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Assessment of a computer-based *Taenia solium* health education tool 'The Vicious Worm' on knowledge uptake among professionals and their attitudes towards the program

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ABSTRACT

Health education has been recognised as a specific intervention tool for control of *Taenia solium* taeniosis/cysticercosis but evaluation of the efficacy of the tool remains. The aim of our study was to assess the effect of a computer-based *T. solium* health education tool 'The Vicious Worm' on knowledge uptake among professionals and investigate attitudes towards the program. The study was carried out between March and May 2014 in Mbeya Region, Tanzania, where *T. solium* is endemic. The study was a pre and post assessment of a health education tool based on questionnaire surveys and focus group discussions to investigate knowledge and attitudes. A total of 79 study subjects participated in the study including study subjects from both health- and agriculture sector. The health education consisted of 1½ h individual practice with the computer program. The baseline questionnaire showed an overall knowledge on aspects of acquisition and transmission of *T. solium* infections (78%), porcine cysticercosis treatment (77%), human tapeworm in general (72%), neurocysticercosis in general (49%), and porcine cysticercosis diagnosis (48%). However, there was a lack of knowledge on acquisition of neurocysticercosis (15%), prevention of *T. solium* taeniosis/cysticercosis (28%), and relation between porcine cysticercosis, human cysticercosis, and taeniosis (32%). Overall, the study subject's knowledge was significantly improved both immediately after ($p = 0.001$) and two weeks after ($p < 0.001$) the health education and knowledge regarding specific aspects was significantly improved in most aspects immediately after and two weeks after the health education. The focus group discussions showed positive attitudes towards the program and the study subjects found 'The Vicious Worm' efficient, simple, and appealing. The study revealed a good effect of 'The Vicious Worm' suggesting that it could be a useful health education tool, which should be further assessed and thereafter integrated in *T. solium* taeniosis/cysticercosis control.

1. Introduction

Taenia solium taeniosis/cysticercosis is endemic in many countries in sub-Saharan Africa (Braae et al., 2015), Latin America, and South-East Asia (WHO, 2013). The diseases are caused by the zoonotic tapeworm *Taenia solium* which affects pigs and humans. *T. solium* is both a health and economic burden due to the severity of cysticercosis, medical costs of human cysticercosis, and losses in swine production (Phiri et al., 2003; Carabin et al., 2006; Mwanjali et al., 2013; WHO, 2013). Highly efficacious anthelmintics for humans and pigs, and vaccines against porcine cysticercosis, have been developed and will be essential tools for short-term reduction of taeniosis/cysticercosis prevalence (WHO, 2013). However, as infection with *T. solium* to a large extend is socially determined, sustainable control and eventually elimination, will require human behaviour change including improvement of hygiene practices, improvement of pig and pork management, as well as improved sanitation. Major risk factors for *T. solium* taeniosis/cysticercosis have shown to be open defecation (Ngowi et al., 2004), free roaming pigs (Komba et al., 2013), lack of meat inspection (Sikasunge et al.,

