

Ethics Approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the research ethics committee (Animal Ethics and Welfare Committee) of the College of Veterinary Medicine, Joseph Sarwuan Tarka University, Makurdi, Nigeria (reference number: JOSTUM/CVM/ETHICS/2025/21). Informed consent to participate was obtained from all of the participants in the study.

Clinical trial number

Not applicable

Consent for publication:

Not applicable

Competing interests:

The authors declare that they have no competing interests.

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Author Contribution

INN drafted and substantially revised the manuscript based on feedback of other authors. RRM, EGH, HID, ID, NHM, TAD, MAS, JOO and CAA have substantially revised the manuscript by providing feedback and suggestions for revisions. INN, RRM, EGH, HID, ID, NHM, TAD, MAS, JOO and CAA contributed to the conception of the work. INN, RRM, EGH, HID, ID, NHM, TAD, MAS, JOO and CAA contributed to the design of the study. RRM, EGH, HID, ID, NHM, TAD, MAS, and JOO contributed to data collection. INN and JOO contributed to data analysis. INN and CAA contributed to the supervision of the study. All authors have approved the submitted version of the manuscript.

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Data Availability

The data generated during the current study are available from the corresponding author on reasonable request.

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Figures

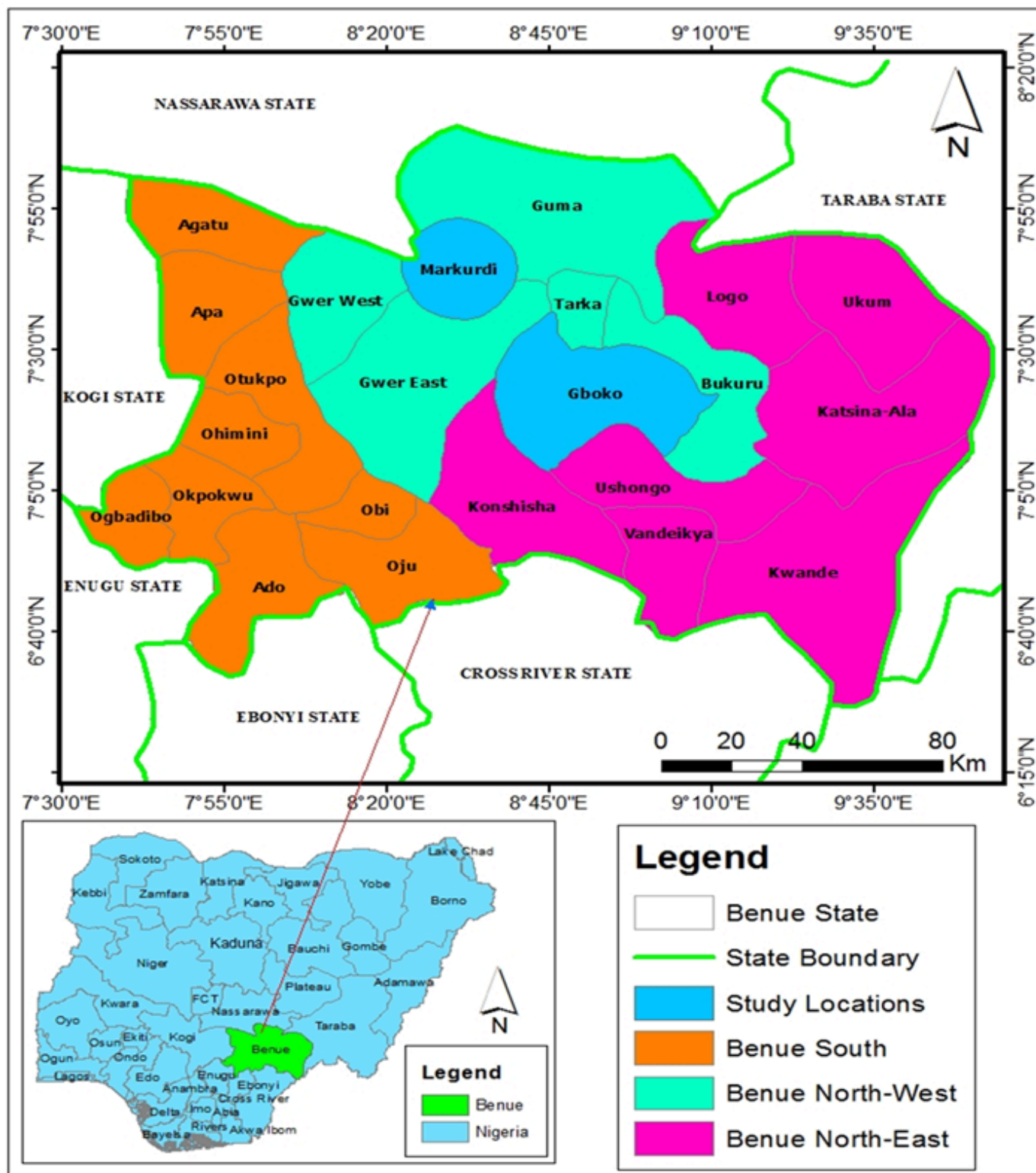


Figure 1

Map of the study area showing study locations. (Source: extracted and modified from the administrative map of Nigeria)

