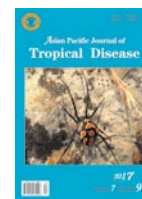


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## Re-evaluation of porcine cysticercosis in Nsukka area of Enugu State, Nigeria

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### ABSTRACT

**Objective:** To re-evaluate the status of *Taenia solium* (*T. solium*) cysticercosis in slaughter pigs due to the great economic and public health implication of the parasite and the increasing pig production and pork consumption in the area.

**Methods:** The prevalence of porcine cysticercosis in Nsukka area of Enugu State, Nigeria was evaluated using structured questionnaires and postmortem examination of pigs slaughtered in three major slaughter slabs in the area, namely, Orba, Ibagwa and Nsukka slaughter slabs. Questionnaires were distributed to willing butchers and pig marketers and completed copies were retrieved and analysed. The slabs were visited every other week during which a total of 379 pigs were examined. Pig carcasses were examined in accordance with standard meat inspection procedures. Briefly, carcasses were examined visually under natural light and palpated before longitudinal incisions were made in the heart, tongue, masseter, neck, intercostal, shoulder and thigh muscles. Carcasses containing cysticerci were recorded as positive for cysticercosis. The sex, age and breed of all animals examined were recorded.

**Results:** *T. solium* cysticercosis prevalence of 3.3% (4/120), 4.3% (5/117) and 0% (0/142) were recorded for Ibagwa, Orba and Nsukka slaughter slabs respectively with an overall prevalence of 2.4% in the three study areas. The type of pig husbandry practiced was the most important factor influencing the prevalence of the infection. Analysis of the questionnaire responses showed that the majority of the respondents were not aware of the zoonotic implication of porcine cysticercosis irrespective of their educational background nor were they aware that epilepsy in the family could be associated with the infection in man.

**Conclusions:** *T. solium* cysticercosis remains endemic in Nsukka area and is a potential major health hazard that must be addressed by an expanded and coordinated study, and control programs.

## 1. Introduction

*Taenia solium* (*T. solium*) taeniasis/cysticercosis is an important zoonosis of considerable public health concern that mainly affects poor communities, especially in countries of Africa, Asia and South America[1]. Man, the only known natural host of adult *T. solium* in which it causes human taeniasis, acquires the infection by the ingestion of uncooked or undercooked pork containing viable cysticercus of *T. solium*. Pigs being the main intermediate host in which the cysticerci of *T. solium* develop become infected by eating viable *T. solium* eggs or whole gravid proglottids voided in human faeces into the environment by infected individuals[2]. Absence

or improper meat inspection as well as clandestine slaughter and sale of pig carcasses contribute significantly to the maintenance and transmission of the infection in man[1]. Porcine cysticercosis is usually prevalent in under-developed or developing countries with limited economic resources, extensive (free range) or poor pig husbandry systems[3-5].

Although the environmental and pig management conditions in Nigeria (especially where open-air defecation is rampant) appear favourable for the transmission of taeniasis/cysticercosis complex, records of the prevalence appear few and far-between. For instance, in this study area, the only published study on porcine cysticercosis and human taeniasis was carried out two decades ago[4]. Consequently, it has become necessary to re-evaluate the status of the infection in slaughter pigs due to the great economic and public health implication of the parasite and the increasing pig production and pork consumption in the area.

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## 2. Materials and methods

### 2.1. Study area

The study was carried out in three slaughter slabs located in three communities of Nsukka region, namely, Orba, Ibagwa and Nsukka urban, in Udenu, Igbo-Eze South and Nsukka local Government Areas of Enugu State, respectively. The state is located between longitudes 6°52'–7°53' E and latitudes 6°38'–7°8' N and is bounded to the north by Benue State, to the west by Anambra State, to the south by Abia State and to the east by Ebonyi State. Enugu State is made-up of 17 local government areas with a population of about 3 253 298 as at 2006 National Population Census[6].

### 2.2. The study design

This work was carried out using post-mortem examination of 379 slaughtered pig and questionnaire survey. Information on the age of the pigs was obtained from the pig marketers and butchers. The sexes and breeds of the pigs were determined by physical examination shortly before slaughter.

### 2.3. Questionnaire survey and interview

This was carried out using structured questionnaires designed to obtain information on the hygienic practices among pig marketers and butchers, origin of the pigs, awareness of the zoonotic importance of *T. solium*/cysticercosis complex and history of epilepsy in the family. All respondents willingly submitted to participate in the questionnaire and were assured of the confidentiality of their identities. The questionnaires were distributed to butchers and pig marketers in the three study areas. The contents of the questionnaire were translated in a local dialect, in the form of an interview, to the respondents who were unable to read or write. Aspects of the questionnaire that raised questions from the respondents were also explained. Thereafter, the copies of the questionnaires were retrieved and the responses were collated and analyzed.

