TAENIA SOLIUM CYSTICERCOSIS IN EASTERN AND SOUTHERN AFRICA: AN EMERGING PROBLEM IN AGRICULTURE AND PUBLIC HEALTH

HA Ngowi,[1] IK Phiri,[2] S Afonso,[3] E Matenga,[4] ME Boa,[1] S Mukaratirwa,[4] S Githigia,[5] M Saimo,[6] C Sikasunge,[2] N Maingi,[5] GW Lubega,[6] A Kassuku,[1] L Michael,[7] S Siziya,[2] RC Krecek,[8] E Noormahomed,[3] M Vilhena,[9] G Nsengiyumva,[10] A Andriantsimahavandy,[11] P Dorny,[12] MV Johansen[13] and AL Willingham III[14]

[1]Sokoine University of Agriculture, Morogoro, Tanzania; [2]University of Zambia, Lusaka, Zambia; [3]Universidade Eduardo Mondlane, Maputo, Mozambique; [4]University of Zimbabwe, Mt Pleasant, Harare, Zimbabwe; [5]University of Nairobi, Nairobi, Kenya; [6]Makerere University, Kampala, Uganda; [7]Onderstepoort Veterinary Institute, Onderstepoort, South Africa; [8]University of Pretoria, Pretoria, South Africa; [9]Universidade de Évora, Evora, Portugal; [10]Ministère de la Santé Publique, Département de la Promotion de la Santé,l'Hygiène et l'Assainissement, Bujumbura, Burundi; [11]Cysticercosis Laboratory, Institut Pasteur de Madagascar, Antananarivo, Madagascar; [12]Prince Leopold Institute of Tropical Medicine, Antwerp, Belgium; [13]Danish Bilharziasis Laboratory, Charlottenlund, Denmark; [14]WHO/FAO Collaborating Center for Parasitic Zoonoses, Danish Center for Experimental Parasitology, Department of Veterinary Microbiology, Royal Veterinary and Agricultural University, Frederiksberg, Denmark

Abstract. Pig production has increased tremendously in Eastern and Southern Africa (ESA), particularly in smallholder rural communities. The increase in pig production has mainly been due to land scarcity, increase in pork consumption in many areas including urban centers, and the recognition by many communities of the fast and greater return of the pig industry, compared with other domesticated livestock industries. Concurrent with the increase in smallholder pig keeping and pork consumption, there have been increasing reports of *Taenia solium* cysticercosis in pigs and humans in the ESA region, although the problems are under-recognized by all levels in many ESA countries. Having recognizing this, scientists researching *T. solium* in ESA formed a regional cysticercosis working group (CWGESA) to increase awareness of the problem and enable effective and sustainable control of *T. solium.* This article summarizes the status of *T. solium* infections in humans and pigs in the ESA countries and highlights the formation and progress of the CWGESA.

INTRODUCTION

It was revealed from previous studies that pig production has increased tremendously in the past decade in eastern and southern Africa (ESA), especially in smallholder rural communities (Phiri *et al,* 2003a). Several factors have contributed to increased rural pig production, including lack of grazing land for ruminants, recognition by many communities of the faster and greater return when investing in pig enterprises than in other livestock, and increase in pork consumption in rural and urban areas of the region. Despite the increase in rural pig production in the ESA, most pigs are reared in rural areas under traditional systems, most of which are characterized by free-range with poor, if any, housing provided. Many areas in the region lack slaughterhouses for pigs, meat inspection services, and control of pork. Recent studies conducted in several countries of the ESA region revealed that porcine cysticercosis caused by the zoonotic tapeworm *Taenia solium* is emerging as a serious problem affecting the economic wellbeing of smallholder pig producers in rural areas and posing human health risks in the general population (Heinz and MacNab, 1965; Andriantsimahavandy *et al,* 1997; Ngowi, 1999; Afonso *et al,* 2001; Githigia *et al,* 2002; Kisakye and Masaba, 2002; Phiri *et al,* 2002; Matenga *et al,* 2002; Nsengiyumva *et al,* 2003). Increases in the prevalence of human epilepsy in countries endemic for porcine cysticercosis in the ESA, without a clear etiology, has also drawn interest in research into the role of *T. solium* as a possible cause of epilepsy in the region. It was further noted that despite the high prevalence of *T. solium* infections in pigs and humans in the ESA, the problems are under-recognized by all levels of many communities in the region. Having recognized this, scientists conducting research on *T. solium* in the ESA formed a regional cysticercosis working group referred to as the Cysticercosis Working Group in eastern and southern Africa (CWGESA), in order to facilitate increased awareness of the problem and help promote a coordinated regional approach for

Correspondence: HA Ngowi, Sokoine University of Agriculture, PO Box 3135, Morogoro, Tanzania.
E-mail: h_ngowi@yahoo.com

research and control of *T. solium* while making more effective and efficient use of scarce resources (Mukaratirwa *et al,* 2003). The CWGESA was initiated in 2001 with the founding member countries Tanzania, Kenya, Uganda, Zambia, Zimbabwe, Mozambique, and South Africa, in various veterinary institutions. It was anticipated that other countries in the ESA, as well as other disciplines and sectors, would be represented in the group when they recognized the problem and participate in the activities. This article summarizes the status of *T. solium* infections in the current ESA countries and highlights the progress of the CWGESA.

