Nigerian Journal of Parasitology
ISSN 1117 4145 Volume 44[1] March, 2023

Seroprevalence of Human Cysticercosis in Amper and Kabwir Districts of Kanke Local Government Area of Plateau State, Nigeria

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Abstract
Human cysticercosis is an important public health problem, particularly in developing countries. The seroprevalence of human cysticercosis in Amper and Kabwir Districts of Kanke Local Government Area of Plateau State was studied between January and March 2019. Blood samples were collected from 151 individuals in the study area. Serum was obtained and Enzyme-Linked ImmunoSorbent Assay (ELISA) was performed to determine the prevalence of 1gG antibodies to cysticercosis. Forty-one (41) out of 151 individuals were positive for human cysticercosis giving a seroprevalence of 27.15%. Seroprevalence was higher in females (29.87%) than in males (24.32%) however, this was not statistically significant ($p>0.05$). Age group 41 to 50 years had the highest (33.33%) seroprevalence of infection while individuals 51 years and above had the lowest (16.67%) seroprevalence. Other risk factors that influenced seroprevalence include the source of drinking water, the type of toilet system used, and the rearing of pigs. Good sanitary measures are suggested to combat this infection.

Keywords: Human cysticercosis, seroprevalence, ELISA, Kanke.

Introduction

Cysticercosis is the infection of various tissues caused by the larval stage of the tapeworm *Taenia solium* (*T. solium*) which is acquired by the ingestion of eggs of the parasite released from taeniasis carriers [1]. It is a health problem, particularly in developing countries. Cysticercosis, a disease caused by infection with the larval stage of *Taenia solium* is reported to be one of the most potentially lethal helminthic infections in humans and is an important public health problem worldwide [2]. It is a parasitic infection caused by the metacestode larval stage (cysticercus) of *Taenia solium* [3]. *Taenia solium* cysticercosis is considered an emerging parasitic zoonosis of global importance due to its impact on agriculture and public health in developing countries [4]. In Nigeria, *T. solium* cysticercosis is a problem in rural areas where most pigs are kept and in urban areas where infected pork can be consumed [5]. In developing countries including Nigeria, cysticercosis is highly endemic in all areas where pigs, cattle and dog raising is practised [6]. The World Health Organization considers *Taenia solium* taeniosis/cysticercosis an eradicable disease based on the simple life cycle of the parasite and the availability of powerful and inexpensive disease control tools [7]. Poor sanitary conditions free

The foregoing study on pages 110-116 was submitted in July 2022.
https://dx.doi.org/10.4314/njpar.v44i1.11

roaming of domestic pigs and lack of awareness of the disease play an important role in the perpetuation of *Taenia solium* taeniosis and cysticercosis in Africa [8].

Cysticercus cellulosae can infect man either through the ingesting of eggs of *T. solium* with food (vegetable, fruits) and water contaminated by faeces of Taenia carriers [9], or by autoinfection when a man harbouring adult worms swallows the eggs because of unhygienic personal habits or by reverse peristaltic movements of the intestine whereby gravid segments are thrown into the stomach [10]. This is equivalent to the swallowing of thousands of eggs. Further development of *C. cellulosae* in man is like that in the pig. Autoinfection is frequent in humans. In West Africa, while a high prevalence of cysticercosis in pigs and humans has occasionally been reported, there is a lack of a consistent and systematic approach in the study of the disease which may result in misestimating its prevalence [3].