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2007), and lack of knowledge of *T. solium* taeniosis/cysticercosis (Ngowi et al., 2007). Health education has in several studies proven effective in creating awareness regarding transmission and prevention of *T. solium*. A study by Ngowi et al. (2008) conducted in north-eastern Tanzania to estimate the effectiveness of health and pig-management education a significant improvement in knowledge regarding porcine cysticercosis and how to prevent it was found, but no change in knowledge regarding taeniosis. Improvement was, however, seen in both the intervention and control group, so it cannot be concluded to be the effect of the intervention. The intervention did not result in any significant improvement in the observed practices of confining pigs or latrine usage. The intervention nevertheless resulted in a significant reduction in consumption of infected pork, reported by the study subjects. The study indicated that the health education resulted in a reduction of the incidence rate of porcine cysticercosis. Mwidunda et al. (2015) showed an improvement of school children's knowledge and attitude towards *T. solium* taeniosis/cysticercosis, Alexander et al. (2012) showed an increase in usages of latrines and hand washing, and Wohlgemut et al. (2010) an increase in confining pigs. A health education intervention by Ngowi et al. (2011) significantly improved knowledge and attitudes, though 28.4% of the study subjects, despite the health education, said that they would still consume infected pork. A health education intervention by Sarti et al. (1997) regarding *T. solium* conducted in a rural community in Mexico showed an improvement in knowledge and a decrease in porcine cysticercosis prevalence after health education, but taeniosis prevalence did not decrease. The studies show an effect on knowledge regarding *T. solium* taeniosis/cysticercosis, but the effect on change of practices cannot be confirmed in all the studies. The assessment of health education for control of *T. solium* taeniosis/cysticercosis is scarce, and evaluation of the importance of health education needed. For these reasons, 'The Vicious Worm' was developed. 'The Vicious Worm' is an education tool that provides information to stakeholders across disciplines and sectors (Johansen et al., 2014). The program gives information on transmission, diagnosis, treatment, risk factors, prevention, and control of *T. solium* taeniosis/cysticercosis. It contains short stories with illustrations, videos, quizzes, pictures, and text divided into three levels depicted as an African setting of a village, town, and city, respectively. At the village level, health information is provided in a simple illustrative way, at the town level in a more technical way useful for professionals, and city level with briefs and information sheets for policy making. The program is in English but currently being translated to other languages (www.theviciousworm.org). The idea with 'The Vicious Worm' is to move health education to an evidence-based specific intervention and to be able to share it globally, reduce training costs, provide uniform training options, and improve the education material continuously (Johansen et al., 2014).

Thus, the aim of this study was to assess the effect of the 'The Vicious Worm' on knowledge uptake among professionals in an endemic area and to investigate their attitudes towards the program and teaching method.

2. Materials and methods

2.1. Study area

The study was carried out in Mbeya Region, situated in South-West Tanzania (7°–9° S, 32°–35°E). Mbeya Region is divided into ten districts/councils and in 2012 the population was 2,707,410, of which 3,85,279 were living in Mbeya City Council (National Bureau of Statistics, 2013). In Mbeya Region *T. solium* is highly endemic with reports of taeniosis prevalence of 4.1% (copro-Ag-ELISA), human cysticercosis prevalence of 16.7% (Ag-ELISA) (Mwanjali et al., 2013), and porcine cysticercosis prevalence of 15–32% (Ag-ELISA) (Komba et al., 2013; Braae et al., 2014).

2.2. Study design

The study was an assessment of the computer-based health education tool 'The Vicious Worm' built on questionnaire surveys and focus group discussions. The study involved the following sessions: (1) a pre questionnaire to assess the study subjects' baseline knowledge regarding *T. solium*, (2) individual health education with the 'The Vicious Worm' for 1½ h, (3) a post questionnaire (identical to the pre questionnaire) given immediately after the health education to assess knowledge uptake, (4) focus group discussions to obtain attitudes and opinions about 'The Vicious Worm', and (5) a post questionnaire (identical to the two previous ones) administrated two weeks after the health education.

2.2.1. The health education

The health education was delivered to the study subjects in group sessions with up to 17 participants per group. All sessions were conducted in the same way, starting with a presentation of the principal investigator (PI) and assistants, purpose of the study and the health education program, and a presentation of prevalence and burden of *T. solium* taeniosis/cysticercosis in the local area. This was followed by guidance how to get started with 'The Vicious Worm'. Hereafter, the study subjects were given 1½ h to work individually or in groups of up to three on a computer with the program. The study subjects were asked to go through all levels and categories in the program. The PI and assistants were present during all sessions assisting with finding information in the program or helping with technical issues. After the intervention all study subjects received a flash drive with 'The Vicious Worm'.

