CONTROLLING *TAENIA SOLIUM* IN NEPAL USING THE PRECEDE-PROCEED MODEL

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Abstract. *Taenia solium* is a predominant food-borne parasitic zoonosis (FBPZ) in Nepal. Using the PRECEDE framework, as defined by Green and Kreuter, we can identify the factors behind the high incidence of this disease. Armed with this information, we can define the actions necessary to control *T. solium*. In accordance with the first step of PRECEDE, social assessment, we set the goal of decreasing the potential for *T. solium* transmission in Nepal by the year 2003. This goal has yet to be endorsed by policy makers. However, an epidemiological assessment based on hospital data alone showed that *T. solium* is an endemic problem in urban Nepal that must be addressed. Based on behavioral and environmental assessments (Steps 1 and 2 of PRECEDE-PROCEED), we defined the following action objectives to be achieved by 2003: 1) Train meat producers and sellers to detect contaminated pork and avoid selling it, 2) Improve pig husbandry to limit the animals' access to human feces, 3) Construct hygienic model slaughterhouses.

These improvements could control the meat-producing environment, thus limiting the potential for cross-carcass contamination and other hygiene deficiencies associated with the spread of *T. solium*. An educational and ecological assessment shows all predisposing, reinforcing and enabling factors are present in Nepal, consistent with PRECEDE requirements. While *T. solium* is clearly defined as a health problem according to PRECEDE, there remain significant hurdles to controlling it. These hurdles lie in administration and policy, where standardized law-enforcement and meat inspection practices are needed. Finally, the government of Nepal must assign high priority to *T. solium* control, as it is a preventable, yet prevalent disease.

INTRODUCTION

The recognition of *Taenia solium*, in particular a neurocysticerosis, is relatively recent in Nepal. With the addition of neurosurgery units to the major Nepalese hospitals came the ability to identify this illness, and it is now considered to be one of the major food-borne parasitic zoonose (FBPZ) threats in Nepal. This paper examines the factors that contribute to the transmission of *T. solium* in Nepal. We applied the PRECEDE-PROCEED model (Green and Kreutes, 1999) to examine the disease from different angles, including social, epidemiological, behavioral/environmental, educational/ecological and administrative/policy.

This model has been used primarily in developed countries, but it has also been used in South Africa for helminth infection control (Taylor *et al*, 1999), and in Nepal for iodine deficiency disorder control (Jimba and Murakami, 2000).

The diagnosis and treatment of *T. solium* is difficult in Nepal, and it is generally acknowledged that controlling *T. solium* transmission is preferable to treating it (Lloyd, 1998). Therefore, this study focused on controlling *T. solium* contamination. Although changing socio-economic conditions is one of the most important factors in controlling the disease (Lloyd, 1998), this is beyond our control. Thus, we sought to identify solutions appropriate in the context of the reality in Nepal.

METHODS

We analyzed Nepal's *T. solium* problem according to the first five steps of the PRECEDE-PROCEED model using locally available primary and secondary data. The incidence of *T. solium*-induced neurocysticercosis, confirmed by biopsy in Patan Hospital (July 1993-February 1998), Bir Hospital (1995-1997) and Kanti Children's Hospital (1995-1997) (Poudyal, 1999), provided data for the epidemiological assessment. Key informant interviews of meat producers and sellers and the health professionals responsible for *T. solium* control, as well as an examination of the incidence of infected pork carcasses at slaughtering locations in Kathmandu and Dharan provided data for the behavioral/ environmental, educational/ecological, and administration/policy assessments.

RESULTS

Social assessment

We set the goal of decreasing the potential for *T. solium* transmission in Nepal by the year 2003.

However, the Nepal Veterinary Council must endorse this goal, and the government must assign a high priority to *T. solium* control.

Epidemiological assessment

Epidemiological data were available only from the major hospitals in Nepal. These data are reflected in the following tables. Between July 1993 and February 1998, 62 of 23,402 surgical patients were confirmed as cysticercosis cases. Forty of these patients were from Kathmandu while 22 patients were from outside Kathmandu. Table 1 shows the age and sex distribution of these cases in Patan Hospital.

