Need of public health education intervention for better knowledge and practices against human Taenia solium taeniasis/cysticercosis

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SUMMARY

Taenia solium taeniasis/cysticercosis (TSTC) is reported to be endemic in pig producing areas around the world and cause significant public health burden and economic losses. In Tanzania, the parasite has been reported in many pig-raising areas calling for sustainable and cost-effective control approaches Poor knowledge,insufficient hygienic practices, and free range pig management are known to contribute in transmission of the parasite. Intervention in these factors can have a significant impact on the preventing transmission. This survey was conducted to assess the community knowledge and practices associated with human TSTC in Kongwa and Songwe Districts. A structured questionnaire was administered to 872 participants from 42 villages in the districts. The findings indicated that, community knowledge of human TSTC was limited in the study area, whereby a total of 539 (61.8%) participants had low knowledge. Regarding practices, the findings indicated that, a total of 653 (74.9%) participants had low level of practices related to human TSTC transmission. A total of 572 (65.6%) partcipants had low level of knowledge and preventive practices related to human TSTC. However Participants from Kongwa District and those with atleast primary level of education were likely to have higher level of knowledge and preventive practices. The study reveals a significant knowledge gap and adverse practices among participants hindering the effforts of controlling *T. solium* transmision. Since, the parasite poses a significant public health concern, the study suggests designing and implementation of public health education to a broad audience for effective public impact.

Keywords: *Taenia solium*, human, crossectional study, control, Tanzania

INTRODUCTION

Human *Taenia solium* Taeniosis/ Cysticercosis (TSTC) is an emerging public health problem of global concern (WHO, 2016). In Tanzania, the parasite has been reported in many rural pig-raising areas and also urban areas calling for sustainable and cost-effective control approaches (Trevisan *et al.,* 2017). Pigs and humans contract cysticercosis by ingestion of eggs shed in the faeces of *T. solium* human carriers (Johansen *et al.,* 2017). Humans also harbor the final (adult) stage of the parasite in the intestines, a condition called taeniasis acquired through consuming raw or partially cooked cystic pork (Garcia *et al.,* 2007). The impact of the parasite on the community is considerably huge in terms of financial losses, morbidities and mortalities, especially in endemic countries (Torgerson *et al.,* 2018). Human Cysticercosis (HCC) becomes more serious

and usually fatal when the manifestation involves the central nervous system (CNS), a condition termed neurocysticercosis (NCC) (Flisser *et al.,* 2003; White, 2000; Winkler, 2012). NCC has been described as the most frequently reported helmintic infection of the CNS and is a major cause of acquired epilepsy in cysticercosis endemic regions (Engels *et al.,* 2003; Garcia *et al.,* 2007).

Taenia solium has a global distribution and is endemic in most parts of sub-Saharan African countries, South and Central America and parts of India (Winkler *et al.,* 2009; Kay, Prüss and Corvalán, 2000). The parasite is infrequently reported in most of Europe (Overbosch *et al.,* 2002; WHO and FAO, 2005). In Tanzania, surveys on HCC and porcine cysticercosis (PCC) have provided evidence that the parasite is spread in many regions of the country (Ngowi *et al.,* 2004; Winkler *et al.,* 2009; Mwang'onde *et al.,* 2012; Komba *et al.,* 2013; Mwanjali *et al.,* 2013; Trevisan *et al.,* 2017; Maganira *et al.,* 2019).

Poor knowledge, insufficient hygienic practices, and free range pig management are known to contribute in transmission of human TSTC (WHO and FAO, 2005). Intervention in these factors can have a significant impact on the preventing parasite transmission in endemic areas.
Studies on knowledge, attitude and practices have shown that knowledge and practices have influence on prevention of human *T.solium* transmission (Elisante *et al.,* 2009; Maridadi *et al.,* 2011). However, limited studies studies are available which describe the influence of knowledge and practices on parasite transmission in endemic areas (Komba, 2008; Maganira *et al.,* 2019; Mwanjali *et al.,* 2013).