### 2.4. Post-mortem examination of the carcasses

The three slaughter slabs were visited every other week for post-mortem examination of the carcasses. Carcasses were thoroughly and systematically inspected by visual examination under natural light, before being palpated and multiple incisions made in the heart, tongue, masseter, neck, intercostal and thigh muscles in accordance with standard meat inspection procedures as previously described[2,7]. All carcasses containing cysticerci were noted and recorded.

### 2.5. Statistical analysis

Data from the study was analyzed using GraphPad Prism statistical software version 5.02 (www.graphpad.com). Fisher's exact test was used to determine the strength of association between the variables (sex, age, source, breed) and occurrence of cysticercosis. The alpha value of significance was set at the probability level of < 0.05.

## 3. Results

### 3.1. Prevalence of porcine cysticercosis

The overall prevalence of porcine cysticercosis in Nsukka environ as shown in Table 1 was 2.4% (9/379). The results in Table 1 showed that prevalence rates of 3.3%, 4.3% and 0% were specifically recorded for Ibagwa, Orba and Nsukka slaughter slabs, respectively.

**Table 1**

Prevalence of porcine cysticercosis in Nsukka area of Enugu State on the basis of location, sex, age and sources of the pigs.

Parameters	Ibagwa		Orba		Nsukka	
	No. Sampled	No +ve (%)	No. Sampled	No +ve (%)	No. Sampled	No +ve (%)
Overall	120	4 (3.3)	117	5 (4.3)	142	0 (0)
Sex of pigs						
Male	58	2 (1.7)	38	0 (0)	56	0 (0)
Female	62	2 (1.7)	79	5 (4.3)	86	0 (0)
Age of pigs (months)						
≤ 12	37	0 (0)	29	1 (0.9)	37	0 (0)
> 12	83	4 (3.3)	88	4 (3.4)	105	0 (0)
Breeds of pigs						
Exotic	115	0 (0)	99	0 (0)	120	0 (0)
Local	5	4 (3.3)	18	5 (4.3)	22	0 (0)
Sources of pigs						
Within the study area	115	0 (0)	24	0 (0)	142	0 (0)
Outside the study area	5	4 (3.3)	93	5 (4.3)	0	0 (0)

### 3.2. Sex distribution of porcine cysticercosis in Nsukka area

The results of the sex related prevalence of cysticercosis in Nsukka area are shown in Table 1. The study recorded overall prevalence rates of 1.8% and 0.5% for female and male pigs, respectively. On the basis of the location of the slaughter slab, the results further showed that 2 (1.7%) out of the 58 male and 2 (1.7%) out of the 62 female pigs examined were positive for cysticercosis in Ibagwa. In Orba, none of the 38 males sampled were positive whereas 5 (4.3%) out of the 79 females sampled were positive. None of the 56 male and 86 female pigs examined in Nsukka slaughter slab were positive for porcine cysticercosis as shown in Table 1. However, no strong ( $P = 0.325$ ) association between sex and the occurrence of cysticercosis was observed.

### 3.3. Age distribution of porcine cysticercosis in Nsukka area

A total of 103 young pigs (≤ 12 months) was examined in the three localities while the remaining 276 pigs were adults (> 12 months). The results in Table 1 showed that the prevalence of porcine cysticercosis in the adult pigs (> 12 months) was 2.1%, while that of the young pigs (≤ 12 months) was 0.3%. Specifically on the basis of location, the results in Table 1 also showed that only 1 pig aged ≤ 12 months of age was positive for cysticercosis in Orba. However, 4 each out of 83 and 88 were positive for porcine cysticercosis in Ibagwa and Orba areas respectively. There was also no strong ( $P = 0.45$ ) association between the prevalence of cysticercosis and the age of the pigs.

### 3.4. Breed related prevalence of porcine cysticercosis in Nsukka area

The results as shown in Table 1 indicated that none of the 334 exotic breeds of pigs slaughtered in all the locations were positive

for porcine cysticercosis. However, 4 out of the 5 local pigs slaughtered at Ibagwa were positive for porcine cysticercosis (0.3%) and 5 out of the 18 slaughtered at Orba were positive (4.3%). No local pig was slaughtered at Nsukka metropolis. There was a very strong association ( $P < 0.001$ ) between the prevalence of cysticercosis and breed of the pigs.

