SOIL-TRANSMITTED HELMINTHIASES AND HEALTH BEHAVIORS AMONG SCHOOLCHILDREN AND COMMUNITY MEMBERS IN A WEST-CENTRAL BORDER AREA OF THAILAND

Malinee T Anantaphruti, Jitra Waikagul, Wanna Maipanich, Supaporn Nuamtanong and Somchit Pubampen

Department of Helminthology, Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand

Abstract. The prevalence of soil-transmitted helminthic infections and health behaviors related to infections in schoolchildren and villagers of a community (4 hamlets) was studied in Hauy Kayeng subdistrict, Thong Pha Phum district, in the north of Kanchanaburi Province. The intestinal helminth infection rate of the schoolchildren was 15.6%. Hookworm infection was the most prominent (9.8%), followed by *Trichuris trichiura* (6.2%), and *Ascaris lumbricoides* (2.2%). The community showed higher prevalence rates and was infected with more types of intestinal helminths than the schoolchildren. Thirty-five point two percent (35.2%) of the residents were infected with soil-transmitted helminths, 30.5% with hookworm, 3.4% with *A. lumbricoides* and 2.2% with *T. trichiura*. Almost all hookworm cases (94.3%) were light intensity infections, while only 1.3% were heavy infections. Moreover, the hookworm infection rate in the community was found to be much higher when a stool culture method was used (39.1%). With this technique, 2.3% *Strongyloides stercoralis* infections were detected in the community population. Examination of the health behavior of the study samples showed that approximately 75% always defecated in a toilet. Schoolchildren who always wore shoes comprised 67%, which was lower than the community, at 85%.

INTRODUCTION

Soil-transmitted helminth infections have been recognized as a public health problem in Thailand. A nation-wide helminth control program was launched by the Ministry of Public Health, and the overall prevalence of intestinal helminthiases decreased from 62.9% in 1957 to 22.5% in 2001. Among those infections, hookworm was the most prevalent. In 2001, the hookworm infection rate was 11.4%, and when classified into regions (Central, North and Northeast), the rates were similar (9.1-9.4%). This figure was lower than in the South (20.2%) (Jongsuksantikul, 2002). However, in remote areas, the prevalence is still higher than those figures (Anantaphruti *et al*, 2002; Maipanich *et al*, 2002).

The border zones of western Thailand are mostly heavily forested areas comprised of mountains and valleys. In the west-central remote areas, 50% or more of the indigenous people are Karen and the sanitation and water supply are poor. In addition, because of the unstable political status of the country bordering western Thailand, Myanmar, there is a trend towards increasing illegal migration into the neighboring border zones of Thailand. Squatter settlements and shantytowns, together with poor sanitation, promote the spread of parasite eggs and larvae.

This investigation aimed to study helminthic infections and health behaviors in relation to the infection of schoolchildren and inhabitants residing in a western zone of Thailand bordering Myanmar.

MATERIALS AND METHODS

Kanchanaburi is a province in western central Thailand, on the Thai-Myanmar border. The study area was Hauy Kayeng subdistrict, 30 km from Thong Pha Phum district, 170 km north of

Correspondence: Malinee Thairungroj, Department of Helminthology, Faculty of Tropical Medicine, 420/6 Rajvithi Road, Bangkok 10400, Thailand.
Tel: 66 (0) 2354 9100-11
E-mail: tmmtr@mahidol.ac.th