Therefore, this study was carried out to determine the knowledge and preventive practices of the community related to human TSTC transmission and management, and their association with socio-demographic characteristics in central and southern zone of Tanzania represented by Kongwa and Songwe Districts respectively. The generated information could help in tailoring appropriate interventions and establish a baseline that could be used to evaluate the effectiveness of future interventions.

MATERIALS AND METHODS

Study area

The survey was conducted from June to September 2019 in Kongwa and Songwe Districts. Kongwa is among the seven Districts of Dodoma region. The District occupies an area of 4,041 square kilometres (NBS, 2012) and it has 22 wards and 92 villages (Mkonda and He, 2017). The human population was 365,952 made up of 61,914 households (NBS, 2016). The key economic activities of the district include agriculture, livestock keeping and other informal sectors. Songwe is among the four Districts of Songwe region. The District is located in south west highlands of Tanzania and has an area of 16,070 square kilometres. The district has 18 wards and 43 villages. The District has a total population of 157,089 composed of 28,282 households. The main economic activities include; farming, livestock keeping, agribusiness, mining and fishing (NBS, 2012). The two Districts were selected purposively based on pig population density, confirmed cases of TSTC and proximity to urban centers (Eom *et al.,* 2011; Komba, 2008; Maganira *et al.,* 2018; Mwanjali *et al.,* 2013).

Study design and data collection:

This was a cross-sectional study and was conducted in accordance with Sokoine University of Agriculture institutional guidelines. The study obtained approval of the National Institute for Medical Research (NIMR) (NIMR/HQ/R.8a/Vol.1X/2802). Permission to conduct the study in the selected villages was obtained from Regional, District and local authorities. Consent for the participation of the selected participants in a household was obtained from the selected individuals as well as the head of the household.

The sample size was calculated using the formula $n=Z^2P(1-P)/d^2$ (Daniel and Cross, 1987.), in which n =required sample size, Z is a *Z* statistic value of 1.96 at the confidence level of 95%, *P* =16%, the estimated prevalence of the infection on the human side nearby the study area (Mwanjali *et al.,* 2013),

and d = 0.05, relative precision. Thus, $n = 1.96^2 \times 0.16 \times (1\text{-}0.16)/0.05^2 = 206$ households (one person per household). This number was more than doubled to adjust for the multi-stage sampling design effect, thus, $n_{adjusted} = 872$. Participating households were randomly selected from 42 villages, 28 from Kongwa (n=87) and 18 from Songwe (n=43) Districts.

To facilitate collection of adequate and correct information, sensitization and mobilization meetings involving researchers and community leaders were conducted, in which the study objectives were explained. Then, a list of all village households accepted to participate was obtained and the list was entered in Microsoft Excel for randomization, using a specific formular. Then, the research team including enumerators visited the selected households and with support from the household head, an eligible household member was identified to participate in the study. The criteria for eligibility were being a permanent household member and being aged between 15–60 years. The study recruited an equal number of households (20 households) per village for all 42 villages.

A Kobo Collect, an open-source Android application for collecting survey data (Kobo Collect v.1.27.3-3) was downloaded from Google Play Store and installed on Android tablets, and the application was used by enumerators for data collection. Data from the households were collected through face-to-face interviews with household heads or representatives. The pre-tested questionnaire included both closed and open-ended questions examining and exploring information on demographic characteristics, knowledge of human TSTC transmission, symptoms, preventive measures, treatment options and sanitary and hygienic practices. Responses on questionnaires were complemented by the direct observation method at the household level.

Data management and analysis:

The collected quantitative data were checked to ensure that the contained information was correct, then imported from the KoBoCollect toolbox into Microsoft Excel and coded before being exported into IBM Statistical Package for Social Sciences SPSS version 20 software for analysis. Univariate analysis was carried out to generate frequencies. The knowledge of respondents was measured using the scoring method from a previous study (Bati *et al.,* 2013; Dohoo *et al.,* 2009), each correct response was scored one and for "incorrect" and "don't know" responses the score was zero. Briefly, weights of 0-10 points were subjectively assigned as overall scores to the responses on questions assessing each knowledge/practice variable.

