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Emergence of Cysticercosis, a neglected meat-borne notifiable zoonosis in Thika sub county of Kiambu county, Kenya

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ABSTRACT

The tapeworm *Taenia solium*, transmitted between humans and pigs, affects millions of people in sub-Saharan Africa. The young form of the tape worm causes a tissue infection called cysticercosis and a specific effect called neurocysticercosis in humans affects the brain; and, is the most common cause of seizes - acquired epilepsy. In addition, infected pigs lead to considerable economic losses due to down grading or total condemnation of the carcass. Thika has been reported as the highest consumer of pork among Kenyan urban areas and a comprehensive survey of cysticercosis in the area had not been previously carried out. A study was done from May 2016 to June 2017 with the purpose to investigate the prevalence and factors associated with taeniosis and porcine cysticercosis in Thika Sub County. The specific objectives were to determine the prevalence and factors associated with *Taenia solium taeniosis/ cysticercosis*, prevalence of *porcine cysticercosis* in pig farms and seroprevalence of porcine cysticercosis in pigs slaughtered in abattoirs in Thika. Taeniosis was present among the community members with prevalence at 6.3 % while 13 cases of cysticercosis have been recorded in Thika Level 5 Hospital. The level of awareness among pig consumers and vendors on *taeniosis/ cysticercosis* was found to be low with fried pork being the most preferred method for pork preparation. Prevalence of *porcine cysticercosis* by lingual palpation was 1.81% among the farms surveyed and seroprevalence using antigen ELISA was1.83%. These results are significant in that they report on presence of *porcine* and human *cysticercosis* and therefore the need to control this important zoonosis in the area.

Key words: Abattoir surveillance, *Cysticercosis,* pork tapeworm, *Taenia solium*

RÉSUMÉ

Le ténia *Taenia solium*, transmis entre l'homme et le porc, affecte des millions de personnes en Afrique subsaharienne. La forme jeune du ver à ruban provoque une infection tissulaire appelée cysticercose et un effet spécifique appelé neurocysticercose chez l'homme affecte le cerveau; et, est la cause la plus fréquente de crises d'épilepsie acquise. De plus, les porcs infectés entraînent des pertes économiques considérables en raison de la perte de valeur ou de la condamnation totale de la carcasse. La région de Thika a été signalée

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comme la plus grande consommatrice de la viande du porc parmi les zones urbaines du Kenya et aucune enquête complète sur la cysticercose dans la région n'avait été réalisée auparavant. Une étude a été réalisée de Mai 2016 à Juin 2017 dans le but d'étudier la prévalence et les facteurs associés à la téniase et à la cysticercose porcine dans la région de Thika. Les objectifs spécifiques étaient de déterminer la prévalence et les facteurs associés à la téniase / cysticercose de *Taenia solium*, la prévalence de la *cysticercose porcine* dans les élevages porcins et la séroprévalence de la *cysticercose porcine* chez les porcs abattus dans les abattoirs de Thika. La téniase a été reportée au niveau des membres de la communauté avec une prévalence de 6,3% tandis que 13 cas de cysticercose ont été enregistrés à l'hôpital niveau 5 de Thika. Le niveau de sensibilisation à la téniase / cysticercose des consommateurs et des vendeurs de porcs s'est avéré faible, le porc frit étant la méthode la plus préférée pour la préparation du porc. La prévalence de la cysticercose porcine par palpation linguale était de 1,81% parmi les exploitations enquêtées et la séroprévalence utilisant l'antigène ELISA était de 1,83%. Ces résultats sont significatifs dans la mesure où ils rendent compte de la présence de cysticercose porcine humaine et donc de la nécessité de contrôler cette importante zoonose dans la zone.

Mots-clés: Surveillance en abattoir, *Cysticercose*, ténia du porc, *Taenia solium*

INTRODUCTION

Cysticercosis is a tropical neglected disease caused by a larva stage of *Taenia solium* (Dorny *et al.,* 2004). People may have little or no symptoms for years, develop approximately one to two centimeter painless solid bumps in the skin and muscles, or have Neurocysticercosis if the brain is affected. After months or years these bumps can become painful and swollen. In developing countries this is one of the most common causes of seizure (Garcia and Brutto, 2005).

The adult tapeworms are found in the intestines of humans while the larval stages are in muscles of cattle and pigs, respectively. Three most common sites of infection in human (primary host) are the brain (*Neurocysticercosis*- one of the most important causes of acquired epilepsy in endemic areas), muscles (*Cysticercosis*) and intestine (*Taeniasis*). Humans acquire an intestinal tapeworm by eating raw or undercooked meat infected with cysticerci. In most countries measures are taken to prevent humans from becoming infected with meat-borne helminths by inspecting the meat in the slaughterhouse or laboratory. Human *cysticercosis* is not acquired by eating meat but through accidental ingestion of eggs shed with the stools by a tapeworm carrier.

