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Seroprevalence of human cysticercosis and its associated risk factors among humans in areas of Kaduna metropolis, Nigeria

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Abstract

Introduction: *Taenia solium* cysticercosis is considered an emerging parasitic zoonosis of global importance due to its impact on both agriculture and public health in developing countries. Epidemiological information on human cysticercosis is limited in Nigeria. This study was conducted to determine the seroprevalence of human cysticercosis in areas of Kaduna metropolis, Nigeria, where small-holder pig farming is practiced.

Methodology: A cross-sectional survey was conducted in Kaduna South and Chikun Local Government Areas of Kaduna metropolis, which are widely involved in small-holder pig farming and pork consumption. A total of 300 human sera were collected and tested for the presence of IgG antibodies to *T. solium* using an enzyme-linked immunosorbent assay (ELISA) technique. A structured questionnaire was used to identify risk factors in the population and was administered to the study population.

Results: A total of 43 of 300 sera tested positive to IgG antibodies, indicating a cysticercosis prevalence of 14.3%. Method of pork preparation and history of epilepsy were found to be strongly associated with seropositivity. Epileptics in this study were two times more likely to be seropositive than non-epileptics. A large proportion (74.0%) of the population had very poor knowledge of cysticercosis, and knowledge of cysticercosis was strongly associated with method of pork preparation and respondents' occupations.

Conclusions: A high seroprevalence of human cysticercosis was found in Kaduna South and Chikun Local Government Areas. The main risk and behavioral factors contributing to the high prevalence include poor knowledge of cysticercosis and lack of knowledge on proper pork preparation methods.

Key words: seroprevalence; *Taenia solium*; cysticercosis; IgG antibodies; ELISA.

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Introduction

Taenia solium is a parasitic helminth known to cause cysticercosis and taeniasis in its hosts. Cysticercosis, a disease caused by infection with the larval stage of *T. solium*, is reported to be one of the most potentially lethal helminthic infections in humans and is an important public health problem worldwide [1]. Humans and pigs acquire cysticercosis by ingesting *T. solium* eggs shed in the feces of humans with taeniasis [2]. Upon ingestion, eggs result in larval worms that migrate to different parts of the human and pig via the circulatory system, forming cysts and resulting in cysticercosis. The major migration site in humans is the central nervous system (CNS), and this results in human neurocysticercosis (NCC). NCC is considered the most important parasitic disease affecting the nervous system and accounts for about 30% of all acquired epilepsy cases in endemic areas [3] associated with considerable morbidity [4]. Taeniasis occurs only in the human host after ingestion of undercooked pork infected with cysticerci; this later develops into an adult tapeworm in the intestine. Unlike cysticercosis, taeniasis has no life-threatening symptoms; nevertheless, its diagnosis is important because of the risk of cysticercosis posed to both the carrier and other people in contact with the carrier. Cysticercosis and taeniasis are strongly associated with poverty, poor hygiene/sanitation, free-range pig husbandry, and lack of meat inspection [5].

Prevalence of human cysticercosis has been reported in South Africa (7.4%), Mozambique (20.5%), Democratic Republic of Congo (21.6%), Eastern Zambia (5.8%) [6], and Mbozi district of Tanzania (45.3%) [7] by researchers using different

diagnostic methods. Though efforts in recent times have been made to document porcine cysticercosis in Nigeria [8-10], reliable epidemiological information on human cysticercosis is still limited, even among at-risk groups. This cross-sectional survey is a baseline study that aimed to establish the prevalence of human cysticercosis in some pig-producing areas of Kaduna metropolis, Nigeria, where preexisting data was unavailable.

Methodology

Ethical statement

The study was approved by the Academic Research Board, Department of Microbiology, A.B.U., Zaria and the Kaduna State Ministry of Health, Nigeria (MOH/ADM/744/VOL 1). Prior to sample collection, a forum was organized within the community to explain the purpose of the study to willing participants. Participants were recruited for the survey based on their willingness to participate in the study, and written informed consent was then sought from them. For minors involved in the study, written consent of either their parents or guardians was obtained.