A respondent was considered to have high level of knowledge/safety practice, or low level of knowledge/ safety practice on a particular variable when his/her total responses scores were 6-10 points and 0-5 points, respectively. Furthermore, each respondent was assigned to a total scoring for combined responses of both general knowledge and safe practices variables. The score performance ranged from 0 to 20 as there were a total of 20 variables, whereby scores of 1-10 points and 11-20 points were considered as low level and high level of knowledge and preventive practices, respectively. The binary logistic regression model was used to test for associations between categorical variables. Knowledge and preventive practice scores were compared with selected social demographic factors using non-parametric tests (Mann–Whitney U test and Kruskal–Wallis test). The significance level was $p < 0.05$.

RESULTS

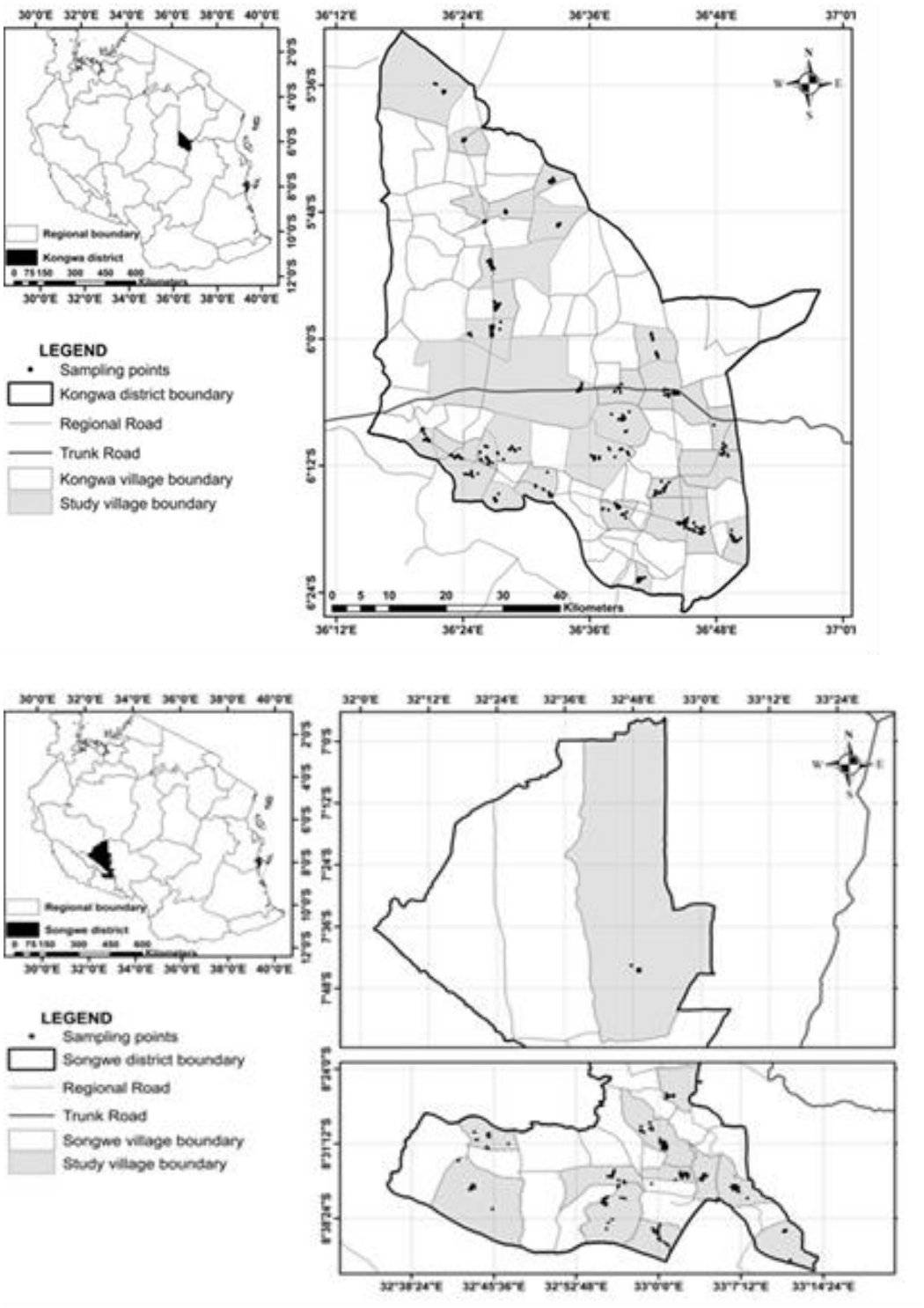

Figure 1. **A**. Map of Tanzania (top left) showing the location of Kongwa District (shaded black) and the enlarged map (right). **B** Map of Tanzania (bottom left) showing the location of Songwe District (shaded black) and two enlarged maps (bottom right). The black dots in enalarged maps of both Districts indicate the distribution of participating households (sampling points). Total of 593 households were sampled in Kongwa District (Figure 1A) and 279 households in Songwe District (Figure 1B) respectively

Table 1: Association between location, sex, age and education level on overall knowledge of human *T. solium* taeniosis/cysticercosis

	Level of knowledge		Odds Ratios (OR)	
	Low n (%)	High n (%)	Crude OR	Adjusted OR (AOR)
District				
Kongwa	331(55.8)	262(44.2)	2.14(1.693,3.176)*	2.49(1.780,3.470)*
Songwe	208(74.6)	71(25.4)	1	1
Total	539(61.8)	333(38.2)		
Sex				
Male	367(62.5)	220(37.5)	0.91(0.683,1.220)	0.93(0.675,1.280)
Female	172(60.4)	113(39.6)	1	1
Total	539(61.8)	333(38.2)		
Age(Years)				
15-25	45(62.5)	27(37.3)	0.97(0.575,1.637)	0.68(0.383,1.212)
26-45	274(61.7)	170(38.3)	1.01(0.753,1.337)	0.83(0.611,1.139)
>45	220(61.8)	136(38.2)	1	1
Total	539(61.8)	333(38.2)		
Educational level				
Primary	383(61.4)	241(38.6)	2.78(1.794,4.330)*	2.93(1.865,4.589)*
Secondary	31(40.3)	46(59.7)	6.57(3.560,12.129)*	7.92(4.174,15.018)*
Tertiary	1(5.3)	18(94.7)	79.71(10.21,622.32)*	92.67(11.69,734.18)*
Informal	124(81.6)	28(18.4)	1	1
