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Development and rapid assessment of Community-Based Health Education Package for the Control of *Taenia solium* Taeniasis/Cysticercosis in Tanzania

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Abstract
Background: We conducted this study to develop and rapidly assess a community-based health education package (CHEP) to serve as a guide to improving knowledge, attitude, and practices (KAP) for controlling *T. solium* cysticercosis Taeniasis (TSCT) in endemic areas in Tanzania.
Methods: Data for the development of the (CHEP) was collected through a questionnaire and observation of household infrastructure. We conducted and analyzed 12 focus group discussions (FGDs) and 38 key informant interviews (KIIs) using ATLAS.ti 8. A household survey using a questionnaire was conducted on 480 respondents and analyzed using SPSS by conducting a chi-square test.
Results: The developed CHEP included the following key messages: (1) improving knowledge and attitudes towards TSCT transmission, causes, health effects, treatment, and control measures, (2) proper pork preparation and general food handling practices, (3) good pig husbandry practices, and (4) improving water, sanitation, and hygiene (WASH) practices. The CHEP developed comprises a Training of Trainers (TOT) manual, a leaflet/brochure, a poster, and a handbook. The results from the rapid assessment reported a statistically significant improvement in knowledge regarding the link between epilepsy and cysticercosis ($p<0.001$) and in the practice of washing fruits and vegetables ($p=0.025$).
Conclusion: Therefore, it is recommended that critical stakeholders conduct one health approach toward implementing CHEP in areas affected by TSCT to control the disease.

Keywords: *Taenia solium; cysticercosis; health education package; Tanzania*

Introduction

There are 2.4 million pigs in Tanzania, and 9% of Tanzanian households keep livestock (URT, 2015). Pig farming contributes significantly to income generation, food security, soil fertility improvement, asset storage, and intangible functions unrelated to community economic gains (Kimbi et al., 2015). Parasites expose free-ranging pigs to infection, such as *Taenia solium*, which hurts profits through the condemnation of infected carcasses and the zoonotic risk of the parasite. The parasite causes TSCT in humans (Roesel et al., 2017). The societal cost of TSCT in endemic communities is exceptionally high; in Tanzania, it has been reported to be USD 8 million annually (Trevisan et al., 2017). The costs comprise the economic loss because of the decline in the market value of infected pork, condemnation of infected pork, diagnosis, and treatment of

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human cases, and the severe impact on farmers' livelihoods (Atawalna & Mensah, 2015). An increase in the prevalence of porcine cysticercosis (PCC) in the Eastern and Southern Africa (ESA) region has been linked to the increase in smallholder pig farming and pork consumption (Phiri et al., 2003). Therefore, it is recommended that critical stakeholders conduct one health approach toward implementing CHEP in areas affected by TSCT to control the disease.

Taenia solium cysticercosis Taeniasis affects over 50 million people worldwide and leads to the death of about 50,000 people annually (WHO, 2013). The main obstacle to effective control of cysticercosis is the low knowledge of parasite transmission (Johansen et al., 2014). Health education plays an essential role in preventing and controlling infectious diseases (Alexander et al., 2012; Johansen et al., 2014; Ngowi et al., 2017). In some communities, various health education interventions have been implemented.

In some communities, various control strategies have been implemented to control TSCT. These strategies include the use and proper maintenance of latrines (Braae et al., 2015; Ngowi et al., 2017), treatment of taeniasis cases with praziquantel or niclosamide (Bustos et al., 2012), treatment of porcine cysticercosis with oxfendazole (Mkupasi et al., 2013), vaccination of pigs (Lightowlers, 2013; Kabululu et al., 2020) and confinement of pigs. Measures also focused on the immediate removal of children's feces in latrines, thorough hand washing with soap/detergents, boiling of drinking water, prohibition of consumption or sale of infected pork, and improved meat inspection. The effectiveness of the measures was low or short-lived, and other strategies were too expensive to apply on a large scale (Ngowi et al., 2008; Mkupasi et al., 2013; Braae et al., 2014; Carabin & Traoré 2014; Kabululu et al., 2020).

Despite control measures, the disease is still widespread in many pig farming areas in Tanzania (Flora et al., 2023; Wilson et al., 2023a). One reason for the endemicity is the low knowledge about TSCT in rural communities (Holst et al., 2022; Nyangi et al., 2022; Makingi et al., 2023; Wilson et al., 2023b). Most of them practice free-range pig farming under poor hygienic conditions (Carabin & Traoré 2014; Shonyela et al., 2017; Nyangi et al., 2022; Flora et al., 2023; Makingi et al., 2023; Wilson et al., 2023b). For effective and sustainable control of the parasite, the One Health approach is the way to go (García et al., 2007; Braae et al., 2016, Okello & Thomas 2017; Ramiandrasoa et al., 2020).

Health education in endemic regions is crucial for an effective and sustainable control program to improve the health and economic situation of the infected population (Sarti et al., 1997; Alexander et al., 2012; Mwidunda et al., 2015; Ngowi et al., 2017). Long-term change can only be successful if community participation accompanies health education programs (Sarti et al., 1997; Alexander et al., 2012; Mwidunda et al., 2015; Ngowi et al., 2017). In the health education studies conducted in Tanzania, the target groups were not fully involved in planning/development, implementation, and evaluation (Ngowi et al., 2008, 2011; Mwidunda et al., 2015). Therefore, there was a need to develop a community-based health education package (CHEP) that fully involves the communities.

