



ISSN 2278 – 0211 (Online)

## Prevalence of Porcine Cysticercosis by Lingual Examination in Smallholder Pig Farms in Kiambu, Kenya

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### **Abstract:**

*Porcine cysticercosis is common in pigs worldwide and associated with free ranging production systems where animals have access to human faeces infected with *Taenia solium*. Its occurrence leads to economic loss to farmers at slaughter but more important is the public health concern where humans may get infection by consumption of infected pig meat. The larval stages develop in muscles and tissues in both pigs and humans. Diagnosis in live pigs is mainly by presence of palpable cysts on the tongue. A cross sectional survey was carried out in 81 smallholder farms in Thika sub-County, Kiambu County, Kenya. Visual inspection and lingual palpation was done to 276 pigs, where two pigs were examined in pig farms with less than 5 pigs while in farms with more than 5 pigs, at least 5 pigs were randomly picked for palpation. The results were recorded as presence or absence of palpable cysts. Farm and pig prevalence of cysticercosis in Thika was found to be 6.2% and 1.81% respectively an indication that cysticercosis is present in the area. Though the prevalence was low as compared to other parts in Kenya, this was first documentation of disease occurrence in this area.*

**Keywords:** Field diagnosis, lingual palpation, prevalence, porcine cysticercosis, taeniosis

### **1. Introduction**

Cysticercosis is emerging as a serious public health problem in the countries of Eastern and Southern Africa especially in rural subsistence farming communities, where raising cattle is not economically feasible (Mukaratirwa *et al.*, 2003). In such areas pigs may range freely, having direct access to human faeces from outdoor facilities, and veterinary inspection of meat does not exist or is inadequate, thus facilitating the continuous transmission of the disease. Among food borne diseases in Eastern and Southern Africa, porcine cysticercosis is ranked low except in South Africa (Jabbar and Delia, 2012). The increasing demand for pork meat in urban areas may result in the transport of infected meat from rural communities to large urban populations.

In Africa, the rapid expansion of smallholder pig production has led to a significant increase of cysticercosis in pigs and humans (Phiri *et al.*, 2003). Traditional pig production systems known as the source of *T. solium* taeniosis/cysticercosis complex are predominant in the continent, representing 60-90% of pig production in rural areas. Poor sanitary conditions, free-roaming of domestic pigs and lack of awareness of the disease play an important role in the perpetuation of the *Taenia solium* taeniosis and cysticercosis in Africa (Mukaratirwa *et al.*, 2003).

Cysticercosis in pig is a condition caused by infection with metacestodes of *T. solium* which occurs after a pig ingests embryonated eggs in feeds contaminated by faeces from persons suffering from taeniasis (Richard, 2017). Human beings host adult *T. solium* in their intestines and these worms produce embryonated eggs called oncospheres in motile segments which are passed with faeces (WHO, 2017). If the oncospheres are consumed by pig, they form tissue cysts (FAO, 2012).

The global prevalence is estimated at about 8% (FAO, 2014). Both human and pig infections have been reported in South Africa, Zimbabwe, Gambia, Togo, Rwanda, Burundi, Malawi, Swaziland, Madagascar and Zaire (Zoli *et al.*, 2003). In Tanzania, cases of porcine cysticercosis were first reported in Mbulu District (Boa *et al.*, 1995) where the prevalence was estimated at 17.4%. In Uganda, 9.4% of pigs surveyed were found positive by lingual palpation for cysticercosis with most

cases coming from the rural areas (Kisakye and Masaba, 2002). A previous study in western Kenya where lingual palpation method of diagnosing cysticercosis was used in western Kenya, the farm and pig prevalence of porcine cysticercosis was estimated at approximately 9.8% and 6.5% respectively (Mutua *et al.*, 2007).

In sub-Saharan Africa, studies on porcine cysticercosis using more sensitive tests reported a prevalence of 40.6% in Eastern Cape Province of South Africa (Krecek *et al.*, 2008), 23.3% in the Eastern, Southern and Western provinces of Zambia (Sikasunge *et al.*, 2008), and 38.4% in Congo (Praet *et al.*, 2010) all using Ag-ELISA.

Pigs in Kenya are mainly kept in small scale extensive system, small scale intensive system and commercial system (Behnke and Muthami, 2011). Extensive system, normally referred to as free range pig rearing system, are mostly found in western parts of Kenya and in slums of the major towns while small scale intensive system and commercial system are found in central Kenya and parts of Rift valley (FAO, 2012). Number of pigs kept range from fewer than 10 up to 100 (Wabacha *et al.*, 2004). Most farmers in this system mix their own feed while in some areas farmers have formed cooperative societies with feed mills (FAO, 2012).