Total	539(61.8)	333(38.2)		

There is association between location and education level on the level of knowledge related to TSTC.
OR= Odds ration or Crudes Odds ratio ;a measure of association between an exposure and an outcome;
AOR = Adjusted odds ratio; a measure of association used to control confounding bias.
*Significant factor at 95%CI (n=872)

Association of location, age, sex and education level of participants with knowledge regarding human *T.solium* taeniosis/cysticercosis

A total of 872 participants were involved in the study, whereby the proportion of 593 (68%) and 279(32%) participants were from the villages of Kongwa and Songwe Districts, respectively. The majority of participants 587(67.3%) were males. The age of all participants ranged from 15-60 years and about half 444 (50.9%) of all participants were adults aged between 26-45 years. Most of the participants 624 (71.6%) had a primary level of education (Supporting Table 1). Among the participants, 539 (61.8%) were found to have low level of knowledge based on selected knowledge variables. Also a proportion of 208(74.6%) participants from Songwe District had low level of knowledge. Interestingly, the majority 124 (81.6%) of participants with informal education had low level of knowledge with respect to human TTSC. Participants from Kongwa Districts and those with primary, secondary and tertiary levels of education were likely to have higher level of knowledge than participants from Songwe District and participants with informal level of education respectively (Table 1)

Association between location, sex, age and education level of participants on preventive practices regarding human *T.solium* taeniosis/cysticercosis

For the general preventive practices variables, findings presented in Table.2 shows that, total of 653(74.9%) participants had lower level of preventive practices regarding transmission and control of human TSTC. Also, further findings showed that, 241(86.4) participants from Songwe District had low level of preventive practices. Also, the majority 136 (89.5%) of participants with informal level of education had low level preventive practices. Participants from Kongwa Districts and those with primary, secondary and tertiary levels of education were likely to have higher level of

preventive practices than participants from Songwe District and participants with informal level of education respectively