MATERIALS AND METHODS

Eastern and southern Africa countries as far as the cysticercosis-working group is concerned, currently include Tanzania, Kenya, Uganda, Burundi, Zambia, Zimbabwe, Mozambique, South Africa, and Madagascar. Most of the reported findings for porcine cysticercosis in the ESA region are based on surveys utilizing lingual observation and palpation of live pigs, retrospective examination of abattoir records, and post-mortem (PM) examination of slaughtered pigs. A few studies have, however, used serological assays, mostly enzyme-linked immunosorbent assays (ELISA). Reported findings for human cysticercosis in the ESA region have mostly been obtained through monitoring of hospital-based patients with neurological conditions, while a few results were obtained through community-based serological surveys of particular socio-economic groups of people. Risk factors associated with the prevalence of porcine and human cysticercosis were assessed through observations supplemented with questionnaire interviews of pig producers and extension workers.

RESULTS

Prevalence of porcine cysticercosis in the ESA region

The prevalence of cysticercosis in pigs in the ESA region, based on various methods of detection is presented in Table 1. Risk factors associated with the prevalence of porcine cysticercosis in the region include free-range pig rearing, lack of toilets or poor hygiene, eating infected pork, drinking unboiled water (especially from a river), poor meat inspection, and lack of knowledge of the mode of transmission of the parasite.

Prevalence of human cysticercosis in the ESA region

Eastern Africa. Little information is available about human cysticercosis in Tanzania. However, questionnaire surveys in areas endemic for porcine cysticercosis revealed that human epilepsy and taeniasis are highly prevalent. Unofficial data collected in a district in the northern highlands of the country revealed that 36.2% of 58 suspected epileptic patients had circulating antigens for *T. solium*, suggesting that human cysticercosis may be prevalent in the area.

In Kenya, two cases of human neurocysticercosis were recorded in 1986, one at Nairobi Hospital and one resident of Kakamega District in the southwestern part of Kenya. One of the cases also had an ocular cyst. The prevalence of human taeniasis is estimated to range from 2-10%. Cases of epilepsy are common, especially in Busia District, where free-range pig keeping is practiced.

Although Uganda has the largest number of non-commercially raised pigs in the ESA region, human cysticercosis has not been noted as a problem in the country. However, the public health risk of human cysticercosis is high, given the observed prevalence of porcine cysticercosis in the country and in the bordering areas of Kenya.

Serological surveys of epileptic patients in Burundi from 1990-2001 estimated the prevalence of human cysticercosis to rage from 11-41%. A study in 1997 estimated a sero-prevalence of 2.8% in the general population.

Southern Africa. In Zambia, there have been recent reports of people manifesting the disease in the form of subcutaneous nodules. An ongoing study designed to assess the presence and burden of human *T. solium* infections in urban Lusaka has thus far estimated a prevalence of 10% of human cysticercosis by antigen-ELISA and 7.5% of taeniasis by stool examination in 40 suspected epileptic individuals (Phiri *et al,* 2003b).

In Zimbabwe, an x-ray study in Bulawayo reported calcified cysts in 11% of patients who presented with seizures. In one serological survey in a hospital in Harare, 12% of epileptic patients were found positive for *T. solium*. Calcified cysticerci are common incidental findings on chest or limb x-rays and neurocysticercosis is an occasional diagnosis at surgery for intra-cranial or spinal lesions.

The first post-mortem case of human neuro-cysticercosis in Mozambique was reported in 1968, followed by a clinical case that was reported in 1999, at Maputo Central Hospital. Several studies have, however, examined epileptic patients and the estimated prevalence range was 12.1-20% using ELISA.

Table 1
Prevalence of porcine cysticercosis in eastern and southern Africa region based on various methods of detection.