Current reports indicate that Kiambu County has 67,500 pigs in 300 households with an average herd size of 5 pigs (Kiambu County, 2016). In recent years pork consumption has increased with the opening up of pork eateries (FAO, 2012). A proliferation of small firms processing pork at various levels in Kenya's major towns has improved the market situation and encouraged local communities to eat pig meat as well as increase pig production. Kiambu County has been reported to be the highest consumer of pork in the country (FAO, 2012; FAOSTATS, 2014). However, as in most of the endemic areas especially in sub Saharan Africa there is lack of proper documentation of this disease and in particular in Thika sub- County, there was no documentation of porcine cysticercosis. This study therefore sought to provide baseline data on prevalence of porcine cysticercosis using lingual palpation in pig farms in Thika sub County.

## 2. Materials and Methods

### 2.1. Study Location

The study was conducted in a total of four Wards, three in Thika sub- County in Kiambu County namely, Kamenu, Gatuanayaga, Township and Kimorori Ward in Muranga South Sub- County of Muranga County. The study area lies between longitude 36.35°N - 37.25°N and latitude 1.45°S - 3.53°S and has moderate tropical climate with average day time temperatures of 25°C and two rainy seasons. The area surrounding the town are farmlands with smallholder livestock farmers and horticulture farming. Two pig abattoirs are located in the study area and supply meat to the community.

### 2.2. Study Design

This study was a cross sectional survey, where the pig farms and individual pigs for evaluation were randomly selected for inclusion into the study.

### 2.3. Study Population

All the pigs in the study area were included in the study. According to 2009 Population and Housing, livestock population census, Kiambu County had 46,493 pigs and County reports of 2013 indicate that the County produced 1803 tonnes per year (KNBS, 2009; Kiambu County, 2013). The pigs are mainly raised in smallholder intensive farms of herd sizes of about 10 pigs.

## 3. Samples and Sampling Framework

The total number of households in the study area was 178, each pig farmer was assigned uniquely identified and their contacts recorded. Cluster random sampling was applied to determine the number of pig farms to sample per Ward. The uniquely identifying numbers were generated and ballot papers picked randomly by a blind folded person until the required number of farms for each ward was achieved. A total of 90 farmers which was 50% of the pig farmers in each Ward were recruited and formed the study sample. Cluster sampling in relation to the number of pig farmers per Ward was as shown in Table 1.

All the 90 farmers selected randomly were visited and a semi-structured questionnaire was administered by the researchers to collect the bio data, background characteristics of each farmer and details of pig production system including the herd size. In each pig farm where the herd size was equal to or less than 5; two pigs were recruited for the study. In pig farms where the herd size was more than 5, five pigs were randomly selected and included in the study. The pigs were manually restrained using a pig snare by an animal handler, the mouth opened and kept open by inserting a firm stick across the mouth (Figure 1). The tongue was extruded out, visual inspection and lingual examination by palpation was done to identify any larval stages (cysts). All pigs above three months of age which were less than 60 kg live weight as estimated with a weighing band and were not in third trimester that were randomly selected for lingual palpation test of cysticercosis test for porcine cysticercosis was also conducted to randomly selected pigs from each farm. In each pig farm with a pig that was positive for porcine cysticercosis by lingual palpation was recorded as positive for porcine cysticercosis while those with no positive case were recorded as negative for porcine Cysticercosis.

#### 4. Sample Size Determination

The sample size was determined based on a previous similar study in western Kenya where lingual palpation method for diagnosing cysticercosis reported the farm and pig prevalence of porcine cysticercosis to be approximately 9.8% and 6.5% respectively (Mutua *et al.*, 2007). Since cysticercosis is endemic in western Kenya, the farm porcine cysticercosis prevalence in Thika Sub County was expected to be a bit lower and therefore estimated to be 5%. The formula used to determine sample size was as described and illustrated below (Daniel, 1999).

$$n = \frac{t^2 \times p(1-p)}{m^2}$$

$$n = \frac{1.96^2 \times 5(1-5)}{0.05^2}$$

$$= 76.8$$

Where:

n = required sample size

t = confidence level at 95% (standard value of 1.96)

p = estimated prevalence

m = margin of error at 5% (standard value of 0.05)

With an expected prevalence of 5%, at 95% confidence interval and an error of 5%, the minimum number of households would be 77 farmers. In current study, 90 pig farmers were selected to cater for none responses or other uncertainties during data correction.

