PARASITOLOGICAL MONITORING OF HELMINTH CONTROL PROGRAM IN NORTHERN THAILAND

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Abstract. Nan Province, located in northern Thailand, is hyperendemic for parasite infections; the helminthic infection rate in 1,010 schoolchildren was 60.0% in 2001. Mass anthelmintic chemotherapy has been conducted with schoolchildren, and selective treatment has been given to people in the community, from 2002. The modified cellophane thick smear method was used to examine the prevalence and intensity of helminth infections in schoolchildren and community people once a year during the period 2002-2004. The prevalence of helminth infections decreased slowly from 60.0 to 40.3% in schoolchildren and from 70.8 to 60.0% in the older age population. Three parasite species were common: hookworm, *Ascaris* and *Haplorchis*, an intestinal trematode. Hookworm presented throughout the whole district. *Ascaris* infection occurred at high rates in some villages, while in some villages none was found. The villages where *Ascaris* infection was nil had high rates of *Haplorchis* infection, and vice versa. Most hookworm and *Trichuris* infections were of light intensity. Heavy intensity infection was found in 12.8-18.1% of *Ascaris* cases examined. Parasite infection rates in Chaloem Phra Kiat District can be classified as low prevalence.

INTRODUCTION

Soil-transmitted helminth infections are widely distributed in tropical and sub-tropical areas, with more than 2,000 million people affected worldwide (Crompton, 1999). Intestinal helminth infection ranks first in terms of disease burden in school-aged children in developing countries. Soil-transmitted helminth infections have nutritional impact on children, not only by causing malabsorption and competition for micronutrients, but also by causing reduction of their fluency and memory (Kvalsvig *et al,* 1991). It is very important that deworming programs should be carried out in areas where parasite infection rates are high to restore children's health and their ability to study.

In January and February 2001, we examined 1,010 schoolchildren at eight schools in Bo Kluea and Chaloem Phra Kiat Districts, Nan Province, northern Thailand. The results revealed a helminthic infection rate of 60.0%, while protozoan infections were seen in 36.2%. Overall prevalence of parasitic infections was 68.1% (Waikagul *et al,* 2002). These baseline data indicate the necessity of control measures for intestinal parasite infections particularly in school-aged children who are an important high-risk group for soil-transmitted helminth infections.

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Control measures started in 2002 with annual campaigns to encourage community participation. An anthelmintic (albendazole 400 mg) was mass administered to all schoolchildren twice a year. Community people, whose stools were positive for parasite eggs, received selective treatment. Nan Province is located in a high mountainous area, and travel to some villages may be difficult or not possible during heavy rains. Parasitological monitoring is important in this control program. This paper reports the results of stool examinations in Chaloem Phra Kiat District during the period 2002-2004.

MATERIALS AND METHODS

Stool examination and analysis

The Faculty of Tropical Medicine, Mahidol University has been assigned to monitor the control project in Chaloem Phra Kiat District, Nan Province (Fig 1). A mobile team, comprised of a medical doctor, four microscopists and two support technicians went to Chaloem Phra Kiat District, once a year, during the years 2002-2004. Stool examination was carried out once a year prior to treatment for both diagnosis and monitoring purposes.

The District Health Officer collected stool samples of schoolchildren and adults in Chaloem Phra Kiat District on a voluntary basis. The mobile team examined stool samples by modified cellophane thick smear method (Katz *et al,* 1972). The intensity of soil-transmitted helminthiases was determined using the WHO standard classification (Montresor *et al,* 2002). This study is part of the helminth control program in Nan Province, which comprises mass treatment and health education for primary schoolchildren and selective treatment after stool examination for community people on voluntary basis. Every villager, whose fecal sample was egg-positive, received selective anthelmintic treatment:

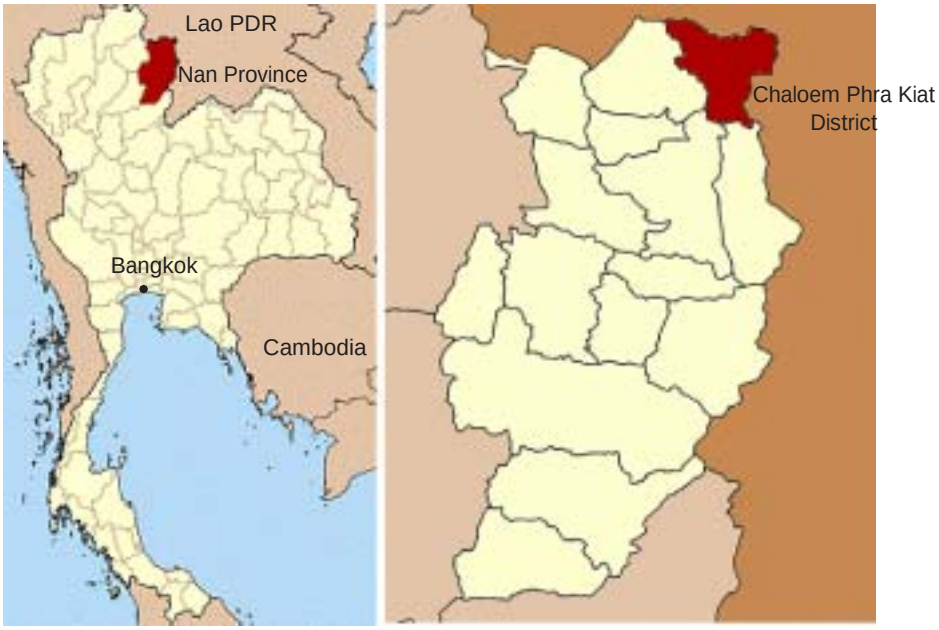


Fig 1–Map of Thailand, shaded area is Nan Province (a) and Chaloem Phra Kiat District of Nan Province (b).

Table 1
Prevalence of intestinal parasitic infections in Chaloem Phra Kiat District, examined by Modified cellophane thick smear methods during 2002-2004.

		Schoolchildren			Villagers		
	Year	2002	2003	2004	2002	2003	2004
	No. examined	952	1,389	539	836	1,848	2,001
	% Positive	52.7	36.9	40.3	70.8	57.6	60.0
Parasites (%)	Ht	14.9	8.2	4.1	48.4	30.1	28.5
	Hw	28.2	9.6	18.7	32.7	30.7	27.3
	Al	11.4	13.6	17.4	4.1	12.4	13.7
	Tt	16.6	12.6	8.9	3.6	7.0	6.8
	Ss	0	0.07	0.2	0.2	0.05	1.0
	Ev	1.6	0.4	1.5	1.4	0.8	0.8
	Tsp	0.2	0	0.2	2.6	1.9	2.3
	Others	0.1[a]	0	0	0.1[a]	0.1[a]	0.05[b]

Other parasites detected by direct smear method are [a]*Echinostoma* sp, [b]*Paragonimus* sp
Ht = *Haplorchis taichui*, Hw = Hookworm, Al = *Ascaris lumbricoides,* Tt = *Trichuris trichiura*, Ss = *Strongyloides stercoralis*, Ev = *Enterobius vermicularis*, Tsp = *Taenia* sp

albendazole 400 mg tablets for roundworm infections and praziquantel 40 mg/kg tablets for flatworm infections. All schoolchildren received albendazole 400 mg tablets single dose, twice a year. Children, whose stool samples were flatworm-egg-positive, received also praziquantel 40 mg/kg tablets.

Identification of trematode infection

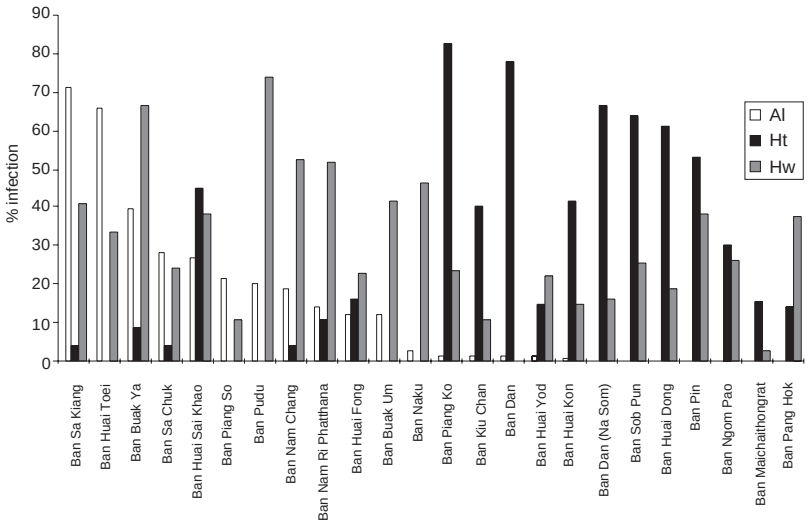
One of the most common eggs found in the district was a small-sized trematode egg. Since differentiation of the eggs of the tiny-sized intestinal flukes and the opisthorchid liver flukes is not possible by the thick smear method, adult worms were identified. While staying in the area, the mobile team collected worms expelled after treatment. At random, subjects whose fecal samples were positive with tiny-sized trematode eggs were selected and given praziquantel 40 mg/kg. Two hours after treatment, a purgative (30 ml of saturated magnesium sulfate solution) was given orally to all subjects and whole fecal samples of all bowel movements (approximately four times) were collected. Samples were repeatedly washed in normal saline solution by sedimentation method. Clean sediments were fixed in 5% formalin and transported to the Faculty of Tropical Medicine. The sediments were examined under a dissecting microscope; worms were collected, stained and identified.