Bir Hospital also provided similar data. Between 1995 and 1997, 4 out of 25,033 surgical patients were confirmed cysticercosis cases as shown in Table 2.

Because there is no meat inspection system in Nepal, it is difficult to determine the prevalence of *T. solium* in meat. However, according to Poudyal (1998, 1999), 34 out of 250 pork samples (13.6 %) collected in Kathmandu and Dharan were infected with *T. solium* larvae as shown in Table 3.

Behavioral assessment

According to epidemiological assessments, meat producers and sellers are unaware of *T. solium* and its

Table 1
Age and sex distribution of cysticercosis cases in Patan Hospital.

Age groups (Years)	Total cases	Male		Female	
		Cases	%	Cases	%
0 - 9	12	6	50.0	6	50.0
10 - 19	18	9	50.0	9	50.0
20 - 29	18	6	33.3	12	66.6
30 - 39	8	2	25.0	6	75.0
40 - 49	5	1	20.0	4	80.0
50 - 59	1	0	0.0	1	100.0
Total	62	24	38.7	38	61.3

Table 2
Cysticercosis cases in Bir Hospital.

Year	Major operated cases	Cysticercosis	%
1995	8,107	1	0.01
1996	8,409	1	0.01
1997	8,517	2	0.02
Total	25,033	4	0.01

Kanti Children's Hospital also confirmed 11 cysticercosis cases during this period.

Table 3
Prevalence of pig cysticercosis in Kathmandu and Dharan.

Name of place	Total meat sample collected	No. of sample tested positive	%
1. Kathmandu			
a. Khichapokhari	148	22	14.9
b. Koteswor	48	6	12.5
2. Sunsari			
a. Dharan	54	6	11.1
Total	250	34	13.6

causes. They exhibit high-risk behavior by continuing to sell "measly pork" (pork containing *T. solium* cysts).

Consumers are unaware of the risk they take when eating pork, and pork consumption is on the rise. Between 1984 and 1992, pork production increased from 7,234 metric tons (MT) to 10,407 MT - a 43% increase, in response to the increasing demand for the meat (Joshi, 1999). Traditionally, the ethnic groups of Rai, Limbu, Tamang and Magar consume pork; however, young people from other ethnic groups have begun consuming pork as well. In addition, many ethnic and religious traditions involve consuming raw, undercooked or barbecued pork, thus increasing the possibility of *T. solium* transmission. Further more, pig husbandry is a significant source of income in rural Nepal and the meat also serves as a primary protein source for many people there.

As a result of the behavioral assessment, we identified the following behavioral objective to be achieved by 2003:

Train meat producers and sellers to detect measly pork and avoid selling it.

Environmental assessment

1. **Pigs are kept in highly unsanitary conditions.** Pigs live in close contact with people and roam the streets where they have access to human feces and other garbage. Pigs imported from India or brought from other border areas are not inspected for disease ante- or post-mortem allowing them to introduce disease into previously uninfected areas.

2. **Pigs are slaughtered in open spaces using non-standardized methods**. Because the slaughtering process is not standardized, fecal contamination of pig carcasses is common. Cross-carcass contamination is common, as knives and slaughtering materials are not cleaned after each animal is slaughtered.

3. **Offal and unwanted carcass portions are dumped in rivers**. Dogs, birds and other carrion-eaters are usually present at slaughtering locations and are fed offal and other waste. If the offal is not disposed in the local river, it is simply dumped nearby leading to widespread environmental contamination.

4. **Pig carcasses are not refrigerated**. Pig carcasses are often transported and stored on rickshaws in the open air. While this does not facilitate *T. solium* growth, it is a public health threat.

5. **Unsanitary defecating practices**. Because sanitary toilet facilities are not typically available in rural Nepal, people defecate in the open air. This practice facilitates the spread of parasites.

Based on this environmental assessment, we identified the following environmental objectives to be achieved by 2003:

Improve pig husbandry in confined areas and limit their access to human feces.

Construct model slaughterhouses with hygienic standards.