The community-based health education package (CHEP), developed and rapidly assessed, is a conventional approach to improving community knowledge, attitude, and practices (KAP) in controlling TSCT. The health education package was developed based on information from the community in four districts in Tanzania, namely Mbulu, Mpwapwa, Mbinga, and Rungwe, on their KAP regarding TSCT control. The package was rapidly assessed through education intervention in the Babati district. Studies by Sarti et al. (1997), Ngowi. et al. (2008), and Alexander et al. (2012) reported poor KAP in India, Mexico, and Tanzania. It was, therefore, necessary to develop this structured CHEP to improve KAP, which will lead to behaviour change believed to be fundamental to controlling TSCT. Community members were involved in the development of the CHEP, from planning through implementation and continuing to evaluation and assessment. The CHEP comprises four components: a Training of Trainers (TOT) manual, posters, brochures, and a manual with illustrations (pictures) on critical TSCT control strategies. The package will be integrated with other existing TSCT control strategies.

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Communities in resource-poor, endemic countries can quickly adopt and implement the developed CHEP. This paper describes developing and rapidly assessing the community-based health education package for TSCT control in Tanzania.

Methods

Study area

Communities in Mbulu, Mpwapwa, Mbinga, and Rungwe districts provided information to develop this CHEP in four different Agroecological zones in Tanzania (Nyangi et al., 2022). Eight villages were purposively selected from four wards in the four districts for being PCC endemic areas and popular in small-scale pig rearing (Boa et al., 2006; Ngowi et al., 2008; Mwang'onde et al., 2014; Shonyela et al., 2017; Mwang'onde et a., 2018; Braae et al., 2015; Nyangi et al., 2022). We applied a simple random sampling technique to select households from each village in the quantitative component. We selected equal numbers of households from each hamlet. We interviewed the household heads; when the household head was absent, we interviewed an adult household member using a structured questionnaire (Nyangi et al., 2022). We purposively selected the participants for the qualitative part (Nyangi et al., 2024). We randomly selected the participants for the rapid assessment of the CHEP from two villages in the Babati district, and we selected the district for being a PCC endemic area and popular in small-scale pig rearing.

Study design

We conducted a cross-sectional survey in eight purposively selected villages in the four study districts. In developing the CHEP, we modified the guidelines (Sarti et al., 1997; Ngowi et al., 2008; Alexander et al., 2012; CDC, 2013). We developed the health education package in three main steps: (i) formative research (Figure 1) (ii) development of the health education package (iii) pilot test and revision (Figure 2). We conducted a rapid assessment between September and October 2021 in two selected villages from the purposely selected Babati district. We selected the district because it is endemic for porcine cysticercosis (PCC) and famous for small-scale pig-keeping.

Selection of households

For the quantitative study, we estimated the sample size using the formula by Fisher et al. (1991). The assumed prevalence of 50% of TSCT was used to compute the minimum sample size required for this study.

$$n = \frac{z^2 pq}{d^2}$$

Where: Zα = standard normal deviation = 1.96; p = estimated prevalence. = 0.5 (50%); q = (1 – p) = 0.5; d = (Precision) = 0.05

$$n = \frac{1.962 * 0.5 * 0.5}{0.052} = 385 \text{ respondents}$$

We added 25% for a design effect and yielded 480 households.

For the rapid assessment, we randomly selected 15 pig farmers and 15 non-pig farmers, 15 government officials and 5 pig butcher/pig traders to attend a two-day workshop on the rapid assessment of the developed CHEP. This makes 50 participants per village during pre-intervention and 50 during post-intervention. The overall objective of this workshop was to facilitate the training of potential resource persons on how to educate and guide community members in implementing measures for control of TSCT in their areas.

For sustainability, we conducted a two-day health education intervention for TSCT control. The first day of the workshop comprises training for local communities' trainers (TOTs). This was followed by a second day of training of the larger communities (villagers, including pig and non-pig farmers) by the trained local trainers (TOTs). Participants in the TOTs workshops included village and ward level health workers who usually conduct health education at the facility (health assistants, clinical officers, nurses, health educational officers), community development workers,

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primary and secondary school science (health) subject teachers, village/ward livestock field officers, animal scientists, few members of the village health committee (VHCs). The second day of the workshop was for a few selected TOTs to train the pig, non-pig farmers, and pig butcher/pig traders. One week before the workshop, we randomly selected a list of all smallholder pig-keeping and non-pig farmers from the village list with the help of local village leaders, ward livestock field officers, and ward executive officers (WEO).

Formative research

Using a formative research guide, we assessed the local context and risk factors for TSCT infection in the target community (Figure 1). Formative research is a process in which researchers identify a target community for study, decide how to access that community, and define the community characteristics essential to a particular public health problem (CDC, 2013).

For this study, we defined the risk factor as an aspect of personal behavior or lifestyle, environmental exposure, or inherited characteristic that epidemiological evidence has linked to one or more preventable health condition(s) (Skolnik, 2016).

