

The Financial Costs Associated with Porcine Cysticercosis and Epilepsy in Iringa Rural District

Gamba Nkwengulila

Department of Zoology and Wildlife Conservation, University of Dar Es Salaam, Dar es Salaam, Tanzania
Email: gamba@udsm.ac.tz

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Abstract

Taenia solium cysticercosis is a zoonotic disease that poses serious public health risk and significant economic losses in the pig industry. Human neurocysticercosis is recognized as an important cause of epilepsy in regions where *T. solium* is endemic. The monetary burden caused by *T. solium* cysticercosis condemned pigs and epilepsy is under-reported in Tanzania, Iringa rural district being no exception. The aim of the present study was to estimate the financial costs associated with porcine cysticercosis (PCC) and epilepsy in Iringa rural areas. The study employed questionnaires and interviews to explore the public health and socio-economic impacts of *T. solium* cysticercosis. A total of 365 randomly selected participants comprising of 306 pig farmers and 59 families with epileptic patients were involved in the survey. The findings indicated that the average selling price was USD 84 for mature pigs and ranged from USD 13 - 27 for piglets. The estimated annual monetary loss due to PCC was USD 144,449. The estimated monetary burden due to epilepsy management in hospitals and/or by traditional healers was USD 78,592 per annum. It is concluded that the monetary burden incurred by pig farmers due to PCC caused economic loss at both the subsistence and commercial levels. Yet, epilepsy has serious potential economic impacts through direct and indirect costs incurred on the management of epileptic patients from family to national level. It is hence recommended to practice indoor pig keeping for the elimination of economic losses caused by PCC infection. There is an urgent need to raise awareness on the economic burden caused by porcine cysticercosis and epilepsy in Iringa rural district.

Keywords

Taenia solium, Costs, Porcine, Cysticercosis, Epilepsy

1. Introduction

Pig production is important in improving the economy and livelihoods of many families in developing countries [1]. The advantage of keeping pigs over other livestock is that pigs grow faster, have high fecundity and short gestation period, can feed on leftover food and are very easy to sell [2]. Thus pigs are kept as a cash reserve to be used whenever there is emergence such as medical needs, school fees or food between harvest seasons [3]. Unfortunately, a parasitic disease caused by *Taenia solium* affects the pig industry resulting into economic losses because of condemnation of pork [4].

The annual economic loss estimated in 10 West and Central African countries due to porcine cysticercosis was about 25 million Euros [5]. In Cameroon the annual losses in the pig industry together with direct and indirect costs caused by human cysticercosis were estimated to be 10 million Euros [6]. Porcine cysticercosis can cause market crisis during the selling of pigs [7], a common phenomenon in endemic developing countries. Often infected pigs would require some treatment before being sold; if not condemned the selling price decreases by 25% - 50% of the market price [8]. Unfortunately, earlier studies focused on pig health and the economic aspects were not considered as important in the control of porcine cysticercosis [9]. Therefore, analyzing the parasite's economic impacts on pig production would highlight the economic problems to pig farmers, the general community and the control strategy that could be put in place [1].

Cysticercosis, especially neurocysticercosis in human, results in serious health problems in many developing countries because it is one of the main causes of late onset epilepsy [6]. The problem is socially important and medically grave due to unreliable drugs for treatment and/or poor prognosis that lead to mortality in underprivileged communities [10]. The direct and indirect costs due to epilepsy management are growing as the number of people with epilepsy in the communities is increasing [11]. Although the government services for treatment of epilepsy are free, the public has no confidence in the public health services; consequently, many patients use private services, incurring high direct and indirect costs [12]. Unfortunately, in Tanzania such economic losses due to both porcine cysticercosis (PCC) and epilepsy have not been quantified, whether in a single district or in a country as a whole. Therefore, the objective of the present study was to estimate the financial costs associated with porcine cysticercosis and epilepsy irrespective of the causes in Iringa rural district.

2. Materials and Methods

2.1. Study Site

The study was carried out in twenty-six villages selected from seven wards of Iringa rural district in Iringa region (Figure 1). The district lies at 1600 m to 2700 m above sea level in southern highlands of Tanzania. Temperatures are normally below 15°C with rainfall ranging between 1000 mm to 1600 mm per annum falling in a single season from November to May. The dry and cold seasons occur after the rain season and lasts from June to September.

2.2. Methods

2.2.1. Study Design and Population Surveyed

This was a cross-sectional survey using questionnaires, interviews and direct observation, and was carried out from September 2011 to August 2012. Using simple random sampling a total of 365 participants from seven wards and twenty-six villages were selected to participate in the study, whereby 306 were pig producers and 59 families with epileptic individuals.