Study area and population

Kaduna metropolis is characterized by a high population density of 1,570,331, with a household population of 314,066 [12,13]. Kaduna metropolis is divided into Kaduna North, Kaduna South, Igabi, and Chikun Local Government Areas. Kaduna South and Chikun Local Government Areas of Kaduna metropolis were selected for the study because pig rearing and pork consumption were common in those areas. A pilot survey in the area revealed small-holder/backyard pig farming and a lack of regular use of veterinary services by pig farmers. Many pork-sale outlets were also common in the communities. Other animals such as cattle, poultry, and goats were also reared in these areas, and the communities practiced subsistence farming. The study area was divided into four areas for easy generation of samples: Sabon Tasha and Television, Ungwan Romi and Gonin Gora, Baranawa and Narayi, and Nasarawa and Kakuri.

Study design and sampling

A descriptive and cross-sectional study was conducted between November 2012 and May 2013. Inclusion criteria for participants were eating pork or being in close contact with people who either eat pork or rear pigs within the home. A structured questionnaire was designed to address relevant information on socio-demographics, pork preparation methods, pig rearing methods, hygiene/behavioral practices, and household conditions. A total of 300 participants were randomly selected for the survey, and questionnaires were administered to them. After questionnaire administration, 10 mL of venous blood was collected intravenously into sterile vacutainer tubes and allowed to clot standing at 4°C. The sera were obtained by centrifuging at 3200 × g for 5 minutes and were then aliquoted into 1.8 mL cryovials and stored at -20°C until analysis.

Serum IgG antibodies enzyme-linked immunosorbent assay (sero-Ab ELISA)

Stored sera were brought out and allowed to thaw before being analyzed. Sera were then screened for IgG antibodies to *T. solium* using ELISA (Diagnostic Automation, Inc., Calabasas, USA), according to the manufacturer's instructions. Results were then read using an ELISA reader set for biochromatic readings at 450/650 to 620 nm. Absorbance readings greater than 0.3 optical density (OD) units were considered positive results.

Data analysis

All collected data were entered into Microsoft Excel 2011 and analyzed by SPSS version 17. Bivariate analysis was then performed using the Chi-square test to check for the association between human cysticercosis seropositivity and other important variables.

Results

Of 300 human sera examined for cysticercal antibodies by Ab-ELISA, 43 sera tested positive, giving a cysticercosis prevalence of 14.3%. Table 1 shows the distribution of the different socio-demographic factors observed within the study population, while Table 2 shows the knowledge, behavioral practices, and medical history of the respondents. The seroprevalence varied by sex, age groups, and also by residential location of respondents, as shown in Table 3. A cysticercosis prevalence of 15.3% was reported among females, which was higher than the 13.5% reported among the males. The mean age of infected individuals was 4 years. Within the different age cohorts, the highest seroprevalence was observed in the 51–70 years age group (54.5%), while the lowest seroprevalence was reported in the 71 years and above age group (14.3%). The location with the highest seroprevalence was the Nassarawa/Kakuri area (23.5%), while the lowest seroprevalence was reported

in the Barnawa/Narayi area. Table 4 shows the associations between different variables in the study population and seropositivity by Chi-square analysis. There was a high proportion (95.3%) of regular pork consumption among the seropositive cases. About 32.5% of the seropositive individuals were farmers and butchers, 25.6% were involved in trading, 20.9% were civil servants, and 20.9% were students. More than half (55.8%) of the seropositive population made use of a pit latrine, 34.9% made use of a water cistern, while the remaining 9.3% defecated in the open. Of the seropositive population, 72.1% did not boil or treat their drinking water, 23.3% reported having epileptic seizures, and 55.8% were involved in small-holder backyard pig keeping, with 48.8% allowing their pigs to roam freely. The majority of the seropositive population (79.1%) had poor knowledge of cysticercosis.

Discussion

Studies on human *T. solium* cysticercosis in Nigeria are very limited. To the best of our knowledge, the present study is the first survey estimating the seroprevalence of human cysticercosis in parts of Kaduna metropolis, Nigeria, where pig rearing and consumption are common practices. Before now, the few cases reported within Nigeria were based on hospital surgical records and post-mortem registers at University College Hospital (UCH) in Ibadan, Oyo State [8].