In humans, the Cysticerci may develop in any organ and their effects depend entirely on their location [11]. Symptoms of Cysticercosis depending on the location of the cysts are seizures, decreased vision/blindness, abnormal heart rhythms/heart failures, and weakness/changes in walking due to damage to nerves in the spine [12]. The larval stage of the pork tapeworm (*T. solium*) infects the human nervous system, causing neurocysticercosis. This disease is one of the main causes of epileptic seizures in humans in many less developed countries and is also increasingly seen in more developed countries because of immigration from endemic areas [13]. In West Africa, cysticercosis in both pigs and man has been reported in Benin, Burkina Faso, Ghana, Ivory Coast and Togo. In some regions of Nigeria, the prevalence of porcine cysticercosis and human taeniasis (20.5% and 8.6% respectively) is quite high [14]. In a study conducted in 2013, among pig rearers in Jos, a prevalence of 9.6% of human Cysticercosis was reported [5]. Similarly, the prevalence of 14.3% of human Cysticercosis in Kaduna Metropolis was reported in 2015 [4]. Immunoglobulin G (IgG) is the predominant Ig detected in cysticercosis: IgA, IgE and IgM antibodies are of little value in diagnosis and cannot be correlated with the patient's clinical condition [15]. A study was conducted in 2016 on the sensitivity of IgG ELISA for diagnosing cysticercosis in high-risk groups in and around Aligarh District of Uttar Pradesh, India. NovaTex. *Taenia solium* IgG-ELISA kit was used to detect antibodies against *Taenia solium*. Two (7.4%) out of the 27 participants were positive for immunoglobin G antibodies for cysticercosis [1]. The two (2) positive cases were males, (out of 25) while none of the 2 females was positive. Also, the 2 positive males were above 45 years of age.

Materials and Methods

Study Area

The study was carried out in Kanke Local Government Area of Plateau State, Nigeria. Kanke Local Government Area is in the Central Senatorial Zone of the State. The two (2) communities, Amper and Kabwir where the sample collection was done are two (2) rural communities in Kanke LGA where farming is the main occupation of the inhabitants and pig rearing is a common feature in almost every home.

Fig.1: Map of Plateau State showing Study Area

Sample Size

One hundred and fifty-one (151) willing and consenting individuals.

The sample size was determined by the formula given by [16]

Ethical Clearance

Ethical clearance was obtained from the Plateau State Ministry of Health. Ethical clearance Reference Number: MOH/MIS/202/VOL.T/X. from the Plateau State Ministry of Health, Jos. In addition, permission was sought and obtained from local authorities.

Participants were informed through district/ward heads after permission was obtained from the health department of the Kanke Local Government Area.

Oral consent was sought from willing adults while young children below 18 years of age, were accompanied by a parent who gave an oral consent Informed consent of willing individuals was sought to collect their blood samples.

Sample Collection
Human blood samples were collected from 151 willing and consenting individuals. Five (5) ml of venous blood were obtained intravenously by a professional from each and transferred into properly labelled sterile vacutainer tubes, then transported to the Mycoplasma Laboratory, Bacterial Research Division of National Veterinary Research Institute (NVRI) Vom on ice packs. The blood samples were allowed to clot standing at 4°C in a refrigerator. Serum was obtained by centrifuging at 3200xg for 5 minutes, aliquoted into 1.8ml cryovials, and then stored at -20°C until analysed for cysticerci antibodies using 1gG ELISA technique.

Questionnaires were administered to everyone to obtain information such as age, gender, occupation, presence, or absence of a toilet in the home, type of toilet (if present), hand washing habit, source of drinking water, rearing of pigs, deworming and knowledge of cysticercosis

Detection of immunoglobin G (1gG) antibodies in sera using Enzyme Linked Immuno Sorbent Assay (ELISA) technique.
The method used by [4, 5] was adopted using previously from semen. 1gG antibodies to cysticercosis were detected in sera using commercially prepared and purchased microwell ELISA Kits (APDIA) following the manufacturer's instruction. Previously frozen serum was allowed to thaw, and dilution was done using the dilution buffer provided in the ELISA kit. The steps were:

- One hundred (100) ul of pre-diluted negative and positive controls as well as the diluted test sera were added into controls as well as the diluted test sera were added into individual wells and labelled appropriately.
- Incubation at 20°C for 10 minutes.
- Contents of wells were shaken, washed out with diluted wash buffer then blotted dry to remove excess moisture.
- Some drops of enzyme conjugate were added to each and then incubated again at room temperature (25°C) for 5 minutes.
- Contents of the well were shaken again, washed with wash buffer then excess moisture was removed.
- Two (2) drops of Chromogen Tetramethyl Benzidine substrate solution were added to each well and then incubated at room temperature for 5 minutes.
- Two (2) drops of stop solution (Phosphoric acid) were added to the well and mixed.
- Results were read using an ELISA reader while positive or negative results were based on the cut-off provided by the manufacturer of the ELISA kit.