2.2.2. Data Collection

The data from the selected households were collected using a structured questionnaire, interview and direct observation. The structured questionnaire for financial costs estimation covered questions on the duration of keeping pigs to market weight, costs of pig food, amount of food enough for one pig per day, costs incurred for prevention and treatment of PCC, selling price, loss incurred because of *T. solium* cysticercosis infection in pigs and epilepsy treatment costs incurred by families with epileptic individuals. The total revenue and costs were computed depending on the variables: total revenue = $S^{pr} \times N^t$; where S^{pr} is the selling price and N^t is the number of pig producers or number of participants.

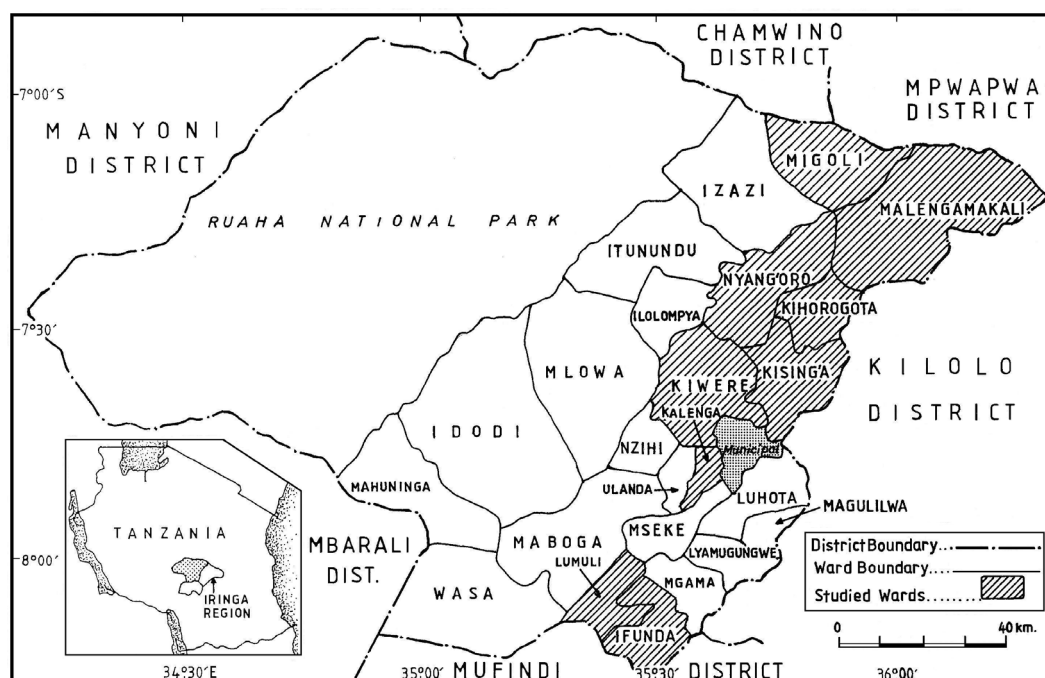


Figure 1. Iringa rural district, study sites.

2.2.3. Data Analysis

Data for financial costs estimation were analyzed using the statistical package for social sciences version 19.0 for windows (SPSS Inc., Chicago IL, USA). The same programme was used for descriptive analysis on variables quantification. 95% confidence interval was used for various factors at the individual level. The significance for non-parametric data was tested using Chi-square and parametric data were tested using t-test. The cost in terms of money was presented in USD (exchange rate used was 1 USD = 1500 TZS). The p-values of less than or equal to 0.05 was considered statistically significant.

3. Results

3.1. General Considerations of the Pig Industry in Iringa Rural District

Based on the surveyed population, 79.8% (95% CI = 2.72 - 2.83, $t_{(301)} = 102.447$, $p < 0.001$) of pig farmers kept pigs for more than six months before selling, and raised not more than five pigs per year. Most pig keepers 85.5% (95% CI = -0.791 - 0.633, $t_{(305)} = 17.730$, $p < 0.05$) sold pigs in their villages. The average cost for one kilogram of feed for pig was USD 0.14. About 82.7% (95% CI = 0.553 - 0.728, $t_{(305)} = 14.330$, $p < 0.05$) of pig keepers preferred industrial feeds such as maize and wheat bran, cotton and sunflower seed cakes for their pigs and 17.7% preferred grass and garbage. The average amount of food for one pig per day was 2 kilograms (Table 1).