Table 1. Distribution of sociodemographic factors among respondents

Variable	Frequency (%), N = 300
Age	
11–30	130 (43.3)
31–50	141 (47.0)
51–70	22 (7.3)
71 & above	7 (2.3)
Sex	
Male	164 (54.7)
Female	136 (45.3)
Marital status	
Married	161 (53.7)
Single	117 (39.0)
Occupation	
Businessmen	73 (24.33)
Civil servants	83 (27.6)
Farmers & butchers	73 (24.33)
Students	60 (20)
Sewage disposal system	
Yes, available	269 (89.7)
No, not available	30 (10)
No response	1 (0.3)
Toilet system used	
Pit latrine	171 (57.0)
Water closet	96 (32.0)
Defecate in open	33 (11.0)
Drinking water source	
Pipe borne water	116 (38.7)
Well/borehole	159 (53.0)
Rivers/streams	25 (8.3)

Table 2. Distribution of knowledge, behavioral practices, and medical history of respondents

Variable	Frequency (%), N = 300
Regular hand washing with soap and water after toilet use	
Yes	189 (63.0)
No	110 (36.7)
No response	1 (0.3)
Treatment of drinking water	
Yes	108 (36.0)
No	192 (64.0)
Regular deworming of self	
Yes	43 (14.3)
No	257 (85.7)
Enjoy eating pork	
Yes	281 (93.7)
No	19 (6.3)
Method of pork preparation	
Cooked & fried	43 (14.3)
Cooked only	194 (64.65)
Roasted	63 (20.95)
Eat pork prepared by self or at commercial outlet	
Self-prepare	138 (46.0)
Visit outlets	74 (24.7)
Do both	75 (25.0)
Involved in pig rearing	
Yes	225 (75.0)
No	75 (25.0)
Use of human feces as manure	
Yes	164 (54.7)
No	135 (45.0)
History of epilepsy	
Yes	41 (13.7)
No	259 (86.3)

Table 3. Cysticercosis seroprevalence in relation to age, sex, and location of respondents

Variables	No. examined	No. positive	Prevalence (%)
Sex			
Male	163	22	13.5
Female	137	21	15.3
Age (years)			
11–30	130	17	13.07
31–50	141	18	12.77
51–70	22	12	54.5
71 & above	7	1	14.28
Location			
Sabon tasha & Television	93	12	12.9
Ungwan Romi & Gonin gora	72	11	15.2
Barnawa & Narayi	75	6	8
Nassarawa & Kakuri	60	14	23.5

Table 4. Associations between variables in the study population

Variables	Seropositivity	Knowledge of cysticercosis	Toilet system
Age	0.235	ND	ND
Sex	0.618	0.943	ND
Marital status	0.994	ND	ND
Occupation	0.613	0.000**	0.09
Rearing of pigs	0.509	0.252	ND
Regular pork consumption	0.625	0.231	0.872
Method of pork preparation	0.044*	0.007**	ND
Home pork preparation or purchase from vendors	0.245	0.460	ND
Use of human feces as manure	0.637	0.396	0.001**
Regular hand washing with soap after toilet	0.191	0.746	0.821
Regular self-deworming	0.718	0.443	ND
History of epilepsy	0.048*OR	0.529	ND

Values within the table represent probability values using Chi square; *Significant association between the specified variables, 95% C I, $p < 0.05$, two-tailed; **Very significant association between specified variables, $p < 0.01$, two-tailed; OR: odds ratio value of 2.0 for indicated variable; ND: not determined

Nevertheless, recently, in a field survey conducted among pig farmers in Jos, Plateau State [11], researchers reported a human cysticercosis seroprevalence of 9.6% in the study community, which was determined by detecting IgG antibodies in sera.