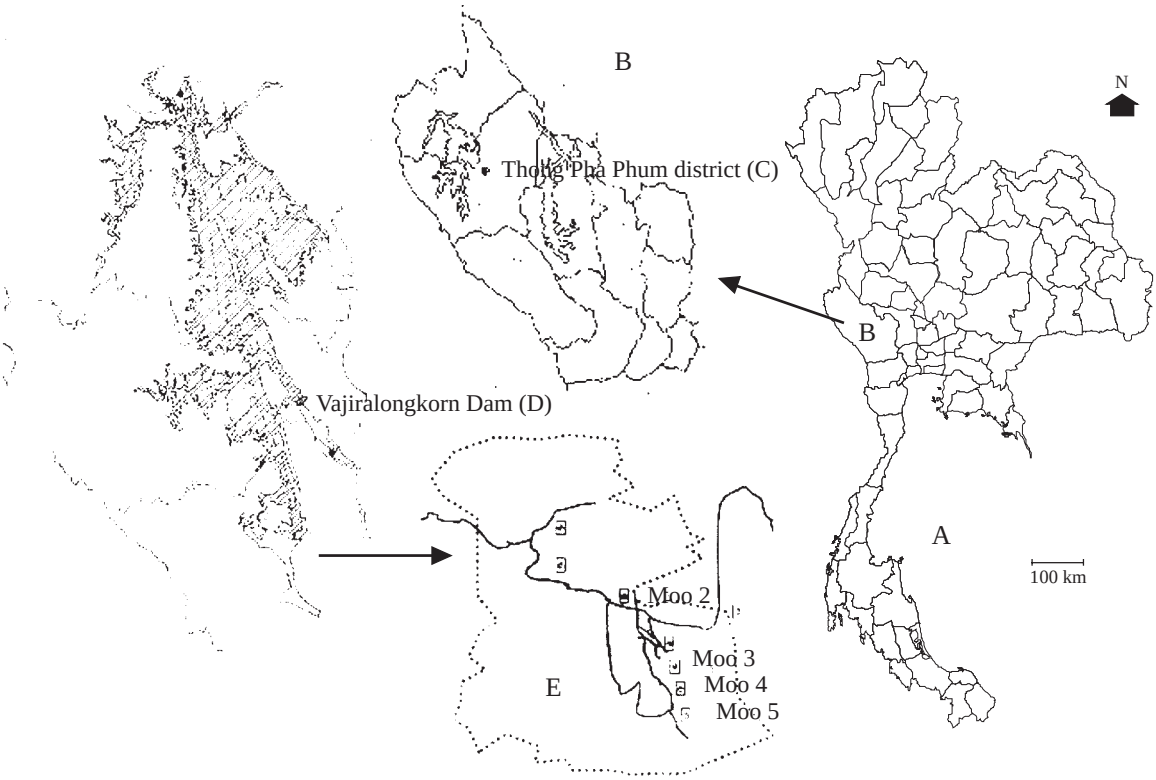

Fig 1–Map of Thailand (A) showing Kanchanaburi Province (B), Thong Pha Phum district (C), Vajiralongkorn Dam (D) and Hauy Kayeng subdistrict (E).

Kanchanaburi (Fig 1). It is a heavily forested mountainous highland. The major water basin is the Vajiralongkorn (Khao Laem) Dam. Most of the residents live on land provided by the Electric Generating Authority of Thailand (EGAT), due to the impact of the construction of the Dam.

The main occupations of the community are agriculture, livestock production and fishing in the water basin of the dam. There are 8 hamlets, composed of approximately 2,000 households with 4,000 males and 3,600 females. Each hamlet has a primary school, and there are 2 junior high schools.

The study was conducted with the schoolchildren and community population of hamlets 2 to 5. Stool examination by Kato-Katz technique was performed with the schoolchildren in grades 2 to 6 and the community population of these 4 hamlets. The intensity of infection was classified into light, moderate and heavy, according to the number of eggs per gram of feces. The polyethylene tube culture method, for detecting the filariform larvae of hookworms and *Strongyloides* sp, was included for the community stool samples.

Questionnaires were designed to obtain data on health behavior and practices in relation to soil-transmitted helminth infections of the schoolchildren and the community population. The children's data were obtained from all schoolchildren in grades 3, 4 and 5 of the studied schools using questionnaires. The community data were obtained from the head of each household by interview. The number of households to be interviewed was based on the formula of Lemeshow, *et al* (1990).

RESULTS

Parasite infection rates of the schoolchildren

The soil-transmitted helminth infection rate of 276 schoolchildren in 4 schools (Ban Paklampilok, Ban Hauy Kayeng, Ban Prajum Mai and Ban Raipa) was 15.6%, ranging from 10.9-20.6%. Hookworm was the most prevalent, at

9.8% (range 8.3-11.8%), followed by *Trichuris trichiura* (6.2%), *Ascaris lumbricoides* (2.2%), and *Enterobius vermicularis* (0.4%) (Table 1).