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 feaces from outdoor facilities, and veterinary inspection of meat does not exist or is inadequate, thus facilitating the continuous transmission of the disease. The increasing demand for pork meat in urban areas may result in the transport of infected meat from rural communities to large urban populations. Neurocysticercosis (NCC), the most serious complication of the disease, is associated with seizures, headaches, intracranial hypertension, focal neurological disorders, hydrocephalus, encephalitis, and occasionally with psychiatric manifestations and dementia (Garcia and Brutto, 2005).

Cysticercosis remains a major neglected tropical disease of humanity in many regions, especially in sub-Saharan Africa, Central America and elsewhere where pigs are raised and consumed. Among food borne diseases in Eastern and Southern Africa, porcine cysticercosis is ranked low except in South Africa (Jabbar and Delia, 2012). It has been estimated that millions of persons worldwide are infected with *T. solium*, mainly in Latin America, South and South-East Asia and Sub-Saharan Africa. 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).

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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). 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. It has been reported that *T. solium* cysticercosis is the main cause of acquired epilepsy in human population and results in considerable public health problems and economic costs to the endemic countries. Although the socioeconomic impact and public health burden of cysticercosis have been demonstrated, up to now no large-scale control programme has been undertaken in Africa. Most disease control trials reported in the literature have been located in Latin America and Asia (Gonzalez *et al.,* 1997).

Control of *T. solium* is based on health education, improvement of sanitation and pig husbandry systems, meat inspection and mass treatment of humans. Novel approaches include single dose treatment with oxfendazole of pigs and vaccination of pigs with recombinant antigens (Gonzalez *et al.,* 1996). Both methods are promising but need to be validated in the field.

Pig production has increased significantly in the Eastern and Southern Africa (ESA) region during the past decade, especially in rural, resource-poor, smallholder communities. Concurrent with the increase in smallholder pig keeping and pork consumption, there have been increasing reports of porcine cysticercosis in the ESA region (Mukaratirwa *et al.,* 2003). Pig farming in Kenya is important with various production systems from free-range to intensive keeping in confinement. Some of the production systems may increase the risk of disease transmission. Previous studies in Homa Bay and Busia in Kenya reported presence of disease at prevalences of 32.8% and 6.5% (Githigia *et al.,* 2007; Eshitera *et al.*, 2012) respectively. With the increase in small holder pig production and pig consumption there has been an increase in number of reports of cysticercosis from Thika, Kenya while no study has been done in this region.

MATERIALS AND METHODS

A community survey was carried out using semi-structured questionnaires to capture socio-demographic data, water and sanitation, pig husbandry and practices, pork consumption and awareness on *T. solium taeniasis*. The

questionnaires were administered to the household head or any adult member of the household. All respondents were also requested to provide a stool sample for laboratory parasitological evaluation for *T. solium* eggs or proglottids. Microscopic examination was done by the direct wet film and iodine stained procedures. The samples were examined for eggs, larvae, or scolexes of different types of microorganisms as well as helminths. To differentiate *Taenia* spp eggs lacto phenol (50/50 liquefied phenol crystals in lactic acid) and Indian ink was injected into the pores and the number of primary uterine branches counted to determine the species (7-13 for *T. solium* and 12-30 for *T. saginata*).

All pork eatery owners in the identified areas were approached and requested to participate in the study. Systematic random sampling was done for the pork eateries and pork meat consumers found in the premises. A semi structured question was used to collect data on the participants' level of awareness on taeniasis and cysticercosis, mode of preparation of the pork, frequency of pork meat consumption, and food handlers knowledge on basic food hygiene.

A hospital based study was conducted at Thika sub County Level 5 Hospital. The hospital data for the last ten years was scrutinized for any confirmed cases of *Taeniosis* or *cysticercosis* by parasitological evaluation or radiology for the last 10 years. Outpatients with diarrhoea or abdominal pains and severe headaches for a period of three months were recruited for this study. A semi-structured questionnaire was administered to willing outpatients to provide information on socio demographic data, any involvement on rearing of pigs, consumption of pork and source of the pork, knowledge and association of epilepsy with pigs. The participants were requested to provide a stool sample for laboratory evaluation to determine the prevalence of taeniosis.

A field survey on pig rearing farms was conducted in Thika region. Pig husbandry and management practices were recorded, describing the pig production systems in relation to numbers, housing and feeding. A semi-structured questionnaire to investigate farmers' perceptions on *porcine cysticercosis* was administered to one adult member in each household who was involved in pig husbandry. Particular emphasis was laid on the factors that may contribute to transmission of *porcine cysticercosis*.

Systematic random selection of every 5th pig presented for slaughter at Thika abattoir was done until 300 pigs were selected. Blood samples were collected in plain tube without anticoagulant from the cava vein during slaughter, allowed to clot and serum was harvested. Cysticercosis Ag ELISA invitro diagnostic kit (apDia, Belgium) was used to detect circulating antigens in the serum and indicates the presence of viable cysts. The current evaluation of *porcine cysticercosis* depends on demonstration of cysts in striated muscles during routine meat inspection. The 300 randomly selected pigs were followed at post mortem phase of meat inspection and observations without interfering with the routine procedures.