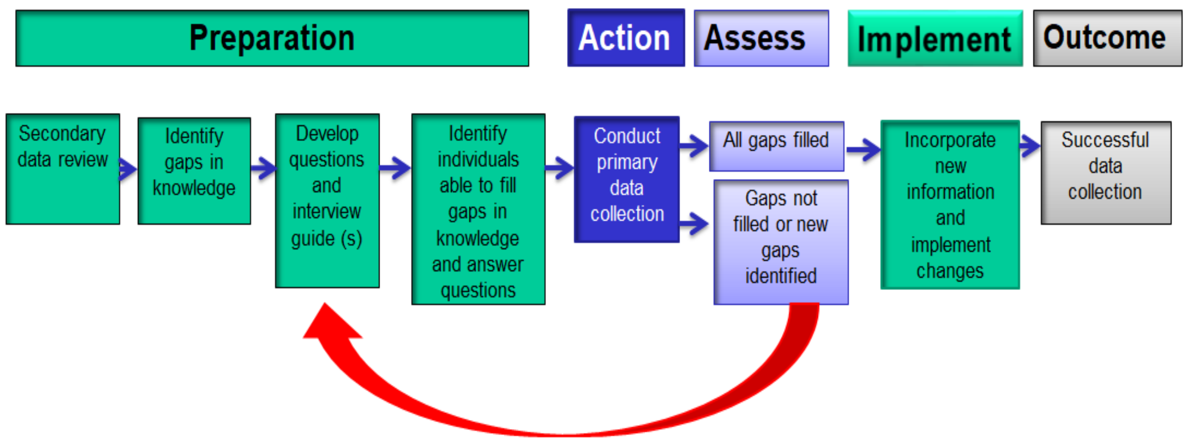

Figure 1: The iterative process of formative research, adapted from CDC (CDC, 2013).

Data collection

We used a community-based mixed-methods approach for this study, which included inputs from the household survey of pig farmers and non-pig farmers and interviews with key informants (KIIs), i.e. primary and secondary school headmasters, veterinary officers, health officers, environment and sanitation officers, community development officers and education officers at the community and district levels using a critical informant interview guide. We also conducted focus group discussions (FGDs) with the village health committee and primary and secondary school teachers to identify potential TSCT infection risks in the study area. We observed household infrastructure using an observation checklist in the same household that had taken part in the household survey. The information collected led to the formulation of critical messages for developing a health education package.

We used qualitative and quantitative triangulation approaches to validate the research findings through multiple data collection methods (CDC, 2013). One way to triangulate data from formative research is to compare information on the same topic from different data sources. Another strategy is to use at least two different data collection methods, such as KIIs, FGDs, and observations (CDC, 2013). We collected data to assess risk factors reflecting the natural and human environment, such as TSCT transmission and behaviors conducive to TSCT transmission through a household survey using semi-structured questionnaires, FGDs, KIIs, and a household infrastructure observation checklist (Nyangi et al., 2022).

For the rapid assessment, the farmer's workshop began with a questionnaire intended to identify farmers' knowledge and practices regarding *Taenia solium* life cycle, knowledge of signs

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of human infection of *Taenia solium,* the transmission of taeniasis and neurocysticercosis, the transmission of porcine cysticercosis, methods of pig keeping, and personal hygiene habits likely to affect the transmission of *Taenia solium* eggs from either pigs or people recognition of tapeworm segments in stool. Farmers received the question to describe what proportion of time they kept their pig tethered during the harvest, planting, and growing seasons of the year and whether the family always used a latrine for defecation, always washing hands with soap after defecating and before eating and washing fruits and vegetables. During the workshop, we conducted health education intervention after administering the questionnaire.

Household survey

We conducted the household survey using a structured questionnaire that included KAPs from pig farmers and non-pig farmers. The questionnaire included questions on demographics, medical history, previous sanitation projects (health policies, strategies, and plans), previous health education and knowledge about TSCT, its transmission, signs/symptoms, treatment, attitude, and practices related to TSCT. We administered the questionnaire to 480 respondents in Swahili, and then translated and recorded the information in English.

Key informant interviews

The key informants were livestock/veterinary officials, health workers/practitioners, community development, environment and sanitation officials, district and county education officers (primary and secondary schools), head teachers of primary and secondary schools, and local government officials who were to be involved in the study. Thirty-eight KIIs were conducted in the four districts with eight villages (two villages per district). A pre-tested interview guide was used to interview the KIIs on various aspects of TSCT. We collected data through the KIIs guide which was used to assess perceptions of actual problems related to factors influencing the prevention and control of TSCT. The same two researchers independently reviewed the written transcripts to improve the reliability of interpretation and reached a consensus before accepting the data for analysis.

Focus group discussions (FGDs)

Village health committee members and primary and secondary school science teachers were purposively selected to participate in the FGDs. Facilitators fluent in Swahili conducted and led the FGDs using an interview guide and a digital recorder. The participants in the Focus Group Discussion gave their consent before their discussions were recorded using a digital audio recorder. We typed the transcribed data into MS Word for further analysis.

Fourteen FGDs were conducted using an FGDs interview guide in all four districts. The plan was to perform 16 FGDs from the eight study villages. We ended with 14 FGDs as two villages had no active village health committee. Out of the 14 conducted FGDs, two had poor-quality audio that could not be heard clearly or transcribed. Therefore, we were left with 12 effective FGDs. The participants were asked to attend a 60- to 90-minute special session for FGDs. Each FGD comprised a minimum of six and a maximum of 12 participants. The same two researchers reviewed the written transcripts independently to improve interpretation reliability and reached a consensus before accepting them for analysis.

Household observation and infrastructure assessment

We conducted household observation and infrastructure assessment using a checklist for each household to capture high-risk behaviors/hygiene practices. Direct observations focused on the presence and quality of the toilet in terms of floor, roof, door, and pit cover, the presence of hand washing facilities with soap (Tippy Taps) in the latrines or outside the latrines, pig housing systems (confinement, tethering, or free-range), and general hygiene of the environment. The household observation was done in the same households where the household survey was conducted.