The prevalence of 14.3% (n = 300) obtained in this study is high compared to those reported elsewhere; 9.6%, 2.4%, and 1.3% reported in Jos [11], Togo, and Benin, respectively [15], but closer to the 16.3% (n = 544) reported in Mbulu community, Tanzania [16]. Other studies using similar antibody detecting techniques have reported prevalence of 7.4% in South Africa and 20.5% in Mozambique [6]. The prevalence in this study, however, is far lower than the 45.3% (n = 830) reported in Mbozi district of Tanzania [7] and the 40.8% reported in Burundi [17], both of which studies also used the antibody ELISA technique. It has been reported that in most endemic villages, more than 10% of the general population are seropositive and seropositivity could be as high as 25% [18]. Sero-epidemiological surveys may be influenced by factors such as the choice of diagnostic test, specificity and sensitivity, and the role and suitability of the test being used.

Antibody-detecting techniques are said to report higher prevalence than do antigen-detecting techniques [2,7]; nevertheless, they are still considered an appropriate screening tool for the presence of disease in a population because they indicate prior exposure to the disease agent. Antibody-detecting techniques therefore prove useful in providing baseline information, particularly in a situation where the prevalence of the disease in question has not yet been established.

There was no significant difference in the cysticercosis seroprevalence between males and females in this study. Both sexes are equally predisposed to infection; sex is not a risk factor. In contrast, however, some studies in Plateau Nigeria [11], Tanzania [7], and Guatemala [18] have reported significantly higher prevalence in females than in males. Another study in Vietnam, however, reported higher infection rates in males than in females [20]. The difference in human cysticercosis seropositivity across the productive age groups in this study could be attributed to social habits within these age brackets where such individuals drink in shebeens and eat pork, which has the tendency to be undercooked.

Location was not identified as a risk factor to human cysticercosis in this study; however, statistical analysis reported higher seropositivity in some locations than others. All the study locations surveyed within the metropolis practiced free-range pig rearing, consumption of pork, barbecuing, and roadside sale of ready-to-eat pork by vendors, all of which are known risk factors for cysticercosis; however, the peculiarity of the impact of these factors with respect to each location may be responsible for the difference in seropositivity among the locations. This study reported a statistically significant association between method of pork preparation and seropositivity of cysticercosis. Preparation method is suggestive of the adequacy of heat treatment; heat from boiling and frying pork penetrates much more and is more likely to kill the cysts than heat from roasting or barbecuing. This current study revealed a significant difference ($p < 0.05$) in seroprevalence between individuals with a history of epileptic seizures and those without seizures, therefore indicating an association between

seizures and cysticercosis. Studies in Cameroon [15] and Western India [22] revealed that 44.6% and 35.7%, respectively, of people with epileptic seizures were seropositive by Ab-ELISA. This study therefore agrees with other research, indicating a strong association between epileptic seizures and cysticercosis [3,7,23-25]. The risk estimate by odds ratio reported epileptics were two times more likely to be seropositive than were non-epileptics. Studies in Tanzania have reported that pork consumption was a significant risk factor associated with neurocysticercosis found among epileptic patients [7,26]. There was a strong association ($p < 0.01$) between knowledge of cysticercosis, occupation, and method of pork preparation. Knowledge about cysticercosis, transmission, prevention, and control and knowing how to safely and adequately process pork before consumption would definitely influence the method of preparation. The strong association ($p < 0.01$) between occupation and knowledge could be attributed to the fact that people in certain occupations are considered to be more knowledgeable about the disease than others.

Conclusions

Findings from this survey supply the first set of data on human cysticercosis prevalence and risk factors in some parts of Kaduna metropolis, Nigeria, where the disease is under-recognized. A seroprevalence of 14.3% was reported; however, there is need for further research to explore the use of complementary diagnostic techniques within the study area and other areas in Nigeria with similar characteristics. Method of pork preparation was a major factor associated with cysticercosis seropositivity; therefore, education intervention programs that would enhance knowledge and encourage behavior change in the affected study area is strongly advocated.

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Authors' contributions

Conceived and designed the experiments: AUE, HII, VJU, and CMZW. Performed the experiments: AUE, EEE. Analyzed the data: AUE, SA. Critically revised the manuscript: SM

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