Statistical Analysis
The questionnaire interview data were analysed for the relationship between seroprevalence of human cysticercosis and hypothesized risk variables of toilet system, boiling of drinking water, rearing of pigs near the compound, vegetable garden near pigsty, regular deworming, and knowledge of human cysticercosis. Pearson Chi-square was used to test for significance at $\alpha = 0.05$. The data were analysed using SPSS (version 25).

Results
The overall seroprevalence of human cysticercosis in Amper and Kanke Districts of Kanke Local Government Area was 27.15% as shown in Table 1. Out of 151 individuals that were examined, 41 were positive for human cysticercosis.

In relation to gender, females had a higher seroprevalence (29.87%) than males (24.30%). Twenty-three (23) out of 77 females were positive, while 18 out of 74 males were positive for human cysticercosis. The difference was not statistically significant.

Table 1: Seroprevalence of Human cysticercosis Detected by 1gG ELISA in Relation to Gender in Amper and Kanke Kabwir Districts of Kanke Local Government Area of Plateau State.

Gender	No. Examined	No. Positive (%)
Male	74	18 (24.32%)
Female	77	23 (29.87%)
Total	151	41 (27.15%)

Regarding age, individuals aged between 41 to 50 had the highest (33.33%) seroprevalence. This was followed by the age group 0 to 10 years (31.67%). The lowest prevalence was observed in individuals aged 51 years and above (16.67%). The difference was also not significant statistically.

Table 2: Seroprevalence of Human cysticercosis detected by 1gG ELISA in relation to Age in Amper and Kabwir Districts of Kanke Local Government Area of Plateau State.

Age Groups (years)	No. Examined	No. Positive (%)
0 – 10	60	19 (31.67)
11 – 20	47	10 (21.28)
21 – 30	13	4 (30.77)
31 – 40	13	4 (30.77)
41 – 50	6	2 (33.33)
51 and above	12	2 (16.67)
Total	151	41 (27.15)

Univariate Analysis of hypothesized risk factors of boiling drinking water (OR = 2.749; 95%, CI = 1.090 – 6.927) was significantly associated with human cysticercosis ($p<0.05$). Toilet system (OR = 0.954; 95%, CI = 0.0442 – 2.059). Rearing of pigs near compound (OR = 1.137, 95%, CI = 0.528 – 2.446). Vegetable garden near pigsty (OR = 1.043, 95%, CI = 0.395 – 2.740), Regular Deworming (OR = 1.240, 95%, CI = 0.596 – 2.579) and Knowledge of cysticercosis (OR = 1.077, 95%, CI = 0.201 – 5.781) were not significantly associated with human cysticercosis ($P>0.05$). The distribution and odds ratio of significant risk factors concerning the infection are shown in table 3.

Discussion

The overall seroprevalence of human cysticercosis in the study area which was 27.15% was significantly higher than results obtained by some other researchers in Nigeria and Africa. In a study conducted on the prevalence of human cysticercosis in Jos, Plateau State, a prevalence of 9.6% was reported [5]. In another study in Kaduna metropolis in 2015, a seroprevalence of 14.3% was reported [4] In an investigation of the seroprevalence of human cysticercosis among pig rearers and their children in some parts of Plateau North a prevalence of 20.8% was obtained [17]. In the Eastern province of Zambia, a seroprevalence of between 12.2 % to 14.5% from a community-based longitudinal study carried out there was obtained [18]. Also, a seroprevalence of 21.8% among people with epilepsy in Southern Rwanda was reported in 2013 [19]. Cysticercosis is a zoonotic neglected disease of significant public health importance, which is responsible for severe health disorders such as seizures and even death.

In relation to gender, there was no significant difference in infection among males and females ($x>0.05$). This means that both males and females have equal chances of being infected.