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For the CHEP pilot, pig farmers, non-pig farmers, schoolteachers, and local leaders, including spiritual leaders and government officials at the community/village level, formed groups and completed a short FGDs interview on the key messages of the CHEP. Their responses formed the basis for the FGDs with 6-12 participants per group. Four groups were formed: (i) pig farmers, (ii) non-pig farmers, (iii) government officials, including spiritual leaders, and (iv) key informants (primary and secondary school science teachers, livestock extension/veterinary officials). The groups wrote on the flip chart what they had discussed in their respective groups; all participants then discussed this.

Health Education Intervention

The health education intervention (rapid assessment) for all participants began with a questionnaire intended to identify farmers' knowledge and practices regarding *Taenia solium* life cycle, knowledge of signs of human infection of *Taenia solium,* the transmission of taeniasis and neurocysticercosis, the transmission of porcine cysticercosis, methods of pig keeping, and personal hygiene habits likely to affect the transmission of *Taenia solium* eggs from either pigs or people and recognition of tapeworm segments in stool. Farmers were also asked whether the family is always using a latrine for defecation, constantly washing hands with soap after defecating and before eating, and constantly washing fruits and vegetables. The administration of the questionnaire was followed by a health education intervention workshop.

After the health education intervention, we conducted the post-intervention using the same questionnaire immediately afterwards. The purpose was to rapidly assess the effectiveness of the health education interventions using the developed CHEP.

Analysis of the data

We exported the data to a Microsoft Excel spreadsheet for cleaning and storage and used SPSS version 20.0 (Armonk, NY: IBM Corp) for statistical analysis. A chi-square test was used to test for associations between categorical variables. The frequencies and percentages of correct responses in the descriptive statistics were summarized. The household observation data were analyzed based on the chi-square test using SPSS version 20.0. (Armonk, NY: IBM Corp).

Participants gave their consent for the KIIs and FGDs interviews to be recorded using a digital audio device. The transcribing was done into Swahili, and later, the transcriptions were translated into English for analysis and reporting. To improve the reliability of the interpretation, the written transcripts were independently reviewed by the two researchers, who were also involved in the transcription, and accepted by consensus for analysis. We analyzed the KIIs and FGDs transcripts using ATLAS.ti 8 for Windows using inductive thematic analysis (Nyangi et al., 2024).

Theories used in the development of the health education package.

The study used the following health behavior theories to guide the process of transforming the assessed risk factors into effective health education messages that would promote behavior change in the community. The models were intended to provide the framework for interpreting the risk factors that make up the health education package.

Integrated behavioral model (IBM)

The Integrated Behaviour Model is recommended because it incorporates constructs from the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB), the Health Behaviour Model (HBM), and the Rational Theory (KAP), as well as other influential theories. The Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB) focus on theoretical constructs that deal with individual motivational factors as determinants of the likelihood of performing a particular behavior (Montaño & Kasprzyk, 2008). Rational (KAP) and TPB theories have shown that the best predictor of behavior is behavioral intention, which is determined by attitudes towards the behavior and social normative perceptions. TPB is an extension of TRA and includes an additional construct: perceived control over the performance of the behavior (Champion & Skinner 2008; Montaño & Kasprzyk, 2008; WHO, 2012). The most important element of behavior in IBM is the intention to change the behavior because without motivation, a person is unlikely to perform a recommended behavior (Montaño & Kasprzyk, 2008, WHO, 2012).

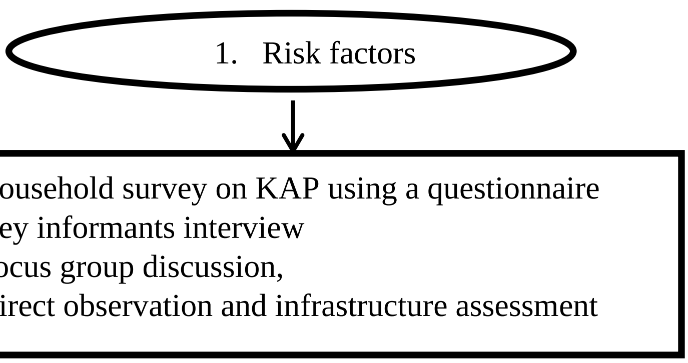
The Integrated Behavioural Model (IBM) lacks the principles of participation and targeting predisposing factors. The limitation is that this theory is only useful when considering individual health behavior, without considering other determinants of a person's health behavior and health status, such as race, socioeconomic status, or education. To complement this, we had to consult another model known as the PRECEDE-PROCEED Model, which is based on its fundamental principle of participation. We also consulted a third model that also forms a basis of our study and that is the health belief model (HBM) with its principle that people are more inclined to engage in healthy behavior when they think doing so can reduce a threat that is likely and would have severe consequences if it occurred. Thoughtful combinations of models may cause stronger interventions, as the models complement each other in describing the studied phenomenon (Champion & Skinner, 2008). However, a potential downside is a practical limit to how many theories can be combined (Champion & Skinner, 2008).

PRECEDE-PROCEED Model

PRECEDE-PROCEED Model relies on its principle of targeting the health education intervention to changeable factors that are most important and that predispose people to behaviours/practices instead of targeting the behaviours directly (Green & Kreuter, 1992). PRECEDE stands for 'Predisposing, Reinforcing, and Enabling Constructs in Educational/Environmental Diagnosis and Evaluation'. At the same time, PROCEED stands for Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development (Green & Kreuter, 1992) and was added to the framework to identify the importance of environmental factors that are determinants of health and health behavior.