The formula to determine sample size for pigs in this study was based on the assumption that the pig population is greater than 10,000 and as described by Fisher *et al.* (1998):  $n = z^2pq/d^2$

Where: -

n-The desired sample size

z-The standard normal deviation, set at 1.96, which corresponds to 95% confidence level

p-The proportion in the target population estimated to have a particular characteristic.

q = 1.0 –p

d = the degree of accuracy desired, here set at 0.05.

In substitution,

$$n = \{1.96^2 \times 0.1 \times (1-0.1)\} / .05^2 = 138.3$$

With an expected prevalence of 10%, at 95% confidence interval and an error of 5%, the minimum number of pigs would be 138 pigs. In this study, 276 pigs were which double the minimum sample was used. It was expected that on average all farms would have a minimum of two pigs and both would be recruited for study and that in farms with more than 5 pigs at least 5 would be selected for the study.

##### 4.1. Data Management and Data Analysis

The data collected from each coded pig farm and for each individual pig examined was recorded on spreadsheets, and cysticercosis evaluated as presence or absence. Pig and farm prevalence of porcine cysticercosis was calculated with the formulae below:

$$\text{Pig prevalence} = \{(\text{number of positive cases}) / (\text{number of pig tested}) \times 100\} \%$$

$$\text{Farm prevalence} = \{(\text{number of farms with a positive case}) / (\text{all farms visited}) \times 100\} \%$$

##### 4.2. Ethical and Logistic Considerations

Clearance was sought from Kenyatta University Ethics Review Committee and approval from Graduate school to carry out the research. Permission to carry out the research was sought from the National Commission for Science, Technology and Innovation (NACOSTI). Clearance was also sought from the County directors of Public health and Veterinary services, Kiambu and Muranga counties. Written and signed informed consent was sought from all the study participants. All data was collected using coded questionnaires using unique identifying numbers and was handled with confidentiality. Study participants were recruited into this study on a voluntary basis and there was no cash award but technical advice on porcine cysticercosis and the risk factors were shared. Lingual palpation tests were carried out humanely and all the pigs were handled gently. In pig farms where pigs were positive for cysticercosis, the County Director of Veterinary Services was notified in order to design control strategies for the disease and advice the farmers.

## 5. Results

### 5.1. Bio Data of Study Population

This study was carried out in 81 pig farms where the pig farmers were visited between 04 October 2016 and 1<sup>st</sup> November 2016. The respondents included 45 (55.6%) females and 36 (44.4%) males who were aged between 20 and 69 years. All respondents were Christians. 72 households (89% of the households visited) kept other livestock alongside the pigs.

The study area has good access to clean water with 77.8% of respondents reporting that they had piped tap water from the Municipality and have been piped into their compound for domestic and livestock use. All households had either a pit or a flush latrine with 60 (75.3%) respondent reporting they had a pit latrine while 20 (24.7%) had flush toilets.

The total number of pigs in all the pig farms visited was 901, with herd size ranging from 1 to 78 pigs, an average of 14.12 and a standard deviation of the mean of 11.12. A total of 58 (71.6%) pig farms had less than 10 pigs while 13 farms (16.1%) had between 11 to 20 pigs and only 10 (12.3%) had more than 20 pigs. The pig herd structure was composed of 27.5% breeders, with a ratio of one boar to three sows, 47.4% were piglets with slightly more females than males and 25.1% fatteners with equal number of males and females.

### 5.2. Prevalence of Porcine Cysticercosis

Among the 81 pig farms that were examined for porcine cysticercosis, majority 42 (51.1%) were in Kamenu while the minority 5 (6.2%) were in Township Ward. On the results of lingual palpation test for cysticercosis which was performed on 276 pigs, 5 (1.81%) of the pigs were found to have visible and palpable cysts on the tongue (Figure 2). The cysts were identified in two male and three female pigs all aged 9 months. The positive cases were from five different pig farms, 4 in Kamenu and 1 from Kimorori Ward. The distribution of the occurrence of palpable cysts was as shown in Table 2.

The study reported a farm prevalence of porcine cysticercosis of 6.2% and pig prevalence of 1.81% in mature market ready pigs with no difference in gender observed in the occurrence of cysts.