### 3.5. Prevalence of porcine cysticercosis in relation to the source of the pigs

The results in Table 1 also showed that 281 of the pigs sampled were sourced locally from farms within the study area while 98 pigs were bought from the north-central part of the country. The results also showed that whereas none of the locally sourced pigs were positive for porcine cysticercosis at the level of postmortem examination, 9 (2.4) out of the pigs from the north-central region were positive. Specifically, 4 (3.3%) of the 5 pigs sourced from the northern part of the country and slaughtered at Ibagwa and 5 (4.3%) out of the 93 slaughtered at Orba were positive for cysticercosis. There was a very strong ( $P < 0.001$ ) association between the prevalence of cysticercosis and the source of the slaughter pigs.

### 3.6. Hygienic practices among the abattoir workers

Table 2 contains information on the hygienic practices among the respondents. The results showed that 30.6% of the respondents practiced open method of defecation always, while 38.9% used the same method once in a while. The remaining 30.6% of the respondents never used the open method of defecation. According to Table 2, majority of the respondents (86.1%) ate while on duty at the abattoir. Out of this number, 19.4% of the respondents washed their hands always before eating while 72.2% washed their hands sometimes and 8.3% never washed their hands before eating. The result of the questionnaire showed that all the respondents ate pork.

**Table 2**

Hygienic practices among abattoir workers and pig marketers in Nsukka area of Enugu State [n (%)].

S/No	Habit	No. of respondents			Total (%) No. of respondents (n = 36)
		Ibagwa (n = 11)	Orba (n = 11)	Nsukka (n = 14)	
1	Bush method of defecation				
	Always	6 (16.7)	4 (11.1)	1 (2.8)	11 (30.6)
	Once in a while	4 (11.1)	2 (5.6)	8 (22.2)	14 (38.9)
	Never	1 (2.8)	5 (13.9)	5 (13.9)	11 (30.6)
2	Eats on duty in the abattoir				
	Yes	11 (30.7)	11 (30.6)	9 (25.0)	31 (86.1)
	No	0 (0.0)	0 (0.0)	5 (13.9)	5 (13.9)
3	Hand washing before eating				
	Always	1 (2.8)	2 (5.6)	4 (11.1)	7 (19.4)
	Sometimes	9 (25.0)	8 (22.2)	9 (25.0)	26 (72.2)
	Never	1 (2.8)	1 (2.8)	1 (2.8)	3 (8.3)
4	Eat pork				
	Yes	11 (30.6)	11 (30.6)	14 (38.9)	36 (100.0)
	No	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

### 3.7. Awareness of porcine cysticercosis and history of epilepsy among the respondents

The results on the awareness of porcine cysticercosis and history

of epilepsy among the respondent are presented in Table 3. The results indicated that 80.6% of the respondents have heard of porcine cysticercosis even though almost all the respondents (94.4%) were ignorant of the zoonotic implication of the disease. On the history of epilepsy, 22.2% of the respondents had a history of epilepsy in their family or neighbourhood.

**Table 3**

Awareness of the zoonotic capability of porcine cysticercosis and history of epilepsy among abattoir workers and pig marketers in Nsukka area of Enugu State [n (%)].

S/No	Level of awareness	No. of respondents			Total (%) No. of respondents (n = 36)
		Ibagwa (n = 11)	Orba (n = 11)	Nsukka (n = 14)	
1	Have heard of porcine cysticercosis				
	Yes	9 (25.0)	6 (16.7)	14 (38.9)	29 (80.6)
	No	2 (5.6)	5 (13.9)	0 (0.0)	7 (19.4)
2	Awareness of the zoonotic capability of porcine cysticercosis				
	Yes	1 (2.8)	0 (0.0)	1 (2.8)	2 (5.6)
	No	10 (27.8)	11 (30.6)	13 (36.1)	34 (94.4)
3	Have history of epilepsy in family or neighbourhood				
	Yes	1 (2.8)	1 (2.8)	6 (16.7)	8 (22.2)
	No	10 (27.8)	10 (27.8)	8 (22.2)	28 (77.8)

## 4. Discussion

The overall prevalence rate of porcine cysticercosis as recorded in this study is 2.4%. This is much lower than 20.5% that was previously reported in Nsukka environs[4]. The decline in the prevalence rate is believed to be due to the intensive pig management system being widely practiced nowadays by pig farmers in the area. Under the intensive management system, pigs are mainly fed concentrate feeds, which significantly reduces their chances of ingesting eggs of *T. solium*. In addition, improved veterinary care such as routine deworming of pigs is being frequently practiced nowadays, which minimizes the chances of the infection. In the past, pigs in the area were mainly raised under the extensive or semi-intensive system, where they roam and scavenge for food, with the attendant risk of ingesting *T. solium* eggs. The decline was also attributed to a remarkable improvement in personal hygiene of people in the study area over the years and the availability of toilet facilities in residential and business premises. Porcine cysticercosis is usually prevalent in places with poor personal hygiene and lack of sanitary infrastructures, extensive (free range) or poor pig husbandry systems and indiscriminate outdoor (open-air) defecation which gives roaming pigs, free access to human faeces[5].