Health Belief Model (HBM)

The Health Belief Model (HBM) was also consulted as it comprises several key concepts that foresee why people will take action to prevent, screen for, or control illness conditions. These include susceptibility, seriousness, benefits, and barriers to behaviour, clues to action, and self-efficacy (Champion & Skinner, 2008).



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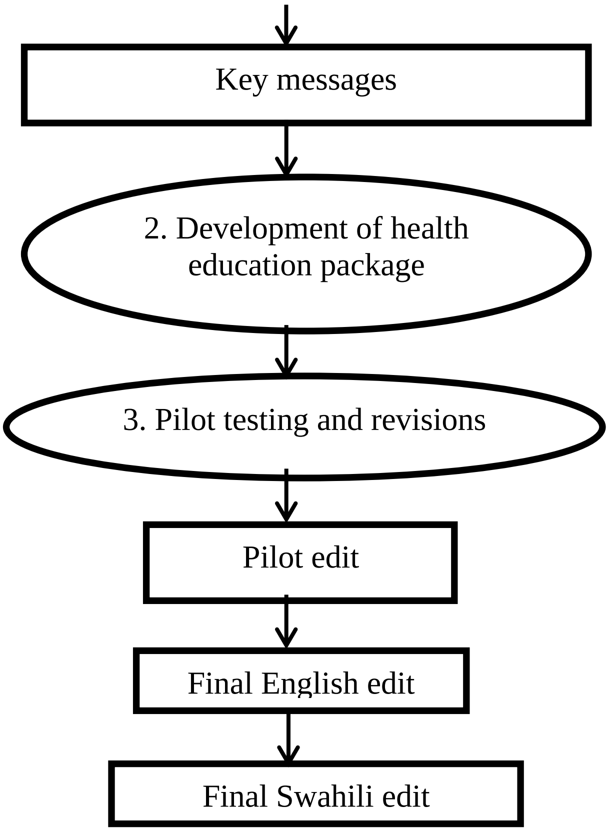

Figure 2: Flow diagram showing the steps involved in the development of the CHEP

Pilot testing of the developed health education package.
The CHEP was then pilot tested in another village far from the study villages. A pilot test was conducted on the CHEP (Community-based Health Education Program) in another village far away from the study villages. A pilot study is typically carried out before a more extensive study (Eldridge et al., 2016). A pilot project is closely linked to a feasibility study, which is the basis for planning a large-scale study (Thabane et al., 2010). Pilot projects are indeed a risk mitigation strategy to reduce a larger project's failure risk.

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Results

The results of the formative research informed the development of this health education package and included an assessment of risk factors (Figure 3).