RESULTS

In 2002, a total of 1,094 samples (61.2%) out of 1,788 specimens were positive for at least one out of eight species of helminths. Among children and adults, 502 (52.7%) and 592 (70.8%), respectively, were egg-positive (Table 1). In 2003, 513 children (36.9%) and 1,064 adults (57.6%) were infected with helminths. In 2004, 217 children (40.3%) and 1,201 adults (60.0%) were infected with at least one of eight species of helminths. The parasite eggs found were those of hookworm, *Ascaris*, *Trichuris*, *Enterobius*, *Strongyloides*, *Taenia*, *Paragonimus* and small-sized eggs of a fluke (Table 1).

Table 2
Intensity of soil-transmitted helminthiasis in Chaloem Phra Kiat District, Nan Province examined in 2003 and 2004 by the modified cellophane thick smear method.

		Children			Adult		
		Light	Moderate	Heavy	Light	Moderate	Heavy
Hookworm	2003	92.1	7.3	0.7	86.2	9.8	4.0
	2004	83.0	9.4	7.5	84.8	11.3	3.8
Ascaris	2003	50.8	27.8	21.4	67.9	25.4	6.7
	2004	41.5	40.4	18.1	53.3	33.9	12.8
Trichuris	2003	92.0	8.0	0	92.1	7.0	0.9
	2004	89.6	10.4	0	95.6	3.7	0.8



Al=*Ascaris lumbricoides*, Ht=*Haplorchis taichui*, Hw=hookworm

Fig 2–Infection rate patterns of *Ascaris, Haplorchis* and Hookworm among 24 villages in Chaloem Pha Kiat District, 2004.

Subjects positive for small-sized trematode eggs were selected randomly; they received praziquantel 40 mg/kg tablets single dose, and stool samples were collected and expelled worms collected after treatment. Whole stool samples of 19 subjects were collected in 2002, and small-sized flukes (Fig 3a) were recovered in stool sediments. The intestinal fluke *Haplorchis taichui* (family Heterophyidae) (Fig 3b) was the only species identified. In 2003, samples from 25 subjects were collected after treatment, and only *H. taichui* was found. Similarly, *H. taichui* was the only species found in the samples collected after treatment of 30 subjects in 2004. *H. taichui* was the most common trematode existed in this district during the period 2002-2004.

In terms of parasitic infections in children compared to adults, the profiles of all species showed a typical age distribution pattern. Roundworm, whipworm and pinworm infection rates were higher in the primary school group than in adults. Hookworm infection rates were higher in adults than in children. Intestinal fluke and tapeworm, foodborne parasites, were more common in the older aged group (Table 1).

Hookworm, round worm and intestinal fluke were the most common parasite in Chaloem Phra Kiat District. To understand the pattern of parasitic infections among villages

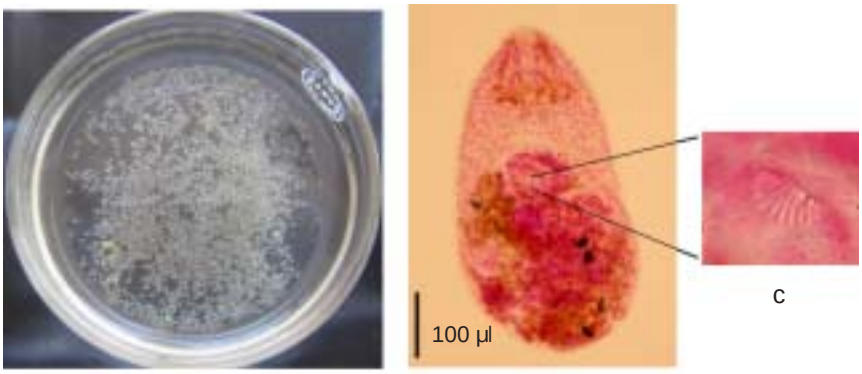


Fig 3–*Haplorchis taichui*, small-sized trematode expelled after treatment with praziquantel (a), stained specimen (b), spines on ventral sucker (c).