3.2. Estimation of Costs for Rearing a Pig to Market Weight

The costs for rearing a pig to market weight were estimated by considering various factors including costs of keeping pigs indoor. An average of 918 pigs were surveyed from 306 pig farmers, and 7 months were the average time required by penned pigs to reach market weight (MW). The average feed cost was USD 0.14 for one kilogram, thus the feeding costs for one penned pig to reach MW were USD 58.80. The total feeding costs for pigs surveyed in the study were USD 2.1 million throughout the rearing period to MW. The cost for pigpen construction ranged between USD 17 - 34 and USD 3 - 13 for new investors and continuous pig investors, respectively. The pigpen construction and maintenance cost an average of USD 14.9 and the veterinary services cost an average of USD 3.1 per annum. Therefore, the total costs for pigpen and veterinary services were estimated to be USD 0.2 million for the pig farmers surveyed. Hence, the total cost of rearing pigs to MW in the surveyed pig farmers was estimated to be USD 2.3 million.

Table 1. Responses on the financial costs estimation to the pig industry.

Factors	Response (%)
Time to market weight (n = 302)	
4 months	7 (2.3)
6 months	54 (17.9)
6< months	241 (79.8)
Number of pigs per farmer (n = 306)	
<5	193 (63.1)
5	48 (15.7)
>5	65 (21.2)
Number of pigs sold per year (n = 301)	
<5	218 (72.4)
5	31 (10.3)
>5	52 (17.3)
Costs for 1kg of feed in USD (n = 276)	
0.06 - 0.2	171 (62)
0.3 - 0.4	59 (21.4)
0.5 - 0.7	12 (4.3)
>0.7	34 (2.3)
Pig feed used (n = 306)	
Grass	7 (2.3)
Industrial feed	252 (82.4)
Garbage	47 (15.4)
Food enough for one pig per day in Kgs (n = 274)	
2-Jan	174 (63.5)
3-Feb	100 (36.5)
Market for pigs (n = 304)	
Transported to other places	44 (14.5)
Within their villages	260 (85.5)

3.3. Estimation of Economic Loss Due to Porcine Cysticercosis and Epilepsy

To estimate the economic loss associated with porcine cysticercosis, it was first necessary to consider the income generated by a pig farmer in the absence of infection. Only few pig keepers in Iringa rural district were able to estimate the costs incurred in raising pigs to market weight, while most of them were able to state the loss acquired due to PCC infection. With the exception of piglets, the average selling prices was USD 84 per pig, thus based on the estimated (n = 36,171) population of pigs, pig farmers in Iringa rural district in the absence of *T. solium* infection could generate about USD 3.0 million per annum. In Iringa rural district few pig farmers 20.7%, (95% CI = 0.623 to 0.856, $t_{(305)} = 3.457$, $p = 0.001$) could diagnose or detect cysticercosis in their pigs while most 79.3% (n = 306) could not detect the presence of cysticercosis in their pigs. The total number of infected pigs reported by the pig farmers was 59, about 6.4% of the surveyed pigs. 55.9% of pig keepers slaughtered their pigs at home and sold pork. About 27.2% of the infected pigs were sold at a reduced price ranging between 25% - 56.5% less than the market price, and 16.9% were totally condemned. The total annual loss due to condemned pigs (n = 2325) per year was estimated to be USD 0.05 million and the total annual loss due to partially condemned pigs (*i.e.* sold at reduced selling price) was estimated to be USD 0.04 million. Therefore, the total loss due to PCC was estimated to be USD 0.09 million (**Table 2**).

The costs for epileptic individuals computed per annum included treatment costs (comprised the transport and medicine costs) and the average was about USD 32 per individual. The total number of PWE in the surveyed

Table 2. Estimated losses due to PCC and epilepsy treatment costs in Iringa rural district.

Scenario	Average costs (USD)	Total (million USD)
Selling price for mature pigs	84	3.0
Cost for rearing one pig	58.8	2.1
Costs for pigpen & veterinary services	18	0.6
Total loss due to condemned pigs	84	0.05
Loss due to partially condemned pigs	37	0.04
Epilepsy treatment costs	32	0.08

population was 59 (10% of the surveyed population). Thus on average the total costs for management of epileptic cases in the area were estimated to be USD 0.08 million per year (n = 2500). Therefore, the total costs for both PCC and epilepsy were summed up and estimated to be USD 0.89 million being 55.6% due to PCC and 44.4% due to epilepsy treatment and other indirect costs (Table 2).