## 6. Discussion

As reported in this study, most of the respondents were women who also took care of the livestock as their husbands did other jobs away from homes. The finding is in agreement with other studies elsewhere (FAO, 2011; Thornton *et al.*, 2002). Studies done in western Kenya among smallholder pig farmers also had more female than male respondents (Mutua *et al.*, 2012; Mutua *et al.*, 2011; Kagira *et al.*, 2010; Mutua *et al.*, 2007)

On availability of sanitary facilities, Kitinda (2013) reported that 75% Kenyans use pit latrine while only 5% have access to executive (flush) latrines and he further observed that most of the pit latrines were found in rural areas which is in general agreement with the current study findings. However, the current study area was in the outskirts of Nairobi City, metropolitan area which explains the relatively high number of households with flush latrines. The finding that majority of the pig farmers had access to piped tap water which is different from other studies in Africa where the researchers consistently report that most of countries in sub-Saharan African lack basic sanitation facilities such as latrines and do not have access to tap water (Mojofane *et al.*, 2003; Ngowi *et al.*, 2009). These improved facilities as well as confining of pigs observed in the study area may have led to low prevalence of porcine cysticercosis reported in this study. A majority of the study respondents (42 out of 81) were from Kamenu Ward which is peri urban area, this finding is in agreement with studies done in Brazil, Mexico and Peru which reported that most of the pig farming was done in peri urban areas due to proximity to the market and source of feed (Gomes *et al.*, 2006; Garcia *et al.*, 2003; Rodriguez *et al.*, 1998).

The pig prevalence of porcine cysticercosis reported in this study was lower than the global, regional and western Kenya reports. The low prevalence may be attributed to low sensitivity of lingual examination and to the improved pig husbandry systems used in the study area. However, the pig farm prevalence was comparable to the work done in western Kenya where the researchers reported a prevalence of 9.8%. The reported prevalence does not concur with prevalence in most parts of sub Saharan Africa. This can be attributed to the fact that the method used has lower sensitivity and does not diagnose infested pigs at the onset of the infection unlike Ag-ELISA that detects antigens even before cyst formation. The Ag-ELISA has been reported to have a sensitivity ranging between 76.3% and 86.7% and a specificity ranging between 84.1% and 98.9% in pigs in South Africa, Zambia and West Cameroon (Dorny *et al.*, 2004; Krecek *et al.*, 2008, and Poudet *et al.*, 2002). More sensitive diagnostic test using Ag ELISA may be used in the study area to establish the true prevalence.

## 7. Conclusion

In conclusion, the study has established that porcine cysticercosis is present in pigs reared in the area and measures should be taken to mitigate this serious zoonotic disease to protect the public.

## 8. Acknowledgements

The authors wish to acknowledge Kenyatta University Vice Chancellor's 2015 Research Grant for funding this work.

Our appreciations go to the County Governments of Kiambu and Muranga- Department of Veterinary Services for permission to carry out research in their facilities. Research Team and Collaborators are grateful for the Technical assistance (animal health assistants) for data collection in the pig farms. We also wish to thank the proprietors and management of all the pig farms for their cooperation and allowing us to carry out the lingual palpation in their premises.

Sl. No.	Ward	Number of farmers proposed for sampling	Total number of farmers per the Ward	Number of farmers surveyed
1	Gatuanyaga	20	39	18
2	Kamenu	47	93	42
3	Township	5	11	5
4	Kimorori	18	35	16
Total		90	178	81

*Table 1: The Total Number of Pig Farmers Per Ward and the Number Recruited in the Study for Evaluation of Porcine Cysticercosis by Lingual Palpation in 2016 in Kiambu, Kenya*

Characteristic	Ward				Total
	Gatuanyaga	Kamenu	Township	Kimorori	
Number of pig farms sampled	18	42	5	16	81
Pig in the sampled farms	307	488	77	29	901
Pig examined for cysts	77	145	34	17	273
Farms with a positive case	0	4	0	1	5
Positive cases	0	4	0	1	5
Farm prevalence	0	9.50%	0	6.30%	6.20%
Pig prevalence	0	2.80%	0	5.90%	1.81%

*Table 4.2: Distribution of Positive Cases Per Ward for Cysticercosis in the Study on Porcine Cysticercosis Prevalence Study in Thika Sub County in 2016*



**Figure 1: Pig Restraint and Handling during Lingual Examination for Palpable Cysts**



Figure 2: Visible Lingual Cysts Observed in Pigs During Lingual Examination for Porcine Cysticercosis

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