All data collected were ascertained for completeness, entered into the statistical software SPSS (Special Program for Social Scientists) version 20 for analysis. The statistical operations were performed with both descriptive and analytical statistics. Data pertaining to the demographics, knowledge and practices relating to human taeniosis and *porcine cysticercosis* were analyzed using medians and frequencies for descriptive statistics. For bivariate analysis odds ratios, chi square and significance level of confidence intervals (95% CI) was calculated. For the multivariate analysis, logistic regression modeling was carried out to evaluate the association between the practices and the

knowledge, and also to control for confounding.

This research was reviewed and approval granted by the Kenyatta University Ethics Research Committee. Permission to carry out the research was granted by National Commission for Science, Technology and Innovation and the County Government of Kiambu County, Medical Officer of Health and Director of Veterinary services. Informed written consent from individual participating adults and guardians of children, assent from participating children under the age of 16 years was given. Participants were recruited on a voluntary basis and were free to withdraw from the study at any time with no negative response. There was no monetary gain for participants in this study but health education and appropriate advice was given. Any participants positive for taeniasis were advised to seek medical care. For pig farms that were positive for *porcine cysticercosis*, the farmers were advised on good pig husbandry practices that would stop transmission of *cysticercosis*.

RESULTS

On evaluation of the stool samples, a total of 26 samples out of the 384 participants sampled from the community (6.7%) were found to be positive with *T. solium*. Prevalence was found to be significantly associated with the ward of the respondent with no difference in gender or age. Majority of the positive cases were among participants who had lack of latrine facilities and those who preferred fried pork. Other risk factors associated with occurrence of *Taenia solium taeniasis* was lack of deworming by the participants. Majority of the community members were not aware of the life cycle of *Taenia solium*, or the risk factors that may lead to its transmission.

Most of the vendors and consumers answered correctly the question on what tape worms were. However, none was able to identify all the practices that would promote the spread of *T. solium* Vendors and consumers run away from the responsibility of controlling the spread of *T. solium* Awareness of the disease, factors that may contribute to its transmission and control was low among pig meat vendors and consumers. Most of the consumers preferred their pork fried which could be a risk as some cysts are not destroyed by this method.

On evaluation of the hospital records for 2005 to 2015, thirteen cases were positive for *Cysticercosis* with cysts appearing in the eyes and other tissues. In seven of the cases, the cysts were located in the eyes, five in other tissues while one of the cases was unspecified. The positive cases occurred in all age groups with no differences in the gender. However, none of these cases were associated with epilepsy though the condition is present in the study area.

Majority of farmers in Thika kept small herd sizes of less than 10 pigs. Zero grazing system where pigs are fed in confinement throughout the year is practiced by almost all farmers in Thika. Although most farmers preferred feeds from manufacturers, the need to cut cost on production has made some farmers to exploit other feed sources that cost less which include swill, house hold left over, fodder from garden, home mixed feeds and neighbours' left over. Most farmers were keen to keep their pigs healthy by de-worming them as well as seeking veterinary services.

Out of 81 farms that were visited, five farms had a positive case giving a farm prevalence of 6.2%. Lingual palpation test for cysticercosis was performed in 273 pigs where five pigs were found to be positive, the prevalence of *cysticercosis* was therefore found to be 1.83 %. *Cysticercosis* status was associated with source of household income, feeding pigs on left-over, and swills from garbage, cooking of swill and frequency of de-worming. Pigs from

respondents whose main source of income was crop farming were at a higher risk of *cycticercosi*s. While feeding pigs on home mixed feeds, left-over, swills from garbage and purchase of replacement pigs were found to increase the risk of pig cysticercosis.

Though none of the pigs examined at the slaughterhouses during the study period had cysts either in the mouth or tissues following routine meat inspection, a seroprevalence of 2.71 was recorded.

DISCUSSION

The findings of this study concur with WHO (2017) prevalence estimates of *Taeniasis* by all tapeworm species which stand at 13.5% and a study carried out in Taiwan, on *T. solium Taeniasis* prevalence which was found at 6%. The findings of this study are also consistent with those found in endemic areas especially in Asia, Latin America and sub Saharan Africa. Prevalence in sub Saharan Africa is estimated at 2.4-10.8% (Gomes *et al.,* 2002). The findings of this study are consistent with prevalence that has been found by other studies in sub Saharan Africa. In Zambia the prevalence was found at 6.3% (Mwape *et al.,* 2012). Mwanjali *et al.* (2013) reported that the prevalence in Burundi was 6.9%, and in Senegal 7.7% both estimated using microscopic examination of stool. In Uganda, Kisakya and Masada (2002) found prevalence at 9.4%. In Busia district of Kenya, Githigia *et al.* (2002) found a prevalence of 4-10% based on a review of Busia district hospital records which is consistent with the study findings in Kiambu County.

CONCLUSIONS

This study concludes that *T. solium Taeniasis* is present among the community members in Kiambu County, but the majority of the respondents were not aware of this disease and therefore took no measures to mitigate disease spread. Major factors associated with its occurrence were lack of latrine, method of pork preparation and lack of deworming medication. The main risk to spread of *porcine cysticercosis* was feeding pig on uncooked swill.

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STATEMENT OF NO-CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this paper.

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