Parasite infection rate of the community

The prevalence of intestinal helminth infections of each hamlet was much higher than for the corresponding schoolchildren. Out of 741 samples examined, 35.2% were infected with soil-transmitted helminths, 30.5% with hookworm, 2.2% with *T. trichiura* and 3.4% with *A. lumbricoides*. Other minor helminths found with a prevalence less than 1% were *Strongyloides stercoralis*, *E. vermicularis*, *Taenia* sp and small intestinal fluke-like organisms (Table 2). Almost all (94.3%) hookworm infections were of light intensity, 4.4% moderate and only 1.3% heavy (Table 3). Stool samples of hamlets Moo 2, 3 and 4 were cultured on filter paper in polyethylene tubes. The results showed that higher helminthic infection positive rates were obtained. Out of 529 samples examined, 219 (41.4%) were found positive for either hookworm or *S. stercoralis* filariform larvae. The infection rates for hookworm and *S. stercoralis* were 39.1% and 2.3%, respectively (Table 4).

Behaviors and practices

Questionnaires were obtained from 254 schoolchildren in grades 3 to 5 of 4 schools, and a community population of 58 in 4 hamlets. Of the children, 125 (49.2%) were male and 129 (50.8%) female. Their ages ranged from 7-15 years, with 43.7% being 10-11 years. Their parents' occupations were mostly agriculture (47.2%) and employee (32.7%). Of the community samples, 27 (46.6%) were male and 31 (53.4%) female; their ages ranged from 15-80 years. Their

Table 1
Results of stool examination of schoolchildren in grades 2-6 in 4 schools of Hauy Kayeng, Thong Pha Phum district, Kanchanaburi Province, February 2002, examined by Kato-Katz method.

Schools	Number examined	Number positive (%)				
		STH[a]	Hookworm	*Trichuris*	*Ascaris*	*Enterobius*
Ban Paklampilok (Moo 2)	64	7 (10.9)	6 (9.4)	1 (1.6)	-	-
Ban Hauy Kayeng (Moo 3)	60	9 (15.0)	5 (8.3)	2 (3.3)	1 (1.7)	1 (1.2)
Ban Prajum Mai (Moo 4)	84	13 (15.5)	8 (9.5)	6 (7.1)	5 (6.0)	-
Ban Raipa (Moo 5)	68	14 (20.6)	8 (11.8)	8 (11.8)	-	-
Total	276	43 (15.6)	27 (9.8)	17 (6.2)	6 (2.2)	1 (0.4)

[a]STH = Soil-transmitted helminths

Table 2
Results of stool examination of villagers of Hauy Kayeng, Thong Pha Phum district, Kanchanaburi Province, May 2002, examined by Kato-Katz method.

Hamlets	Number examined	Number positive (%)					
		STH[a]	Hookworm	*Trichuris*	*Ascaris*	*Strongyloides*	Others[b]
Moo 2	188	65 (34.6)	57 (30.3)	2 (1.1)	1 (0.5)	2 (1.1)	8 (4.3)
Moo 3	167	57 (34.3)	51 (30.5)	1 (0.6)	4 (2.4)	0	2 (1.2)
Moo 4	245	88 (35.9)	76 (31.0)	5 (2.0)	16 (6.5)	2 (0.8)	4 (1.6)
Moo 5	141	51 (36.2)	42 (29.8)	8 (5.7)	4 (2.8)	0	3 (2.1)
Total	741	261 (35.2)	226 (30.5)	16 (2.2)	25 (3.4)	4 (0.5)	17 (2.3)

[a]STH = Soil-transmitted helminths
[b]Moo 2: *Taenia* = 2, Intestinal fluke-like= 5, *Enterobius* = 1
Moo 3: *Taenia* = 1, Intestinal fluke-like = 1
Moo 4: *Taenia* = 1, Intestinal fluke-like = 2, *Enterobius* = 1
Moo 5: *Taenia* = 1, Intestinal fluke-like =2

Table 3
Intensity of hookworm infection of villagers of Hauy Kayeng, Thong Pha Phum district, Kanchanaburi Province, May 2002, examined by Kato-Katz method.