Table. 2: Association between location, sex, age and education level of participants on overall preventive practices against human *T. solium* taeniasis/cysticercosis (N=872)

	Level of Practices		Odds Ratios (OR)	
	Low n (%)	High n (%)	Crude OR	Adjusted OR
District				
Kongwa	412(69.5)	181(30.5)	2.139(1.693,3.176)*	2.49(1.780,3.470)*
Songwe	241(86.4)	38(13.6)	1	1
Total	653(74.9)	219(25.1)		
Sex				
Male	435(74.1)	152(25.9)	0.912(0.683,1.220)	0.93(0.675,1.280)
Female	218(76.5)	67(23.5)	1	1
Total	653(74.9)	219(25.1)		
Age (Years)				
15-25	53(73.6)	19(26.4)	0.971(0.575,1.637)	0.68(0.383,1.212)
26-45	338(76.1)	106(23.9)	1.004(0.753,1.337)	0.83(0.611,1.139)
>45	262(73.6)	94(26.4)	1	1
Total	653(74.9)	219(25.1)		
Educational level				
Primary	470(75.3)	154(24.7)	2.787(1.794,4.330)*	2.93(1.865,4.589)*
Secondary	45(58.4)	32(41.6)	6.571(3.560,12.129)*	7.92(4.174,15.018)*
Tertiary	2(10.5)	17(89.5)	79.714(10.211,622.32)*	92.67(11.697,734.183)*
Informal	136(89.5)	16(10.5)	1	1
Total	653(74.9)	219(25.1)		

There is association between location and education level on the level of practices related to TSTC.
OR= Odds ration and Crudes Odds ratio ;a measure of association between an exposure and an outcome;
AOR = Adjusted odds ratio; a measure of association used to control confounding bias
*Significant factor at 95%CI.

Association of location, sex, age and education level of participants on knowledge and practices regarding human *T. solium* taeniosis/ cysticercosis

Table.3 shows results for the combined responses, whereby a total of 572(65.6%) respondents had lower level of knowledge and preventive practices regarding human TSTC. The majority 215(77.1%) of participants from Songwe had low level of knowledge and preventive practices whereas 130(85.5%) respondents with informal level of education had low level of knowledge and preventive practices related to human TSTC. Participants from Kongwa Districts and those with primary, secondary and tertiary levels of education were likely to have higher level of preventive practices.than participants from Songwe District and participants with informal level of education respectively.

Table 3: Association between location, sex, age and education level of participants on overall knowledge and practices against human *T. solium* taeniosis/cysticercosis (N=872)

	Level of knowledge and practices		Odds Ratios	
	Low n(%)	High n(%)	COR	AOR
District				
Kongwa	357(60.2)	236(39.8)	2.221(1.606,3.070)*	2.379(1.690,3.348)*
Songwe	215(77.1)	64(22.9)	1	1
Total	572(65.6)	300(34.4)		
Sex				
Male	387(65.9)	200(34.1)	0.956(0.710,1.287)	0.940(0.679,1.303)
Female	185(64.9)	100(35.1)	1	1
Total	572(65.6)	300(34.4)		
Age(Years)				
15-25	51(70.8)	21(29.2)	0.752(0.433,1.306)	0.515(0.280,0.946)
26-45	291(65.5)	153(34.5)	0.960(0.716,1.286)	0.799(0.582,1.098)
>45	230(64.6)	126(35.4)	1	1
Total	572(65.6)	300(34.4)		
Educational level				
Primary	404(64.7)	220(35.3)	3.218(1.990,5.204)*	3.358(2.058,5.479)*
Secondary	35(45.5)	42(54.5)	7.091(3.751,13.403)*	8.843(4.548,17.192)*
Tertiary	3(15.8)	16(84.2)	31.515(8.475,117.186)*	36.622(9.650,138.977)*
Informal	130(85.5)	22(14.5)	1	1
Total	572(65.6)	300(34.4)		

There is association between location and education level on the level of overall knowledge and practices related to TSTC. OR= Odds ration or Crudes Odds ratio ;a measure of association between an exposure and an outcome; AOR = Adjusted odds ratio; a measure of association used to control confounding bias
*Significant factor at 95%CI.