Country	Area surveyed	Method of detection	Number of pigs examined	Prevalence (%)	Reference
Tanzania	Northern highlands	Abattoir	45,794	0.04-4.90	Nsengwa (1995)
	Northern highlands	PM	83	4.50-37.70	Boa *et al* (1995)
	Northern highlands	Lingual	770	7.30-17.40	Ngowi (1999), Ngowi, 2003 (unpubished data)
	Southern highlands	Lingual	1,789	5.50-16.90	Boa *et al* (2002), (unpublished data)
Kenya	Busia and South Nyanza District	Lingual	407	10.00-14.00	Githigia *et al* (2002)
Uganda	Northern District	PM	897	33.70-44.50	Anyanzo (1999); Kisakye and Masaba (2002)
Burundi	Various			2.00-39.00	Newell *et al* (1997)
Zambia	Southern Province	PM, Ag-ELISA	1,316	20.60, 56.60	Phiri *et al* (2001)
	Eastern Province	Lingual, Ag-ELISA	151	5.20, 9.30	Phiri *et al* (2002)
	Southern Provinces	Lingual, Ag-ELISA	98	8.20, 20.80	Phiri *et al* (2002)
Zimbabwe	National	Abattoir	1,000,000	0.03-4.30	Robinson (1978)
	Western region	Abattoir	99,525	2.70-28.60	Matenga *et al* (2002)
Mozambique	Tete Province	Serology	387	6.50-33.30	Afonso *et al* (2001)
South Africa	National	Abattoir	> 100,000	0.00-25.10	Viljoen (1937); Heinz and MacNab (1965)
	Eastern Cape	Lingual	191	Up to 55	Krecek (2003), (unpublished data)
Madagascar	Data not available				

Hospital records in Kwazulu-Natal, in South Africa, revealed a prevalence of human taeniasis of <1 to 16%. The prevalence of human cysticercosis has been related to the area of origin and the race of the patient. Human cysticercosis appears to be most prevalent in Eastern Cape Province, particularly in the poor, former black homeland, rural areas of Transkei and Ciskei where pigs are allowed to roam freely and sanitation is largely absent. In these areas, a prevalence of up 20% has been found using serological methods. A few studies in other areas of the country have indicated that all provinces have foci of transmission, but the prevalence depends on pig-rearing methods, meat control measures, and the socio-economic conditions in the area. Juvenile cases are common and it is common to observe epilepsy in patients with active cysts. Interesting and alarming sources of human cysticercosis in South Africa include a mixture prepared by traditional healers in which tapeworm segments are added and the mixture is used to treat severe intestinal tapeworm infections. Another practice is whereby some women add the contents of tapeworm segments to beer as a punishment to their unfaithful husbands or lovers.

Human cysticercosis was first reported in Madagascar, in 1969. Serological surveys of epileptic adults and children estimated a prevalence ranging of 17.6-36%. Six serological surveys conducted between 1994 and 1999 in different areas estimated a prevalence range of 7-21%. Neurocysticercosis in Madagascar

has been found to be associated with epilepsy, blindness, and vegetable production.

DISCUSSION

Data presented in this review clearly indicate that porcine cysticercosis is widely prevalent in the region preventing smallholder farmers from marketing their pigs. Because most of the studies of porcine cysticercosis in the ESA region used less sensitive diagnostic tests, such as lingual and meat examination methods, the reported figures are probably an underestimate of actual prevalence. There is more evidence from South Africa on the prevalence of human neurocysticercosis as compared to the other ESA countries. This may be attributed to a greater awareness and more resources than elsewhere, especially with regard to the diagnostic facilities for human cysticercosis. The observation of epileptic seizures in patients with active *T. solium* cysts in South Africa contrasts with findings from Latin America, whereby seizures are commonly observed in individuals with calcified cysts. Another important observation in the ESA region is the presence of vertical transmission of porcine cysticercosis that was recently observed in Uganda. More studies are needed in the ESA region to assess the actual prevalence and impact of *T. solium* infections in the region and investigate effective prevention and control measures.

Current status of the CWGESA

Since the formation of the CWGESA, several activities have been done or initiated. In August 2002, the CWGESA organized an international action-planning workshop on cysticercosis/taeniasis with special focus on the ESA that was held in Arusha, Tanzania, involving scientists, government authorities, health and veterinary officials, community leaders, and delegates from international and regional support agencies (Anonymous, 2003). One of the objectives of the workshop was to share evidence of *T. solium* infections in the ESA region with relevant persons, regionally and internationally, to activate will, interest, and support for further studies, surveillance, and control efforts. The workshop also aimed at formulating an action plan to guide regional activities. It was found necessary to have multidisciplinary and intersectoral initiatives in order to effectively combat the problem. It was also found important to have global networking to increase awareness of the problem and facilitate support and cooperation in regional activities related to *T. solium* control. The CWGESA has had several other achievements since its formation, including acquisition of some funds for regional activities from various entities regionally and internationally, and linking its activities with ongoing related activities, such as a study to assess the global burden of *T. solium* cysticercosis/taeniasis sponsored by the WHO, and a study to assess the effectiveness of health education intervention in reducing the incidence of porcine cysticercosis in northern Tanzania, which is sponsored by DANIDA. Currently, the working group is in the process of registering as a non-governmental organization, as agreed by its members during their second general meeting that was held in Dar es Salaam, Tanzania, in 2003.