The 2.4% prevalence recorded in this study is comparable to 4.2% reported in Ibadan, Oyo State, Nigeria[8]. It is, however, lower than the findings of other researchers in different parts of Nigeria and beyond. In Northern Nigeria, prevalence rates of 6.3%[3] and 14.4%[7] were reported for Kebbi and Taraba States, respectively, while 32.8% prevalence was recorded in Kenya[9]. The disparity in the prevalence rates recorded in this study and those from the northern part of Nigeria is also attributed to the management system of pig production in the area which increases the odds of acquiring the infection by the pigs. In the north, pigs are usually raised under the extensive or semi-intensive system as intensive pig farming is often seen as a taboo due to religious reasons[7]. Human defecation

along roads and in crop fields is also common in many communities in the northern part of Nigeria.

The results of this study showed a very strong association between porcine cysticercosis and the source of the pigs, whereby pigs from the northern part of Nigeria, were more likely to be infected than those from the Southeastern Nigeria. It is interesting to note that pigs sourced from the north-central part of Nigeria accounted for all the positive cases of porcine cysticercosis recorded in this study. There was also a very strong association between porcine cysticercosis and the breed of pigs sampled in the present study whereby the local breed of pigs accounted for all the positive cases of cysticercosis. It should be noted that the exotic breed of pigs is mainly managed intensively due to their high cost and vulnerability to environmental and disease conditions while the local pigs are usually managed extensively. Therefore, the risk of cysticercosis is higher among the local breeds compared to their exotic counterparts.

The sex distribution of porcine cysticercosis as recorded in this study whereby more female pigs than the males had cysticercosis is in agreement with the reports by Gweba *et al.*[3] and Karshima *et al.*[7] who reported higher prevalence rates of the disease in female pigs. However, no significant association between sex and the prevalence was established both in the present study and the studies cited above[3,7]. The preponderance of cysticercosis in females could be due to stress and relaxation of immunity associated with hormonal imbalances associated with pregnancy and lactation[10]. Furthermore, females are usually kept longer in pig farms than males, as females are used mainly for production. This longer stay in the farm increases the chances of the infection among the females.

The prevalence of 0.3% and 2.1% recorded for young pigs ( $\leq 12$  months of age) and adult pigs ( $> 12$  months of age) respectively is an indication that the occurrence of the disease increases with age. This agrees with the reports of higher prevalence rates in adult over young pigs in Cameroon and Mexico[11,12]. This higher prevalence in adult may be due to the fact that older animals may have had longer exposure than the young ones. It could also be that the young pigs are protected via the initial exposure period, perhaps via maternal transfer of antibodies but becomes susceptible latter. Maternal antibodies are protective for porcine cysticercosis and have been shown to slowly decrease in piglets born to cysticercosis-infected sow[13,14].

The results of the survey on the awareness of the zoonotic capability of porcine cysticercosis showed that the majority of the animal handlers and butchers did not understand the association between porcine cysticercosis and human *T. solium* taeniasis. Such lack of awareness on the zoonotic importance of porcine cysticercosis among the respondents may be due to their poor educational background. This is worrisome because the majority of the abattoir workers eat while on duty (86.1%) and defecate in open air (69.4%). These practices may help to perpetuate the cycle of the infection between man and pigs.

In conclusion, the results of this study have shown remarkable drop in the prevalence of porcine cysticercosis in Nsukka region from 20.5% recorded 20 years ago by Onah and Chiejina[4] to 2.4% in the present study. Although the 2.4% prevalence of porcine cysticercosis is low, it is an indication that the area is still at risk. Efforts should be made to stamp-out the disease since *T. solium* cysticercus has tremendous zoonotic and economic consequences. The existence of

*T. solium* cysticercosis is promoted by unhygienic condition, free range pig husbandry and poor toilet/latrine facility in areas where the pigs are reared. *T. solium* cysticercosis remains an under-recognised public health problem, which deserves more attention from the authorities.

### Conflict of interest statement

The authors declare that they have no competing or conflict of interest.

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