Hamlets	Intensity of infection			
	Light	Moderate	Heavy	Total
Moo 2	51	5	1	57
Moo 3	49	2	0	51
Moo 4	72	3	1	76
Moo 5	41	0	1	42
Total	213 (94.3)	10 (4.4)	3 (1.3)	226

Table 4
Infection rates of *Strongyloides stercoralis* and hookworm in 3 hamlets of Hauy Kayeng, Thong Pha Phum district, Kanchanaburi Province, detected by culture technique.

Hamlets	Number examined	Number positive (%)		
		Hookworm	*Strongyloides*	Total
Moo 2	141	55 (39.0)	2 (1.4)	57 (40.4)
Moo 3	166	65 (39.2)	4 (2.4)	69 (41.6)
Moo 4	222	87 (39.2)	6 (2.7)	93 (41.9)
Total	529	207 (39.1)	12 (2.3)	219 (41.4)

Table 5
General information from interviewees of schoolchildren and population in the community of Hauy Kayeng, Thong Pha Phum district, Kanchanaburi Province.

Categories	Sex, No. and (%)			Age (Range)	Occupation, No. and (%)[a]		
	Male	Female	Total		Agriculture	Employee	Other
Schoolchildren	125 (49.2)	124 (50.8)	254	7-15	137 (53.9)	83 (32.7)	34 (13.4)
Community	27 (46.6)	31 (53.4)	58	15-80	26 (44.8)	23 (39.7)	9 (15.5)

[a]Occupation of schoolchildren' parents

occupations were mainly agriculture (44.8%) and employee (39.7%) (Table 5). Fifteen (5.9%) of the schoolchildren's houses had no latrine. However, 100% of the community had latrines (Table 6). The percentage of schoolchildren' latrines situated outside the house was 59.1%, whereas, the percentage of community latrines inside the house was 51.7% (Table 6).

Both the schoolchildren and the community had been taking anthelmintics during the year before interview; more than 50% of schoolchildren (65.7%). However, 58.6% of the community had never taken anthelmintics (Table 7). The health behaviors of the two interviewee groups in relation to soil-transmitted helminthic infections are shown in Table 8. Although 77.6% of schoolchildren always defecated in a toilet, 19.7% of them did sometimes, and 1.9% never did. The results for preventive practices for soil-transmitted helminthiases showed that 66.9% always wore shoes, and that only 36.2% always washed their hands before meals. There were higher percentages for practicing sometimes, *ie* washing the hands before meals (62.6%) and eating using the hands without a spoon (78.3%). The percentage of the community who maintained the behavior of using a toilet was similar to the schoolchildren (74.1%) who always defecated in a toilet. Higher

Table 6
Number of houses with latrines and types of latrine of residences of 254 schoolchildren and 58 population in the community of Hauy Kayeng, Thong Pha Phum district, Kanchanaburi Province.

Categories	Number (%) of houses		Type of latrine, number (%)			
	With latrine	Without latrine	In house	Outside house	Pit	Other
Schoolchildren	239 (94.1)	15 (5.9)	62 (24.4)	150 (59.1)	25 (9.8)	17 (6.7)
Community	58 (100.0)	-	30 (51.7)	24 (41.4)	4 (6.9)	-

Table 7
Practices of 254 schoolchildren and 57 community members in relation to anthelmintic drug taking, during the year before interview.

Practice	Schoolchildren, No. (%)	Community, No. (%)
Had anthelmintic in last year	167 (65.7)	23 (39.7)
No anthelmintic in last year	87 (34.3)	34 (58.6)
Total	254	57

Table 8
Health behavior in relation to preventing helminthic infection of 254 schoolchildren and 58 community members.