REFERENCES

Afonso SMS, Neves L, Afonso CMCS, Nota A, Vilhena M, Ito A. *Cysticercosis cellulosae* in Tete Province, Mozambique. Proceedings of the Workshop on Human Helminth Infections 'Future Research Foci', Lusaka, Zambia. 2001.

Andriantsimahavandy A, Lesbordes JL, Rasoahari-malala B, *et al*. Neurocysticercosis: a major aetiological factor of late-onset epilepsy in Madagascar. *Trop Med Int Health* 1997;2:741-6.

Anonymous. Proceeding of the International Workshop on *Taenia solium* Cysticercosis/ Taeniosis with Special Focus on Eastern and Southern Africa. Arusha, Tanzania. *Acta Trop* 2003;87:1-186.

Anyanzo T. Prevalence of *Cysticercosis cellulosae* in three sub-counties of Moyo County, Moyo District, Uganda. Bachelor of Veterinary Medicine, special project report, 1999.

Boa ME, Bogh HO, Kassuku AA, Nansen P. The prevalence of *Taenia solium* metacestodes in pigs in northern Tanzania. *J Helminthol* 1995;69**:**113-7.

Githigia SM, Murekefu K, Ngesa SM, Otieno RO, Kahai R. The prevalence of porcine cysticercosis and risk factors in Busia District, Kenya. Proceedings of the 11th Annual Meeting of ENRECA Livestock Helminths Research Project in Eastern and Southern Africa, Lusaka, Zambia. 2002.

Heinz HJ, MacNab GM. Cysticercosis in the Bantu of southern Africa. *S Afr J Med Sci* 1965;30:19-31.

Kisakye JJM, Masaba SC. *Cysticercus cellulosae* in pigs slaughtered in and around Kampala City. *Uganda J Agric Sci* 2002;7:23-4.

Matenga E, Mukaratirwa S, Willingham AL. Prevalence of porcine cysticercosis and hydatidosis in slaughtered animals in southwestern Zimbabwe: a retrospective study. Proceedings of the 11th Annual meeting of ENRECA Livestock Helminths Research Project in Eastern and Southern Africa, Lusaka, Zambia. 2002.

Mukaratirwa S, Kassuku AA, Willingham AL, Murrell KD. Background to the international action-planning workshop on *Taenia solium* cysticercosis/taeniosis with special focus on Eastern and Southern Africa. *Acta Trop* 2003;87:3-5.

Newell E, Vyungimana F, Geerts S, Van Kerckhoven I, Tsang VC, Engels D. Prevalence of cysticercosis in epileptics and members of their families in Burundi. *Trans R Soc Trop Med* 1997;91:389-91.

Ngowi HA. Endoparasites of zoonotic importance in pigs in Mbulu District, Tanzania. Faculty of Veterinary Medicine, Sokoine University of Agriculture, Tanzania. 1999. Masters Dissertation.

Nsengiyumva G, Druet-Cabanac M, Ramanankandrasana B, Bouteille B, Nsizabira L, Preux P-M. Cysticercosis as a major risk factor for epilepsy in Burundi, East Africa. *Epilepsia* 2003;44:950.

Nsengwa GRM. Porcine cysticercosis in northern Tanzania between 1985-1988, *Tanzania Vet J* 1995;15:9-11.

Phiri IK, Dorny P, Gabriel S, *et al*. The prevalence of porcine cysticercosis in Eastern and Southern Provinces of Zambia. *Vet Parasitol* 2002;108:31-9.

Phiri IK, Gabriel S, Dorny P, Willingham AL, Vercruysse J. Cysticercosis in Zambia. Proceedings of the 18th International Conference of the World Association for the Advancement of Veterinary Parasitology, Stresa, Italy. 2001

Phiri IK, Ngowi H, Afonso S, *et al*. The emergence of *Taenia solium* cysticercosis in Eastern and Southern Africa as a serious agricultural problem and public health risk. *Acta Trop* 2003a;87:13-23.

Phiri IK, Siziya S, Sikasunge CS, Willingham III AL, Dorny P. A human taeniosis/cysticercosis survey in Lusaka, Zambia: preliminary results. Proceedings of the 12th annual meeting of the ENRECA Livestock Helminths Research Project in Eastern and Southern Africa. 2003b.

Robinson JTR. Some epidemiological, economic and legislative aspects of bovine and porcine cysticercosis in Rhodesia. 1978. Masters Thesis.

Viljoen NF. Cysticercosis in swine and bovines, with special reference to South African conditions. *Onderstepoort J Vet Sci Anim Husbandry* 1937;9:337-570.