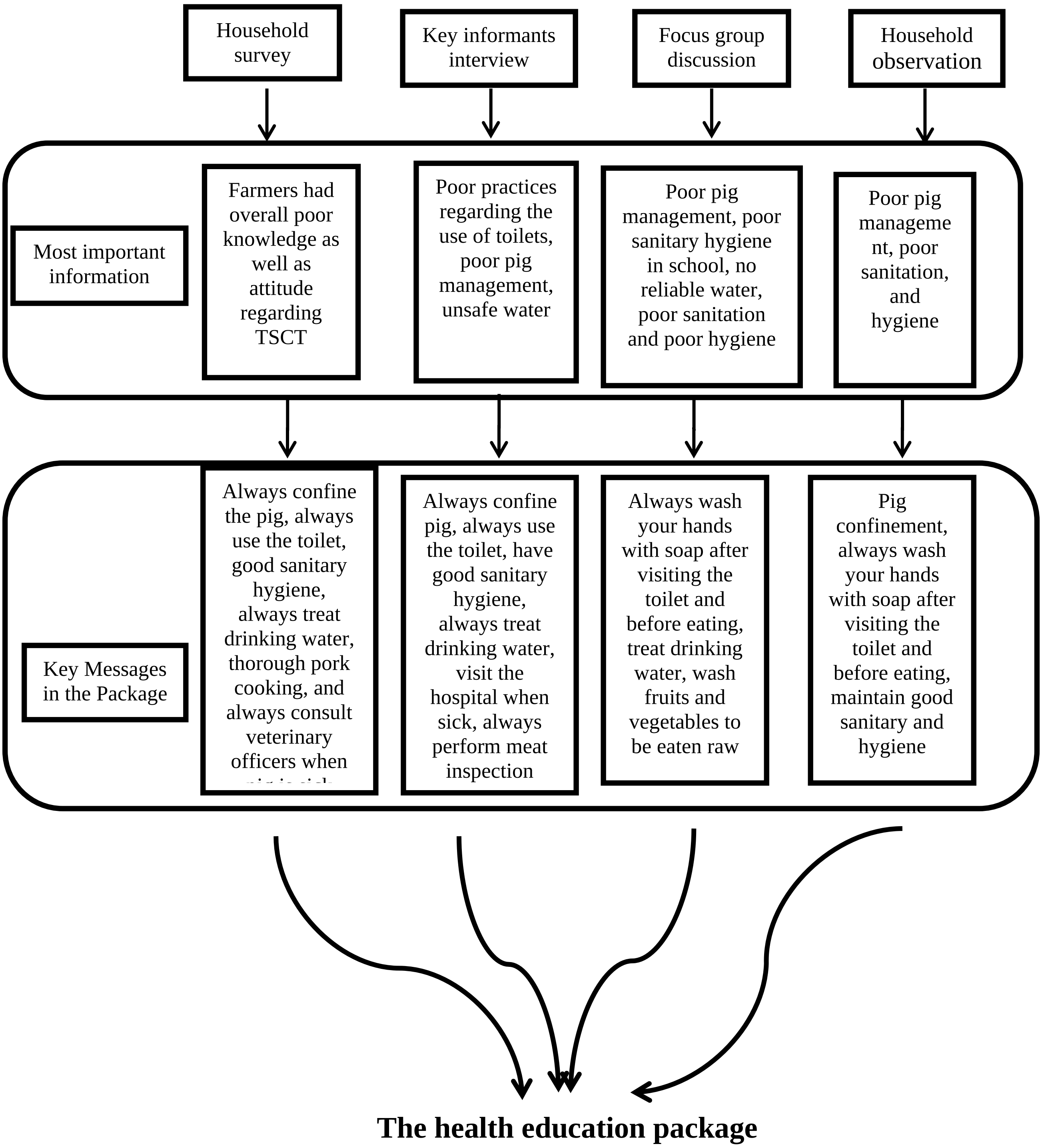

Figure 3: The process of development of a CHEP from defining risk factors to the key messages

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Key messages

Table 1: The formative research and risk factor assessment led to the formulation of the following key messages

Theme	Important information	Key messages
Clean and safe drinking water	Farmers and other community members were not treating drinking water	• Always boil (treat) drinking water
Pig management	Low knowledge of porcine cysticercosis transmission and control	• Always confine your pigs and feed them properly
Proper use of latrines	Some community members were practicing open defecation especially, on village open market day	• Always use latrines and they should be maintained in a good sanitation/hygiene
Personal hygiene	Farmers and other community members didn't have functional hand-washing facilities in the toilets	• Always wash your hands with water and soap after visiting the toilet and before eating
Food safety/hygiene	People in a local bar and open market were practicing improper cooking and poor handling of pork	• Proper cooking of pork (cooking then frying)
Food safety/hygiene	Washing fruits and vegetables that have to be eaten raw is very important.	• Always wash fruit and vegetables before eating them raw
Medical services	Most patients with epilepsy seek traditional treatment before visiting hospitals or churches, while most children visit the hospital when parents observe worms in their feces	• Visit the hospital when you feel sick
Food safety/hygiene	The practice of backyard slaughtering and unreliable meat inspection	• Always slaughter pigs in a slaughterhouse/slab and perform meat inspection
Extension services	People were self-treating their pigs while others were using traditional medicines	• Always consult the veterinary officer when your pigs are sick

Results of the pilot test of the education package

Results from the FGDs showed that participants understood the key messages, with most questions on transmission and the causes of PCC and tapeworm answered correctly (Nyangi et al., 2024). Feedback on the key messages was generally positive, with most participants having a significant problem with whether they had ever heard of tapeworm. This question was ambiguous because the Swahili term used was confusing to them since the word is used in the Swahili language for both tapeworm and cyst. Therefore, with the help of the district and ward livestock officers, the research team revised the message and made it clear and understandable.

Composition of the community-based health education package and the proposed main implementation steps

The ready-to-use community-based health education package (CHEP) developed by the community to control TSCT consists of a training manual for TOTs. The second component consists of a practical guide/booklet with illustrations (pictures) of critical TSCT control strategies distributed to all TOT participants, communities, and primary and secondary school teachers. The booklet is helpful for all community members, as it is easy to understand using pictures and a few captions in Swahili. The third component is a brochure (Appendix A in a Supplementary Materials File) with important TSCT control information, distributed to community members and students. The fourth component of CHEP is a poster (Appendix B in a Supplementary Materials File) showing the life cycle of the tapeworm (*Taenia solium*) and control points along the cycle.

Rapid assessment of the CHEP

For the rapid assessment, the pre-intervention survey was completed by 57 (45.7%) pig farmers, 16 (19.8%) TOTs, and 28 (34.6%) non-pig farmers. The post-intervention survey was completed by 45 (53.6%) pig farmers, 7 (8.3%) TOTs, and 30 (35.7%) non-pig farmers. Among the participants, 39 (23.6%) were female and 126 (76.4%). The majority, 114 (69.1%), had primary school education, and the majority, 50 (35%), were between the ages of 41 -50. There was an improvement in the knowledge and practices about tapeworm/taeniasis and cysticercosis, though most of the improvements were not statistically significant. Knowledge regarding tapeworm treatment increased from 61 (81.3%) pre-intervention to 76 (95.0%) post-intervention (P = 0.008), while the knowledge regarding the condemnation of infected pork increases from 65 (83.3%) pre-intervention to 73 (90.1%) post-intervention (P = 0.445). Practices about washing vegetables and fruits statistically significantly improved (P = 0.025), while that of pig confinement increased from 45 (77.6%) pre-intervention to 54 (88.5%) post-intervention, though the improvement was not statistically significant (Table 2).