	Always	Sometimes	Never
Schoolchildren			
Defecate in toilet[a]	197 (77.6)	50 (19.7)	5 (1.9)[b]
Wear shoes	170 (66.9)	82 (32.3)	2 (0.8)
Wash hands before meals	92 (36.2)	159 (62.6)	3 (1.2)
Eat with hand (without spoon)	48 (18.9)	199 (78.3)	7 (2.8)
Wash vegetable before consuming fresh	231 (90.9)	23 (9.1)	-
Community			
Defecate in toilet	43 (74.1)	15 (25.9)[b]	-
Wear shoes	49 (84.5)	8 (13.8)	1 (1.7)
Wash hands before meals	48 (82.8)	9 (15.5)	1 (1.7)
Eat with hand (without spoon)	15 (25.9)	35 (60.3)	8 (13.8)
Wash vegetable before consuming fresh	47 (81.0)	10 (17.2)	1 (1.7)[c]

[a]No answers = 2; [b]Defecate in the forest, digging a hole, at school; [c]Never consume fresh vegetables

percentages for community behavior over schoolchildren were wearing shoes (84.5%) and washing hands before meals (82.8%).

Rainwater was the main source of drinking water in the villages, with frequencies of 93.3% for schoolchildren and 77.6% for villagers (Table 9). Water from canal/stream/natural well was used by 13.0% and 20.7% of these groups, respectively. More than half of schoolchildren (51.2%) and villagers (64.0%) drank untreated rainwater. Boiling of water was practiced in 15% of both studied groups.

DISCUSSION

It was concluded that the community in the study area did provide favorable conditions for soil-transmitted helminth infection. The Depart-

Table 9
Practices in relation to drinking water among 254 schoolchildren and 58 community members.

	Schoolchildren		Community	
	Number	Percent	Number	Percent
Type of drinking water[a]				
Rain water	237	93.3	45	77.6
Canal/stream/natural well	33	13.0	12	20.7
Concrete well	32	12.6	1	1.7
Tap water	27	10.6	6	10.3
Others	3	1.2	1	1.7
Methods of treatment				
No treatment	130	51.2	36	64.0
Filter[b]	71	28.0	12	20.7
Boil	39	15.3	9	15.5[c]
Other	14	5.5	-	-

[a]More than one choice was accepted; [b]With thin cloth; [c]Sometimes

ment of Communicable Disease Control, Ministry of Public Health, found that the rate of hookworm infection in the central region was 9.3%, which took into account both children and adults. The result of our study was similar to those reported at the national level in schoolchildren only. For the regular treatment of helminthic infections of high-risk groups, particularly school-age children, as endorsed by the WHO, the best method of delivering the anthelmintic drug is through the school system. From our questionnaire results, over 60% of schoolchildren had anthelmintic drugs during the year before interview. In addition, the authorizing health center, Hauy Kayeng Health Center, had been giving annual mass treatment of schoolchildren in grades 1-3 for all responsible schools (Personal communication). The low helminth infection rates among schoolchildren must be due to the success of annual mass treatment.

Generally, the pattern of hookworm infection increases according to age and reaches its peak in adulthood. Our study showed that hookworm infection in the community was as high as four times greater than the children, and of cited national data. In 1987, Temcharoen *et al* conducted a study of intestinal parasites in workers, personnel and their families during construction of the Khao Laem Dam. They found that 19.5% harbored helminthic infections, and that among these, 12.2% were hookworm infections. Over a decade, from our result, hookworm had increased infection a great deal.

Transmission of soil-transmitted helminthes is linked to generally poor living conditions, poor public health supply, and poor sanitation. Individual health behavior is also an important factor in parasite transmission. More than 20% of the questionnaires from both groups indicated that the respondents sometimes and never defecated in a toilet. Hence, the helminth eggs from the feces of infected persons were able to contaminate the environment. Water and soil were the important risk factors for infection. Coelho *et al* (2001) reported the presence of *Strongyloides stercoralis*, *Ancylostoma*, *Ascaris* and *Hymenolepis* in water and raw vegetables consumed at nursery schools. A similar study of water used for drinking/cooking from different places in Hyderabad City, India, found the water to be contaminated with eggs of *Enterobius vermicularis*, *Ascaris*, *Trichuris*, adult *E. vermicularis*, and larvae of *S. stercoralis* (Jonnalagadda and Bhat, 1995). In soil samples, contamination by soil-transmitted helminth eggs of *Ascaris*, *Trichuris* and hookworm, was reported. The positive soil samples were collected from bushes, wells, shaded areas, house dust, playgrounds, and large trees (Maipanich *et al*,

1995). In our study, untreated water from canals or streams, as well as natural well water were sources of drinking water. Although no study was undertaken to determine parasite contamination in drinking water in the study area, helminth eggs and larvae probably contaminate the water or soil. This may be the reason for the relatively high prevalence of hookworm and *S. stercoralis* infection in the community.