2.2.2. Questionnaire

A questionnaire with 24 multiple choice questions regarding *T. solium* was developed to assess the study subjects' knowledge related to *T. solium.* There were five to seven answer options to each question, with only one correct answer per question. The questionnaire gave one point for each correct answer with a possible maximum overall knowledge score of 24. Answers were pre-coded for different specific aspects regarding *T. solium,* and tested knowledge of both porcine cysticercosis, human cysticercosis and taeniosis, and the relation and prevention. If one question was answered wrong, that aspect would be categorized as wrong. The acquisition and transmission of porcine cysticercosis and human taeniosis were coded together as transmission and acquisition of *T. solium* infections, whereas acquisition of neurocysticercosis was coded separately to obtain information on the study subject's knowledge of this aspect specifically. The questionnaire was self-administered and provided in English. The questions were answered individually, with no time limit, and without help from the program, but help regarding translation and understanding matters were provided by the PI and assistants. The questionnaire was reviewed and pre-tested on experts from University of Copenhagen, and three experts from the study area with similar cultural background as the study subjects. The participants did not receive the questionnaire with the correct answers until after the two weeks follow-up assessment.

2.2.3. Focus group discussions

The focus group discussions, carried out by the PI, lasted from 20 to 60 min and were conducted in English. A total of five focus group discussions (FGD) were conducted to obtain attitudes and opinions about 'The Vicious Worm'. The groups included in the FGD were two groups of agriculture/livestock diploma students, a group

Table 1
Characteristics of study participants.

Sector	Profession	No. included	No. for follow up	Degree	Gender males/females	Mean age
Agriculture	Veterinarians	10	10	5 bachelor/5 masters	10/0	38 (range: 27–51)
	Meat inspectors	3	3	3 diplomas	3/0	45 (range: 33–55)
	Agriculture/livestock extension officers	17	16	5 certificates/12 diplomas	9/8	40 (range: 22–59)
	Agriculture/livestock diploma students	28	28	28 diplomas	24/4	29 (range: 23–46)
Health	Health officers	5	4	3 diplomas/2 bachelor	4/1	46 (range: 34–55)
	Medical officers	6	5	6 bachelor	3/3	31 (range: 26–48)
	Assistant medical officer students	10	10	10 diplomas	9/1	40 (range: 28–48)

of agriculture/livestock extension officers, a group of veterinarians including veterinary students, and a group of assistant medical officer students. A protocol based on the guidelines by Kruger (2002) was developed before conducting the FGD. Six questions were formulated to get information on what the study subjects found positive about the program, whether they found it useful and what they thought could improve 'The Vicious Worm'. Comments from the FGDs were transcribed by the PI and audio-recorded. To analyse the FGD, all data were grouped into categories and themes (Ngowi et al., 2007). The themes were scored according to how often they were mentioned. A score of 1–5 was given depending on the frequency of the theme across the groups. If a theme was important to all the groups, a score of 5 was given. Comments from the FGDs with the same meaning were grouped together in categories and then grouped together in themes so important points mentioned multiple times were found.

2.2.4. Selection of study subjects

Individuals with specialised training concerning human health, and health of pigs or pig management and production, were selected as study subjects. These professionals were seven veterinarians, three veterinary students, three meat inspectors, 17 agriculture/livestock extension officers, 28 agriculture/livestock diploma students, five health officers, six medical officers, and ten assistant medical officer students. Professionals were chosen as study subjects as they play a key role in passing on information to high risk populations in rural areas. For example, the meat inspector is a link between the knowledge obtained during health education and both traders selling pigs and the consumers buying potential infected pork at places of slaughter. Health education among professionals has a great value as they play an essential role in high risk areas.