4. Discussion

The present study investigated the monetary burden caused by PCC and epilepsy of unknown causes from pig keeping communities in Iringa rural. Pig keepers had an average of 3 pigs because of high costs in feeding, veterinary, housing investment and caring as pig farmers are also engaged in other socio-economic activities. Investment and recurrent costs and the system of raising pigs were the main determinants to the number of pigs a farmer could keep [13]. The costs for pigpen construction and purchase of starting stock raised the costs for new investors (*i.e.* investing for the first time), whereas continuing investors needed only to repair the pigpens. The average cost of feeding one indoor kept pig to market weight reported in the present study was higher than the costs reported by [13]. This may be contributed by the value of the currency that changes from time to time and the regional differences. Most pig farmers could not afford to keep pigs indoors because of high feed costs and pigs were left to scavenge freely. Therefore, the free range keeping method (scavenging) and garbage's were options of feeding their pigs. Likewise, restless pigs due to inadequate quantity and quality of food supply reduced the growth rate of pigs, and further increased the time of attaining the market weight. Size variation and external appearance of pigs determined the selling price. The selling price found in the present study was more or less similar to the price reported in Mbulu district [13].

Rejected pigs due to infection by *T. solium* were commonly slaughtered at home (55.9%). The pork sold in this way earned money equivalent to market price. The lack of legal/public slaughter slabs and strict meat inspection and hygiene in remote villages promoted slaughtering PCC infected pigs at home. However, this was further attributed to the lack of knowledge in the general community on the consequences of consuming *T. solium* infected pork. Because most infected pigs are slaughtered and sold at home or street places, most pig farmers in Iringa rural rarely experience the economic loss caused by PCC. On the other hand those who could not sell at market price the loss ranged from 25% - 56.25% of the average market-selling price. The loss was 100% where pigs were completely condemned. However, the losses reported in the present study were higher than those reported in Western and Central Africa and Cameroon by [6], respectively.

One of the reasons for PCC persistence in Iringa rural is the persistent infection of *T. solium* in human. The central nervous system (CNS) is one of the predilection sites for *T. solium* cysticerci one of the main causes of late onset epilepsy. Neurocysticercosis is one of the neglected tropical diseases (NTD) [14] with considerable socio-economic and public health impacts. The present study looked at the social impacts and monetary burden of epileptic case management regardless of the causes. Most people with epilepsy (PWE) identified in the present study were above eighteen (age ranged between 19 - 48 years), a vital and energetic group, and usually a very productive group in any community. The costs for epileptic case management ranged from USD 32 - USD 100 per annum, which was unaffordable for most families because of poverty. However, for those who believed in public health services, the government incurred the medical expenses. On the other hand, where PWE sought the services of traditional healers, the individuals and their families incurred the expenses. Since epilepsy results into morbidity and/or mortality the community and families consider epileptic people as disabled who need care. The increased number of PWE in a community, therefore, leads to an increase in the number of people depen-

dent on others, which has a negative economic impact on affected families, as well as the government. The impact is particularly significant at family level as in poor rural areas the main economic activity is agriculture, which is heavily dependent on family labour (*i.e.* individual members in the family). Consequently, both porcine cysticercosis and epilepsy have a negative penalty economically.

5. Conclusion

The costs for food and veterinary services, ignorance and cultural issues were the limiting factors of keeping bigger herds of pigs. The costs for raising a pig to MW in intensive husbandry were not affordable to most pig farmers; they thus resorted to free range and tethering methods. The practice of slaughtering pigs on the streets or at home and selling the pork earned more or less equivalent to a healthy pig sold at market price. The large number of late onset epilepsy reported in the present study whose causes were unknown, could be a result of *T. solium* infection in the CNS. Hence it would be important to undertake a serological survey for confirmation of the source. The increased number of epileptic persons leads to loss of productive power as they cannot make a living for themselves but become dependent on the family, which thus suffers economically.

Limitation of the Study

Timely availability and insufficient funds were the major limitations to this study.