Kato's thick smear method was widely used for the diagnosis of soil-transmitted helminthiases. By this technique, the overall prevalence of *Strongyloides stercoralis* infection in Thailand in 2001 was 0.6% (Jongsuksantikul, 2002). However, detection of infective filariform larvae by culture method is suitable for diagnosing strongyloidiasis. By polyethylene tube culture method, the infection rate in schoolchildren was 1.8% in Nakhon Si Thammarat Province (Anantaphruti *et al*, 2000). In our present study in the community, a higher infection rate was found, almost double that found in a previous investigation or as much as four times when compared with a report of Jongsuksantikul, in 2002.

To control soil-transmitted helminthiases, a combined program must be initiated and introduced to the target community; the program includes micronutrient supplementation, improvement of environmental sanitation, clean water supplies, and basic food safety. All these components should be packed and channeled through the health-promoting schools network. Regular mass deworming of school-age children and other high-risk groups should be proposed. School-based strategies for helminth control should be activated and expanded in parallel with other school-based health programs; this includes a helminth-health education campaign with media tools and personal hygiene practice. Preparation and production of appropriate health education materials are required to support the control program. It is necessary to implement a control program in our study area in the future.

ACKNOWLEDGEMENTS

This work was supported financially by the Government budget of Mahidol University. Thanks are extended to Vajiralongkorn Dam Electricity Generating Authority of Thailand for supporting accommodation during the fieldwork.

REFERENCES

Anantaphruti MT, Maipanich W, Muennoo C, Pubampen S, Sanguankiat S. Hookworm infections of schoolchildren in southern Thailand. *Southeast Asian J Trop Med Public Health* 2002; 33: 468-73.

Anantaphruti MT, Nuamtanong S, Muennoo C, Sanguankiat S, Pubampen S. *Strongyloides stercoralis* infection and chronological changes of other soil-transmitted helminthiases in an endemic area of southern Thailand. *Southeast Asian J Trop Med Public Health* 2000; 31: 378-82.

Coelho LM, Oliveira SM, Milman MH, Karasawa KA, Santos RD. Detection of transmissible forms of enteroparasites in water and vegetables consumed at school in Sorocaba, Sao Paulo state, Brazil. *Rev Soc Bras Med Trop* 2001; 34: 479-82 (In Portuguese).

Jongsuksantigul P. Soil-transmitted helminthiases control in Thailand. Lecture note presented at ACIPAC International Training Course on School-based Malaria and Soil-transmitted Helminthiases Control for Programme Managers at the Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand on September 6, 2002.

Jonnalagadda PR, Bhat RV. Parasitic contamination of stored water used for drinking/cooking in Hyderabad. *Southeast Asian J Trop Med Public Health* 1995; 26: 789-94.

Lemeshow S, Hosmer DW, Klar J, Lwanga SK. Sample size for sample surveys. Adequacy of sample size in health studies. Chichester: John Wiley and Son, 1990; 8: 41-4.

Maipanich W, Itiponpanya N, Rojekittikhun W, *et al*. Intestinal parasitoses among hilltribe people and soil contamination in Nan Province, Northern Thailand. *J Trop Med Parasitol* 2002; 25: 30-7.

Maipanich W, Waikagul J, Pahuchon W, Muennoo C, Visiessuk K. Contamination of soil-transmitted helminth eggs in soil samples from Nakhon Si Thammarat Province. *J Trop Med Parasitol* 1995; 18: 22-30.

Temcharoen P, Chularerk U, Viboolyavatana J. Intestinal parasites among the workers and their families at three electricity generating dams in Thailand. *Southeast Asian J Trop Med Public Health* 1987; 18: 89-93.