Table 2: Comparison of knowledge and practices before and immediately after the health education intervention

	Correct response n (%)		
Question	**Pre-intervention**	**Post-intervention**	**P-value (χ^2)**
Knowledge-related questions			
Heard of human tapeworm	62 (77.5)	78 (95.1)	0.001
Tapeworm prevention	76 (96.2)	78 (96.3)	0.975
Tapeworm treatment	61 (81.3)	76 (95.0)	0.008
Heard of human cysticercosis	50 (62.5)	73 (89)	<0.001
Health effect of human cysticercosis	69 (93.2)	80 (98.8)	0.065
Heard of porcine cysticercosis	61 (79.2)	78 (64)	0.006
Prevention of porcine cysticercosis	76 (97.4)	78 (97.5)	0.980
A link between porcine cysticercosis and epilepsy	48 (64.9)	73 (92.4)	<0.001
At risk of getting tapeworm	40 (51.3)	48 (59.3)	0.057
At risk of getting human cysticercosis	44 (57.1)	48 (59.3)	0.328
Safe to eat infected pork	69 (88.5)	76 (93.5)	0.392
Condemnation of infected pork	65 (83.3)	73 (90.1)	0.445
Practice-related questions			
Confining pigs	45 (77.6)	54 (88.5)	0.109
The problem of roaming pigs	68 (89.5)	75 (94.9)	0.203
Wash vegetables and fruits	70 (99.3)	79 (100)	0.025
Using toilet	72 (94.7)	78 (98.7)	0.114
Wash hands after visiting the toilet	69 (92.0)	76 (95.0)	0.433
Wash hands before eating	68 (91.9)	76 (95)	0.433

All p-values are based on a Chi-square analysis of numbers across the four districts

Generally, there was an improvement in tapeworm/taeniasis and cysticercosis knowledge in all three groups. When the results were separately analyzed for the pig farmers, non-pig farmers and the TOTs group showed that during the pre-intervention survey, non-pig farmers had greater knowledge about tapeworm transmission (P<0.001), tapeworm treatment (P=0.394) and

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tapeworm health effect (P=0.394). Pig farmers were more aware of how tapeworms can be prevented and the health effects of porcine cysticercosis. The link between porcine cysticercosis and epilepsy was most likely to be understood by pig farmers, who were more likely to condemn infected pork. The post-intervention survey showed a significant improvement in most aspects of tapeworm/taeniasis and cysticercosis compared with baseline knowledge (Table 3).

Table 3: Comparison of knowledge of pig-farmers, non-pig farmers, and TOT

Variables	Correct response n (%)			P-value (χ^2)
	Pig-farmers	TOT's	Non-pig farmers	
1. Tapeworm transmission				
Pre-intervention	15 (41.7)	11 (68.8)	25 (92.6)	<0.001
Post-intervention	28 (63.6)	6 (85.7)	25 (86.8)	0.076
2. Tapeworm prevention				
Pre-intervention	34 (97.1)	16 (100)	26 (92.9)	0.455
Post-intervention	42 (93.3)	7 (100)	29 (100)	0.288
3. Tapeworm treatment				
Pre-intervention	24 (75.0)	13 (81.3)	24 (88.9)	0.394
Post-intervention	41 (93.2)	7 (100)	28 (99.6)	0.663
4. Tapeworm health effects				
Pre-intervention	29 (82.9)	15 (93.8)	27 (96.4)	0.176
Post-intervention	43 (97.7)	7 (100)	29 (100)	0.661
5. Health effect of human cysticercosis				
Pre-intervention	31 (93.9)	14 (93.3)	24 (92.3)	0.970
Post-intervention	44 (97.8)	7 (100)	29 (100)	0.667
6. Prevention of porcine cysticercosis				
Pre-intervention	37 (100)	14 (100)	25 (92.6)	0.144
Post-intervention	42 (95.5)	7 (100)	28 (100)	0.642
7. A link between porcine cysticercosis and epilepsy				
Pre-intervention	21 (63.6)	9 (60.0)	18 (69.2)	0.821
Post-intervention	42 (95.5)	7 (100)	24 (100)	0.229
8. At risk of getting tapeworm				
Pre-intervention	18 (51.4)	7 (43.8)	15 (55.6)	0.282
Post-intervention	32 (71.1)	4 (57.1)	12 (41.4)	0.051
9. At risk of getting human cysticercosis				
Pre-intervention	18 (52.9)	8 (50.8)	18 (66.7)	0.351
Post-intervention	32 (71.1)	4 (57.1)	12 (41.4)	0.103
10. Safe to eat infected pork				
Pre-intervention	31 (88.6)	13 (81.3)	25 (92.6)	0.788
Post-intervention	42 (93.3)	7 (100)	27 (93.1)	0.898

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*TOT: Training of trainers (government officials who will train the large community)
All p-values are based on a Chi-square analysis of numbers across the four districts

Regarding practices, pig farmers were more aware of the effect of free-roaming pigs while non-pig farmers were more aware of the practices related to washing fruits and vegetables before consumption, using toilets, and washing hands before eating and after visiting the toilet (Table 4)

Table 4: Comparison of practices of pig farmers, non-pig farmers, and TOT's

Variables	Correct response n (%)			P-value (χ^2)
	Pig-farmers	TOTs*	Non-pig farmers	
1.Do you completely confine your pigs				
Pre-intervention	7 (20)	3 (27.3)	3 (25)	0.855
Post-intervention	3 (6.8)	3 (60.0)	1 (8.3)	0.019
2. Do you think it is harmful if pigs roam free?				
Pre-intervention	32 (91.4)	14 (93.3)	22 (84.6)	0.607
Post-intervention	41 (93.2)	7 (100)	27 (96.4)	0.569
3. Do you always wash vegetables and fruits				
Pre-intervention	32 (94.1)	13 (86.7)	25 (96.2)	0.478
Post-intervention	43 (100)	7 (100)	29 (100)	**
4. Do you always use the toilet				
Pre-intervention	33 (94.3)	13 (86.7)	26 (100)	0.203
Post-intervention	42 (97.7)	7 (100)	29 (100)	0.541
5. Do you always wash your hands after visiting the toilet				
Pre-intervention	31 (91.2)	13 (92.9)	25 (92.6)	0.801
Post-intervention	42 (95.5)	7 (100)	27 (93.1)	0.627
6. Do you always washing hands before eating				
Pre-intervention	31 (91.2)	12 (92.3)	25 (92.6)	0.978
Post-intervention	42 (95.5)	7 (100)	27 (93.1)	0.627

All p-values are based on a Chi-square analysis of numbers across the four districts
*TOT: Training of trainers (government officials who will train the large community)
**: No statistics are computed because the variable is a constant.