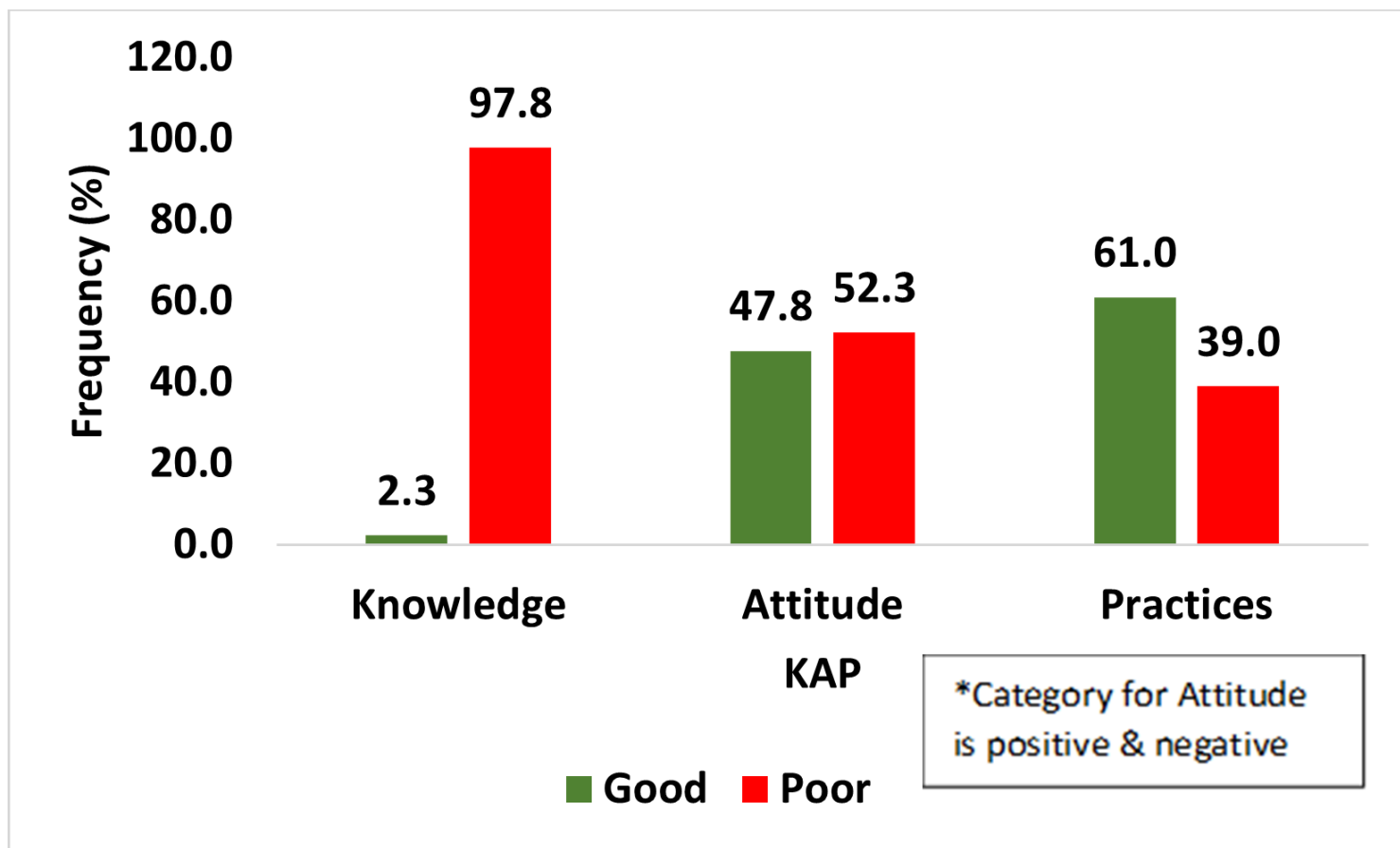


Figure 2

Knowledge, attitudes and practices for toxoplasmosis among study participants in Benue north-west senatorial district, Nigeria.

Supplementary Files

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