DISCUSSION

Effective and sustainable prevention of any infectious disease requires an assessment not only of the prevalence of an infection in the community but also their knowledge, attitudes and practices regarding the disease (Maridadi *et al.,* 2011; Trevisan *et al.,* 2017) and how they influence prevention of TSTC. The study investigated community knowledge and practices on TSTC prevention and how they are influenced by location, sex, education and age in the selected villages of Kongwa and Songwe Districts as case studies. The participants in the study included those without primary education 152(17.4%), primary eduction 624(71.6%), secondary education 77(8.8%) and tertiary level 19(2.2%) (Supporting Table 1). The findings of the study revealed that community knowledge was generally low and there were poor preventive practices against human TSTC in the studied Districts. Similar observations were made in other community-based studies carried out in Kilolo District, found in southern highlands of Tanzania, where participants had low knowledge about TSTC including failure to link taeniosis, HCC and PCC (Elisante, 2009; Maridadi *et al.,* 2011; Mwanjali *et al.,* 2013; Mwang'onde *et al.*, 2014).

However, there was differences between Districts on the knowledge and preventive practices (AOR=2.379, 95% CI, (1.690, 3.348), $p < 0.001$) (Table 3), where participants with primary education and above were likely to have better knowledge and preventive practices in Kongwa than participants from Songwe District. The geographical location were found to be significantly associated with the level of knowledge and preventive practices regarding the transmission and management of human TSTC. The cause of this difference

is not known. Nonetheless the difference could be attributable to the fact that Kongwa District is close to Dodoma capital city of the country where the possibility of accessing public health education is higher compared to Songwe District which is located relatively in remote location. Furthermore, Songwe District is a new district established in 2012 with relatively limited access to safe and sufficient clean water to facilitate hygienic practices (Thomas *et al.,* 2011; NBS, 2012; NBSAS, 2015) to facilitate prevention of TSTC that is a common cause of NCC.

It should be noted that, neurocysticercosis is an important cause of acquired epilepsy in humans in endemic countries, however, in this study, most participants were not able to associate epilepsy with the parasite but rather with witchcraft or evil. This was not surprising in areas with low knowledge as other studies in similar settings reported more or less similar findings (Winkler *et al.,* 2009; Pandian *et al.*, 2011; Mwang'onde *et al.*, 2014; Sankhyan *et al.,* 2015; Kungu *et al.*, 2017). The limited community knowledge of TSTC was also noted in other countries where TSTC is endemic (Kisinza *et al.,* 2008; Mutua *et al.,* 2010; Sankhyan *et al.,* 2015; Kungu *et al.,* 2017; Millogo *et al.,* 2019). This may be related to the fact that specific knowledge related to the transmission of TSTC was lacking in the general community as it was reported in Delhi and Mexico (Sarti *et al.,* 1997 and Alexander *et al.*, 2012).

The adoption of preventive practices is highly influenced by knowledge of the transmission cycle of the TSTC (Ngowi *et al.,* 2008). Also, the use of safe and clean water, hand washing with soap and latrine use are considered by WHO as the key hygiene behaviours that limit the burden of infectious diseases including TSTC (Thomas *et al.,* 2013; WHO, 2021). In this study, the assessment of preventive practices found a low number of respondents drinking treated water (Supporting Table 2). This could probably be due to the limited supply of safe and clean water as well as the lack of specific knowledge related to water safety as observed in most of the study villages and other studies elsewhere in Tanzania (Thomas *et al.,* 2013; World Health Organization, 2015). Where there was no reliable water sources people are likely to use any available sources which are likely to increase the risk of exposure to contaminated water with *T. solium* eggs from human carriers especially where open-door defecation is common (Sarti and Rajshekhar. 2003; García *et al.,* 2007; Ngowi *et al.,* 2007; Alexander *et al.,* 2012).