This is similar to the result obtained in Jos in 2012 where although female pig rearers had a higher seroprevalence than males (11.1 versus 6.8), the difference was not significant [3]. Similarly, in Kaduna metropolis, a study carried out in 2015 on the seroprevalence of human cysticercosis and it is associated risk factors showed that sex is not a risk factor as both males and females were seen to be equally predisposed to infection [4].

In relation to age, the highest prevalence was recorded in the age group of 41 – 50 years, while the least was in those aged 51 years and above. Statistically, there was no significant difference thus age is not a risk factor in relation to infection. Various risk factors such as the presence of a toilet system in

Table 3: Seroprevalence of cysticercosis in relation to Knowledge, Attitudes and Practices of Individuals in Amper and Kabwir Districts of Kanke Local Government Area of Plateau State.

Factor	Level	No. Examined	No. Positive (%)	p-value
Occupation	Farming	28	6 (21.43)	0.56
	Students	99	29 (29.29)	
	Civil Servants	6	1 (16.67)	
	Others	21	8 (38.10)	
Presence of Toilet System	Yes	49	13 (26.56)	0.20
	No	102	28 (27.45)	
Hand washing after toilet	Yes	135	35 (25.93)	0.325
	No	16	6 (37.5)	
Source of Drinking Water	Pipe/Tap	2	0 (0)	0.20
	Well	49	9 (18.37)	
	Borehole	88	30 (34.09)	
	River/Stream	9	2 (22.22)	
	Others	3	0 (0)	
Boiling of drinking water	Yes	38	10 (26.31)	0.028
	No	113	31 (27.43)	
Rearing of Pigs in/near the compound	Yes	100	28 (28.0)	0.743
	No	51	13 (25.4)	

the home, boiling of drinking water, rearing of pigs in or near the compound, having a vegetable garden near the pigsty, regular deworming of the participant and knowledge of human cysticercosis were tested in relation to infection. Only boiling drinking water was significantly associated with infection. One hundred and thirteen (113) out of the 151 participants did not boil their drinking water and 31(27.43%) of these were positive for human cysticercosis. The odds ratio of 2.749 and the p-value of 0.028 were obtained. For other risk factors such as occupation, source of drinking water and method of pig rearing, the Chi-square value in each case was higher than 0.05.

Conclusion

This study has shown that the seroprevalence of human cysticercosis in the study area is of public health interest. Public enlightenment is important since the awareness about the disease in the area is low. Regular hand washing especially after defecating should be encouraged and emphasized to prevent infection and autoinfection. House owners should be encouraged to build toilets in their homes to reduce open or indiscriminate defecation. Vegetables should also be properly washed before consumption to reduce infection to the barest minimum.

Acknowledgements

We acknowledge the Health Department of Kanke Local Government Area, Plateau State for their cooperation. We also acknowledge the staff of the Mycoplasma Laboratory, Bacterial Research Division of NVRI, Vom for their help in carrying out the analysis.

Declarations

Ethics Approval

Ethical clearance was obtained from the Plateau State Ministry of Health. In addition, permission was sought and obtained from local authorities. Informed consent of willing individuals was sought to collect their blood samples.

Authors' Contributions

FOK, JAY and CMA conceptualized the study; FOK and JAY designed the study. FOK, JAY and CMA participated in the fieldwork and data collections JAY performed the data analysis, FOK and CMA interpreted the data. FOK prepared the first draft of the manuscript, reviewed by CMA and JAY. All authors contributed to the development of the final manuscript and approved its submission.

Conflict of Interest

The authors declare that there is no conflict of interest.

Funding Source

Funding was by TETFUND

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Citation
Kum, F. O., Yohanna, J. A., and Adeiyongo, C. M. (2023). Seroprevalence of Human Cysticercosis in Amper and Kabwir Districts of Kanke Local Government Area of Plateau State, Nigeria. *Nigerian Journal of Parasitology* 44(1) 110-116

https://dx.doi.org/10.4314/njpar.v44i1.11

Nigerian Journal of Parasitology
ISSN 1117 4145 Volume 44[1] March, 2023