As the study was carried out among professionals, all the participants had a moderate to good level of English. Through schooling professionals have been exposed to English, and therefore did not experience any major challenges with the language, neither with the questionnaire or using the program. Furthermore, the program was supported with pictures and cartoon drawings to minimise any language barriers that might occur. The study subjects were selected with priority towards those living in or close to Mbeya City. Veterinarians selected for the study were private, regional-, district-, and research veterinary officers, and final-year veterinary students from Mbeya City, Livestock Research Institute Uyole (TALIRI Uyole) and Ileje district. Meat inspectors from pig slaughter slabs and agriculture/livestock extension officers were selected from the area around Mbeya City. Agriculture/livestock diploma students were selected from Mbeya Agriculture Training Institute, Uyole (MATI Uyole) among the ones who had attended a class in computer science and held a certificate in agriculture/livestock. The health officers were selected from employees at Mbeya City Council health office. Medical officers were selected from the Department of General Outpatients at Mbeya Referral Hospital. Assistant medical officer students were selected from final-year students at Mbeya Medical Training Centre. See Table 1 for characteristics of participants.

2.3. Data management and statistics

Data on knowledge and knowledge uptake regarding specific aspects of *T. solium* taeniosis/cysticercosis were analysed using SPSS 22.0. Values of 1 or 0 depending on improvement were calculated. Analyses of knowledge improvement for the study subjects were performed using descriptive statistics and binomial tests. The test proportion was set to 0.50, and 95% confidence interval calculated. Different knowledge aspects regarding *T. solium* taeniosis/cysticercosis were pre-coded in the questionnaire. Two to four questions were coded for each aspect, and a total of eight aspects were predefined. The study subjects' knowledge regarding specific aspects was compared pre and post the health education, and pre and two weeks post the health education using McNemar chi-square test. Logistic regression analyses were used to assess factors for knowledge uptake and odds ratios. Factors included gender, former experience with *T. solium*, computer experience, education level, and sector of employment. For the analysis of education, comparison was made between study subjects holding a bachelor/master degree and those holding a certificate or diploma.

2.4. Ethical considerations

The project was embedded in an on-going Danida-funded project 'Securing rural Livelihoods through Improved smallholder Pig Production in Mozambique and Tanzania 2010–2015' (SLIPP). The study was approved by the collaborative partner Sokoine University of Agriculture in Morogoro, Tanzania. Permissions from the

Table 2
Mean knowledge scores (%) before, immediately after, and two weeks after the health education among the different groups of professions included in the study.

Profession	Mean knowledge scores (%) in relation to health education		
	Before	Immediately after	Two weeks after
Veterinarians	87.9	92.5	92.1
Meat inspectors	83.3	94.6	90.4
Agriculture/livestock extension officers	71.7	77.1	77.5
Agriculture/livestock diploma students	70.0	76.7	76.3
Health officers	75.0	85.0	81.3
Medical officers	76.3	90.4	94.2
Assistant medical officer students	70.8	85.4	84.6

Table 3
Percentage of study subjects with knowledge regarding specific aspects of *Taenia solium* taeniosis/cysticercosis before, immediately after, and two weeks after the health education.

Knowledge aspect	Before (%)	Immediately after (%)	*p*-value	Two weeks after (%)	*p*-value
Acquisition and transmission of *T. solium* infections	78	85	0.332	91	0.035
Acquisition of NCC	15	29	0.019	30	0.013
HT in general	72	87	0.008	87	0.027
NCC in general	49	67	0.004	64	0.023
PC diagnosis	48	75	<0.001	78	<0.001
PC treatment	77	94	0.001	91	0.021
Relation between PC/HT/NCC	32	23	0.327	22	0.186
Prevention of PC/HT/NCC	28	49	<0.001	50	0.001

PC: porcine cysticercosis, HT: taeniosis, NCC: neurocysticercosis/human cysticercosis.

Table 4
Odds ratios (OR) for factors of knowledge improvements immediately after and two weeks after the health education were calculated using logistic regression analysis. Factors analysed were gender, previous experience with *Taenia soliu*m, previous experience with a computer, level of educational, and sector of employment.