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Discussion

The community participated in developing this health education package on TSCT control to bring about behavior change and promote community ownership of the program. The rapid assessment of the package resulted in a great improvement in knowledge and practices in all three groups assessed (pig farmers, TOTs, and non-pig farmers) (Table 2-4). This conventional approach is more suitable for most endemic areas where other approaches such as video and digital technology are not feasible because of poor infrastructures such as lack of electricity, internet, and computers/laptops/tablets/smartphones. The following health behaviour models were used to translate the measured risk factors into actionable educational messages to encourage the population to change their behaviour.

The Health Belief Model (HBM) includes several key concepts that predict why people will take action to prevent, screen for, or control health conditions (Champion and Skinner, 2008). These include susceptibility, seriousness, benefits, barriers to a behavior, incentives to act, and self-efficacy; all of which are strong predictors of preventive health behaviors (Champion & Skinner, 2008). Our results do not support this model, as most respondents/participants were not aware that they were at risk of contracting TSCT (perceived susceptibility); the majority were also unaware of the severity of the disease and its consequences (perceived severity) as most were unaware of the health effects of taeniasis on humans as well as cysticercosis to both pigs and humans. The study supports the model as most participants believed in the effectiveness of the recommended risk reduction measures (perceived benefits). However, most of them thought about the tangible costs of the measure (perceived barriers), such as the cost of building pig pens, access to pig feed, and the cost of building modern toilets. People had low self-efficacy in controlling TSCT, as the majority felt that some of the actions needed to control TSCT are difficult to achieve (self-efficacy). The education package developed was intended to influence the population's perceived susceptibility to TSCT to improve their behavior to prevent infection.

Therefore, the lack of knowledge and awareness and poor hygiene and sanitation in the study area would likely lead to infection with TSCT. This led to including the following messages in the package alongside the key points on TSCT prevention.

1) Raise awareness of TSCT among the study population. The messages included were the risk of infection" (perceived vulnerability) (Champion & Skinner, 2008).
2) Conviction of participants/respondents that it is within their choice to change their behaviour and reduce the risk of infection (self-efficacy) (Champion & Skinner, 2008). This implies that they can protect themselves from TSCT through improved hygiene practices.

In terms of the integrated behavioral model (IBM), the results of this study support the model as most respondents showed the intention to carry out the behavior, especially after they became aware of the consequences of TSCT for themselves and pigs. Individuals' habituation to scientific knowledge alone does not necessarily lead to behavior change. Rather, behavior is related to perceptions, values, power relations, and feelings and cannot be changed simply by acquiring knowledge (Gazzinelli et al., 2012). There is extrinsic motivation, when a person engages in an activity to achieve or avoid a particular outcome, many of the things you do every day are likely extrinsically motivated. Intrinsic motivation is where there is an internal drive for success or meaningfulness. Finally, the family is motivated to care for those they love (Rodgers & Loitz, 2008). The person will perform a recommended behavior (Rodgers & Loitz, 2008). The package will be shared with key stakeholders and policymakers involved from the beginning; these included politicians, ministries of health and education, and the critical informants mentioned in this paper. These are the key people who enforce the existing laws if people are unwilling to change their practices and behaviour.

Based on the **PRECEDE-PROCEED** model, the primary purpose of this model is to provide a framework for planning and evaluating health behavior change programs. This model is applied to the design of this study because its methodology addresses the problem of health education focusing too much on program delivery and too little on program design. This is planned to meet evidenced needs (Bartholomew et al., 2006). The underlying principle of this model is participation, which states that success in achieving change is enhanced by the active involvement of the proposed target group in describing their priority problems and goals and in developing and implementing solutions (Green & Kreuter, 1992). In developing the package, much emphasis was placed on creating a community-based health education package that meets the target community's needs. Interventions that involve the community can promote behavior change and community ownership of programs (Gazzinelli et al., 2012). The CHEP is expected to be accepted by the community, as evidenced by the KAP baseline survey experience. The community showed that lack of education is a critical factor for TSCT infection, and they wanted more health education to raise awareness and improve KAP to control TSCT.

Conclusion

With community participation, we develop the community-based health education package (CHEP), which is expected to be an adequate population education intervention in remote areas where other educational tools, such as videos and digital tools, cannot be used. Practical educational tools must be integrated into interventions for combating TSCT infections and other neglected tropical diseases, as expressed in a Research Agenda for Helminths Disease (Boatin et al., 2012). Interventions, including health education to prevent TSCT and other worm infections, are urgently needed to improve the sustainability and effectiveness of other existing control strategies as part of an integrated approach. Communities in resource-poor endemic countries can quickly adapt and implement the developed CHEP. This paper describes the development and rapid assessment of the community-based health education package (CHEP) for TSCT control in Tanzania.

Ethical considerations and consent to participate

The National Institute of Medical Research (NIMR) approved the study with approval number NIMR/HQ/R.8a/Vol. IX/2802. The study also received approval from the ethics committee of the Klinikum rechts der Isar, Technical University of Munich, Germany, under the number 537/18 S-KK. We explained the study objectives to each participant and obtained verbal consent.

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Competing interests

None declared

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