Indeed, the open door defecation coupled with pig rearing practices where pigs are freely roming was a common practice in the study areas (supporting Table 2). Furthermore, the study observed some community centers in study villages (local bars and markets) lacking toilets which may encourage open defecation practices, resulting in environmental contamination with *T. solium* eggs. Nevertheless, it was encouraging to observe greater availability of toilets in schools than in individual homes. Having functional toilets in schools may thus be a positive initial step in increasing the utilization of toilets among members in the community.

Toilets/ latrine use has in recent years been highly promoted in most of the districts in Tanzania through health promotion program coordinated by the Ministry of Health. The program is estimated to increase the overall access to basic latrine up to an average of 93% countrywide (Thomas *et al.,* 2013) suggesting that, public health eduction through campaigns is one of the effective tools of positive changes in the community. Unfortunately, the programme did not cover some parts of the country including the studied Districts based on information colleted from the respective District health authorities of Kongwa and Songwe respectively.

Furthermore, the study indicated that not all participants practice hand washing with soap after attending the toilets, meaning that other people would possibly remain with contaminated hands, hence increasing the chance of parasitic infection transmission. This may further increase the risk of transmission of TSTC as shown in previous studies where the prevalence of parasitic infections and infestations in Tanzania is related to poor hand-washing behavior (Ngowi *et al.,* 2004; Mwang'onde *et al,* 2014; Thomas *et al.,* 2013; Kabululu *et al.,* 2015). The unsafe practices observed in this

study were also noted by other studies in Southern and Nothern Tanzania where *T. solium* infection is endemic (Maridadi *et al.,* 2011; Mwang'onde *et al.,* 2014; Mwanjali *et al.,* 2013; Ngowi *et al.,* 2004). This signifies the fact that education intervention of human TSTC and its management is needed to minimize the knowledge gap and adverse practices (Elisante, 2009; Maridadi *et al.,* 2011; Mwang'onde *et al.,* 2014; Ngowi *et al.,* 2008, 2004).

The study reveals that, there is a significant knowledge gap and adverse practices regarding human TSTC transmission and management, leading to misconceptions and ineffective control measures in all areas not covered by publich health intereventions. Having primary education or higher is not sufficient to have knowledge and better practices on prevention of transmission of TSTC. Lesson learned from National health promotion programs coordinated by the Ministry of Health where the average access to basic latrine reached 93% countrywide suggest that the implementation of public health education could have more impact and should be designed to reach a broad audience, including school children, community leaders, and the general population.

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CONFLICTS OF INTEREST

The authors declare no competing interests.

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SUPPORING INFORMATION

Supporting Table 1. Social-demographic distribution of participants (N = 872)

Variable	Participants n (%)
District	
Kongwa	593 (68.0)
Songwe	279 (32.0)
Sex	
Male	587 (67.3)
Female	285 (32.7)
Age	
15-25years	72 (8.3)
26-45years	444 (50.9)
>45years	356 (40.8)
Education level	
Informal	152 (17.4)
Primary education	624 (71.6)
Secondary education	77 (8.8)
Post-Secondary	19 (2.2)

Supporting Table 2 Knowledge and preventive practices of participants regarding human *T. solium* taeniasis/cysticercosis (N=872).

Characteristic	Participants' responses n (%)
Knowledge	
Has heard about human TSTC	
No	722(82.8)
Yes	150(17.2)
It is safe to consume PCC infected pork	
No	89(10.2)
Yes	783(89.8)
Human acquires TSTC through fecal contaminated water/food	
No	751(86.1)
Yes	121(13.9)
T. solium infect both human and pigs.	
No	752(86.2)
Yes	120(13.8)
Human TSTC can cause epilepsy/ seizures.	
No	772(88.5)
Yes	100(11.5)
Practice	
Pigs roam freely in open fields	
No	15(1.7)
Yes	857(98.3)
Always wash fruits and vegetable before consumption	
No	80(9.2)
Yes	792(90.8)
Always use toilets/latrines at home	
No	355(40.7)
Yes	517(59.3)
Washing hands with soap after defecation	
No	293(33.6)
Yes	579(66.4)
Use official water sources	
No	293(33.6)
Yes	579(66.4)
Always drink treated water	
No	673(77.2
Yes	199(22.8)