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References

- [1] Carabin, H., Cowan, L., Christine, M.B., Nash, T. and Willingham III, A.L. (2005) Methods of Assessing the Global Burden of *Taenia solium* Cysticercosis/Taeniosis. *Trends in Parasitology*, **21**, 327-333. <http://dx.doi.org/10.1016/j.pt.2005.05.009>
- [2] Cate, E.D., Florence, K.M., Mike, L. and Jared, M.W. (2011). Educating People Participating in the Pig Industry to Reduce Epilepsy Due to *Taenia solium*. *Novel Aspects on Epilepsy*, **12**, 213-220.
- [3] Engels, D., Urban, C., Belotto, A., Meslin, F. and Savioli, L. (2003) The Control of (Neuro) Cysticercosis; Which Way Forward? *Acta Tropica*, **87**, 177-182. [http://dx.doi.org/10.1016/S0001-706X\(03\)00064-0](http://dx.doi.org/10.1016/S0001-706X(03)00064-0)
- [4] Ngowi, H.A., Mkupasi, E.M., Lekule, F.P., Willingham III, A.L. and Thamsborg, S.M. (2011) Impact of Farmer Education on Their Knowledge, Attitudes, and Practices in Southern Tanzania: A Case for *Taenia solium* Control. *Livestock Research for Rural Development*, **23**, Article #2.
- [5] Zoli, A., Nguetkam, S.O., Nsame, D.N., Speybroeck, N., Ito, A., Sato, M.O. and Geerts, S. (2003) Neurocysticercosis and Epilepsy in Cameroon. *Transaction of the Royal Society of Tropical Medicine and Hygiene*, **97**, 683-686. [http://dx.doi.org/10.1016/S0035-9203\(03\)80103-7](http://dx.doi.org/10.1016/S0035-9203(03)80103-7)
- [6] Praet, N., Speybroeck, N., Manzanedo, R., Dirk, B., Denis, N.N., Zoli, A., Fabrice, Q., Pierre-Marie, P., Helene, C. and Stanny, G. (2009) The Disease Burden of *Taenia solium* Cysticercosis in Cameroon. *PLoS Neglected Tropical Diseases*, **3**, e406. <http://dx.doi.org/10.1371/journal.pntd.0000406>
- [7] Hanneke, M.B., Marco, M. and Josemir, S.W. (2008) The Global Burden and Stigma of Epilepsy. *Epilepsy & Behavior*, **12**, 540-546. <http://dx.doi.org/10.1016/j.yebeh.2007.12.019>
- [8] Engels, D. and Savioli, L. (2006) Reconsidering the Underestimated Burden Caused by Neglected Tropical Diseases. *Trends in Parasitology*, **22**, 363-366. <http://dx.doi.org/10.1016/j.pt.2006.06.004>
- [9] Foyaca-Sibat, H., Del Rio-Romero, A. and Ibanez-Valdes, L. (2004) Prevalence of Epilepsy and General Knowledge about Neurocysticercosis at Ngangelizwe Location, South Africa. *The Internet Journal of Neurology*, **4**.
- [10] Rodriguez-Hidalgo, R., Benitez-Ortiz, W., Praet, N., Saa, L.R., Vercruyssen, J., Brandt, J. and Dorny, P. (2006) Taeniasis-Cysticercosis in Southern Ecuador: Assessment of Infection Status Using Multiple Laboratory Diagnostic Tools. *Memorias Instituto Oswaldo Cruz, Rio de Janeiro*, **101**, 779-782. <http://dx.doi.org/10.1590/S0074-02762006000700012>
- [11] Praet, N., Kanobana, K., Kabwe, C., Maketa, V., Lukanu, P., Lutumba, P., Polman, K., Matondo, P., Speybroeck, N., Dorny, P. and Sumbu, J. (2010) *Taenia solium* Cysticercosis in the Democratic Republic of Congo: How Does Pork Trade Affect the Transmission of the Parasite? *PLoS Neglected Tropical Diseases*, **4**, e817.

<http://dx.doi.org/10.1371/journal.pntd.0000817>

- [12] Heap, J. (1990) Cerebral Cysticercosis as a Common Cause of Epilepsy in Gurkhas in Hong Kong. *Journal of Royal Army Medicine Corps*, **136**, 146-149. <http://dx.doi.org/10.1136/jramc-136-03-04>
- [13] Ngowi, H.A., Mlangwa, J.E.D., Carabin, H., Mlozi, M.R.S., Kassuku, A.A., Kimera, S.I. and Willingham III, A.L. (2007) Financial Efficiency of Health and Pig Management Education Intervention in Controlling Porcine Cysticercosis in Mbulu District. *Livestock Research for Rural Development*, **19**. <http://www.lrrd.org/lrrd23/1/ngow23002.htm>
- [14] Pokhrel, S., Reidpath, D. and Allotey, P. (2011) Investment in Social Science Research in Neglected Diseases of Poverty: A Case Study of Bill and Melinda Gates Foundation Social Sciences Research in Neglected Tropical Diseases. *Health Research Policy and Systems*, **9**, 2.

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