Variable	OR, (95% CI[a]) and p-value in relation to the health education			
	Immediately after		Two weeks after	
	OR	*p*-value	OR	*p*-value
Gender				
Male	Ref 1.49	0.570	Ref 1.95	0.340
Female	(0.38–5.90)		(0.49–7.71)	
Experience with *T. solium*				
Yes	Ref 1.35	0.667	Ref 0.84	0.773
No	(0.34–5.40)		(0.25–2.80)	
Experience with a computer				
Yes	Ref 1.22	0.775	Ref 1.24	0.735
No	(0.31–4.92)		(0.35–4.41)	
Educational level				
Bachelor/master	Ref 0.96	0.948	Ref 1.06	0.923
Certificate/diploma	(0.27–3.39)		(0.32–3.50)	
Sector				
Agriculture	Ref 8.29	0.047	Ref 4.96	0.044
Health	(1.03–66.81)		(1.04–23.62)	

[a] CI: Confidence interval, ref: reference.

local veterinary and health authorities and principals at the training institutes were sought before the study was conducted. The study was introduced and explained to all study subjects, and all study subjects were asked for permission ahead of the implementation of the study and allocated an identification number to insure confidentiality.

3. Results

A total of 79 study subjects were included in the study, hereof 58 (73%) employed in the agriculture sector and 21 (27%) in the health sector. Of the study subjects, 17 (22%) were females and 62 (78%) were males. Mean age was 36 years (range: 22–59 years, SD = 10). Different levels of education were represented among the study subjects: five had a certificate (6%), 46 had a diploma/final-year diploma students (58%), 10 were final-year students doing an advanced diploma (14%), 13 had a bachelor degree/final-year bachelor student (16%), and five study subjects had a master degree (6%). A total of 15 (19%) study subjects reported that they had no previous experience with computers with the largest proportion among agriculture/livestock extension officers. The study subjects were all working or studying in Mbeya Region. The compliance was 96% in the follow-up study two weeks after the education.

3.1. Knowledge uptake

The time for training with the program was fixed from the beginning based on the pretesting in both Denmark and Tanzania. Most people spent 1 h with the program and they were asked to have patience or have a break outside until time was up and they could answer the questionnaire together with the rest of the group.

Among the study subjects 77% (95% CI: 67.7–86.3) had significantly improved ($p < 0.001$) their knowledge score immediately after the health education, and for 70% (95% CI: 59.7–80.3) the improvement persisted two weeks after ($p = 0.001$).

The veterinarians had the highest mean knowledge score and the agriculture/livestock diploma students the lowest. Irrespective of the scores, all groups gained knowledge as a consequence of the health education as the mean knowledge score immediately after and two weeks after the health education increased compared to the mean knowledge score before (Table 2).

Looking at specific aspects of *T. solium* taeniosis/cysticercosis immediately after the education the study subjects' knowledge was significantly improved in all categories apart from acquisition and transmission of *T. solium* infections and the relation between porcine cysticercosis, human cysticercosis, and taeniosis. Two weeks after the education, all aspects except the relation between porcine cysticercosis, human cysticercosis, and taeniosis had significantly improved (Table 3).

Being employed in the health sector compared to the agriculture sector was found to be a significant factor for improvement of knowledge immediately after ($p = 0.047$) and two weeks after the health education ($p = 0.044$). Other factors investigated for knowledge improvement were not found significant (Table 4).

3.2. Attitudes

Five FGD were conducted with 6–17 study subjects in each; Two groups with 14 agriculture/livestock diploma students, a group

with 17 agriculture/livestock extension officers, a group of three veterinarians and three veterinary students, and a group with ten assistant medical officer students. The FGD revealed a general positive attitude towards 'The Vicious Worm'. The study subjects found the program educative and appealing due to the useful and practical information provided and its depiction of African settings. The computer-based design was found both interesting and useful, but also a limitation for some study subjects, who suggested a supplement as leaflets or similar information material for use in rural areas. The study subjects underlined the simple language and easily understood information in the program as positive. The scores in order of perceived importance of the themes discussed in FGD were efficiency (scored 5), simplicity (scored 5), appeal (scored 4), and accessibility (scored 2).