Educational and ecological assessment

Predisposing factors: Key informant interviews and a literature review revealed that a limited number of health professionals are aware of the danger measly pork presents. Moreover young urban people, regardless of ethnic group and ethnic traditions, have incorporated pork into their diet increasing the number of potential *T. solium* victims.

Enabling factors: To improve *T. solium* control, we must train meat producers and sellers in the safe handling of meat. The National Zoonose and Food Hygiene Research Center, a non-governmental organization in Nepal, initiated a pilot training program to address the lack of proper meat handling; this program should become government-sponsored, and part of a routine training program for all meat handlers. Collaboration with other donor agencies may be necessary to improve slaughterhouse operations.

Reinforcing factors: Key informants noted that international, as well as national, involvement in strengthening livestock services including international aid geared towards improving livestock management and production would help reinforce better meat handling practices. Training recently graduated veterinary doctors from the new Veterinary College in Nepal in food hygiene in a practical setting would allow them to contribute to improving meat hygiene as well. It should also be noted that improving meat hygiene will help control not only *T. solium* but also many other meat-borne diseases.

Administrative and policy assessment

Administrative assessment: The key informant interviews highlighted the numerous administrative obstacles Nepal has to overcome. Law enforcement must be further developed and meat inspectors must be trained. The primary hospitals must track and record the incidence of *T. solium* and neurocysticercosis.

Policy assessment: Key informants pointed out that regional cooperation is necessary because of the unregulated cross-border meat trade. South Asia must agree on a general food-borne disease control policy that can be applied to *T. solium* as well as other diseases.

Techniques that minimize the spread of *T. solium* are also effective at controlling other FBPZs. Defining a general policy and grouping all FBPZs together as a large and common threat highlights the importance of controlling all FBPZs including *T. solium*, and will help governments recognize the importance of assigning FBPZ control a higher priority in their agendas.

DISCUSSION

Hospital data alone highlight *T. solium* as a major FBPZ in Nepal. The frequency of *T. solium* in rural areas where people cannot reach hospitals, remains untracked, but one must judge that due to poorer hygiene in rural areas, the incidence of the disease is even greater than we have measured. In addition, the risk of humans contracting cysticercosis can be judged as extremely high based on the high incidence of pig cysticercosis.

Behavioral and environmental assessments point to specific action objectives to reduce the incidence of *T. solium* infection in Nepal. At this time, we must target meat producers and sellers for both behavioral and environmental changes rather than consumers, because sellers are fewer in number, more easily identified and their practices unlike consumer practices are not as deeply rooted in tradition which makes them more amenable to change. In addition, the consumer is limited to what the market provides. Thus, only after meat producers are trained can we expect consumer education to help lower the incidence of *T. solium*. In rural areas, we must focus on the pig keepers to change the husbandry environment and give them basic hygiene training, such as using toilets, wearing shoes and washing their hands.

A standardized, enforced meat inspection system is the administrative key to *T. solium* control. In other countries, previous studies showed that meat inspection detected only an estimated 32-38 % of cysticercosis cases (Rickard and Adolph, 1977; Walther and Moske, 1980); however, because tongue palpation is time consuming and not sensitive enough (Lloyd, 1998), and immunodiagnosis is difficult, meat inspection is the only appropriate diagnosis method in Nepal. In addition, meat inspection can help prevent other food-borne diseases. However, regional cooperation is necessary to establish a common strategy to control food-borne diseases as a whole.

In a country where acute infectious diseases are still common and often lead to human death, it is difficult to prioritize a single disease such as cysticercosis which is caused by *T. solium*. Widespread morbidity also makes it difficult to identify the solutions and first steps to take. By using the PRECEDE-PROCEED model, however, we can identify ways to start short-term targeted interventions in Nepal's context. As the country grows and priorities change, the interventions may also change. Therefore, the holistic assessment PRECEDE-PROCEED represents should be repeated regularly.

ACKNOWLEDGEMENTS

We would like to thank the organizers of the 3rd Seminar on Food-Borne Parasitic Zoonoses, particularly Dr Piyarat Butraporn of the Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand, for his invitation and hospitality.

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