4. Discussion

This study shows a highly significant effect on knowledge uptake and a positive attitude towards 'The Vicious Worm'. A moderate to relatively high percentage of the study subjects had an already-existing knowledge on many aspects of *T. solium* taeniosis/cysticercosis before the health education. However, this study showed a lack of knowledge of acquisition of neurocysticercosis, relation between porcine cysticercosis, human cysticercosis and taeniosis, and prevention of *T. solium* taeniosis/cysticercosis. 'The Vicious Worm' improved the study subjects' knowledge in most aspects of *T. solium* taeniosis/cysticercosis. In the current study and in other health intervention studies, a relatively broad knowledge regarding taeniosis and porcine cysticercosis has been shown (Sarti et al., 1997; Maridadi et al., 2011; Mwidunda et al., 2015), but when it comes to neurocysticercosis/human cysticercosis and the relation between the diseases, knowledge is lacking. The current study adds to the findings by Mwidunda et al. (2015), Alexander et al. (2012), and Sarti et al. (1997) showing a lack of knowledge regarding neurocysticercosis/human cysticercosis among different population groups (school children, people living in rural communities, and professionals). The lack of knowledge regarding the relation between porcine cysticercosis, human cysticercosis and taeniosis found in the current study is in accordance with other studies involving farmers (Sikasunge et al., 2007; Ngowi et al., 2008). The complex lifecycle of *T. solium* and the outcome of different disease scenarios make it difficult to fully comprehend even among trained professionals. Most study subjects knew about *T. solium*, but neurocysticercosis is still a relatively new aspect to many people in endemic countries. Due to the complex nature of *T. solium*'s life cycle, it is difficult to comprehend the linkage between eating infected pork, excreting invisible eggs and getting epilepsy due to cysts in the brain. A major concern with lack of understanding the relation between the diseases caused by *T. solium* is that it is likely essential in breaking the life cycle, and thus, obtaining control of *T. solium*. The lack of understanding indicates the great importance to include health education in all control programmes for *T. solium*. We further recommend emphasizing neurocysticercosis when providing education regarding *T. solium*. In the updated version of The Vicious Worm this has been further highlighted to meet this concern. In a study by Maridadi et al. (2011) males, higher levels of education, and individuals above 40 years of age were found to be the most knowledgably, but interestingly in the current study neither gender nor educational level, were shown to be significant factors for knowledge uptake. This is in contrast to the difference in knowledge uptake among school children found by Mwidunda et al. (2015), where boys and older age groups among school children got higher scores. Furthermore, in our study neither former experience with *T. solium* nor experience with computers was found to be significant factors for improving knowledge. The current study indicated that regardless of gender, education level, experience with *T. solium,* and computers, 'The Vicious Worm' can be used to improve study subjects' knowledge. However, being employed in the health sector compared to the agriculture sector was a significant factor for improvement of knowledge immediately after as well as two weeks after the health education. However, due to a relatively small sample size the high odds ratios should be evaluated with caution. An explanation for the study subjects employed in the health sector to be more likely to improve their knowledge could be the high knowledge score before the health education among veterinarians and meat inspectors, which might not allow the questionnaire to detect improvements. A possible increase in knowledge among veterinarians could not be measured if the participants achieved top scores at baseline. Besides this error where the improvement in knowledge could not be measured, it did not have any impact whether the participants had little knowledge, for example a score of 12, or moderate knowledge, for example a score of 20, in the ability to document improvements, which is a very important finding. The current study focused on professionals in Mbeya Region, Tanzania, therefore the effect of the program should be further investigated among other relevant groups of stakeholders as well as groups with less knowledge regarding *T. solium* in other *T. solium* endemic areas. Although the number of study subjects was limited, the data is still indicative of an effect of 'The Vicious Worm'. Furthermore, the follow-up study was conducted only two weeks after the health education, and it could be desirable to investigate the long-term effect of the program, which is currently taken place in the study area. The study subjects showed positive attitudes towards 'The Vicious Worm', and thus, the program should be considered included in future control programmes after a more in depth evaluation.

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