for future management of the control program, distribution of each parasite species was analyzed at the village level. *Ascaris* infection appeared in 17 out of 24 villages, among these 6 villages had very low prevalence (Fig 2). *Haplorchis* infection appeared in 19 villages, mostly appeared in villages with low or no *Ascaris* infection, except in 7 villages that *Haplorchis* mixed with *Ascaris* infection. Hookworm appeared in all villages (Fig 2).

Soil-transmitted helminth infection among children and adults in Chaloem Phra Kiat District was classified into light, moderate and heavy infection according to number of eggs per gram of feces counted in 2003 and 2004. Similar percentages of infected population found in both age groups under classified intensity. Most of the infection fell into light intensity particularly in hookworm and whipworm. The percentage of light infection was lower in the year 2004 than in 2003 for all species of parasites, except whipworm infection. For roundworm, only half of the infected population was classified in the light infection, and over 10% was in the heavy class. The percentage of heavy intensity was higher in the children than in adult (Table 2). The number of eggs per gram of feces for *Haplorchis taichui* varied from 37 to 13,172. Classification of intensity of heterophyid infections is not available.

DISCUSSION

The results of this study involved a comparison of three cross-sectional studies for three consecutive years. At the beginning of the control program implementation, soil-transmitted helminth infections in Chaloem Phra Kiat District could be classified as an area with moderate prevalence (cumulative prevalence of 50-70%) according to the WHO guide for managers of helminth control programs (Montresor *et al,* 2002); however, moderate to heavy intensities of *Ascaris* infections were seen in more than 10%. In our project, children were treated twice per year. Although, the cumulative prevalence among schoolchildren decreased into the low-prevalence category (<50%), the rate of moderate to heavy *Ascaris* infections was still greater than 10%. It was noted that number of participated schoolchildren in the year 2004 was 539, less than half of the number participated in 2003 (1,389), and many of these were newly enrolled students who had not taken anthelminthic drug given in the previous year. Treatment targeting all schoolchildren should be continued twice per year until moderate and heavy intensity infections were no longer existed. Reinfection occurs rapidly sometimes, if factors that enable transmission exist. To achieve the control objective, deworming must be integrated into a range of health promotion measures (Kobayashi *et al,* 2007). Active preventive education should be carried out in every

school in the district, the methods of parasites transmission and preventive measures such as latrine usage, washing hands with soap before and after meals and shoes wearing should be repeatedly given by integrating to all the teaching subjects, and full participation to the control program of every schoolchildren must be emphasized.

Thrice annual deworming with pyrantel pamoate was conducted over a period of five years among a population of primary schoolchildren in Malaysia (Kan, 1986). The STH prevalence was reduced by about 15%. A school helminth control program in the Seychelles was conducted for three years. Based on deworming three times a year, the cumulative prevalence of STH in schoolchildren was reduced from 60.5 to 33.3% (26.7%) (Montresor *et al,* 2002). The prevalence reduction results of these two control programs were similar to our intervention. However, the proportion of heavily infected children in our study was reduced slightly for *Ascaris* infection, but increased for hookworm infection. In our observation villages with high *Ascaris* infection were located on high plain where water for usage is limited. The villagers had poor personal hygiene and low latrine usage which are the main factors contributing to *Ascaris* infection particularly in children. Low latrine usage results in high contamination of fecal material to the soil and eggs of *Ascaris* may find the way to mouths of children who play on the ground by contaminated hands.

The parasites present in this area can be classified into two groups according to their transmission pattern, *ie*, soil-transmitted helminths (STH) and food-borne helminths (FBH). A higher FBH infection rate was clearly demonstrated in adult subjects; the consumption of raw meat must be a normal practice among adults in this area. Of the FBH, infection with *H. taichui*, an intestinal fluke transmitted by freshwater fish, was most common. Raw freshwater fish dishes are more likely to be eaten in this area than raw pork or beef because freshwater fish in this area are highly infected with intestinal trematode metacercariae. The *Taenia* tapeworm infection rate was much lower.

The differences in parasite species occurrence may depend on the geographic localities of the villages. The villages with no *Haplorchis* infection are located on high land with no running stream. Therefore, fish consumption is less common. Personal hygiene and sanitation may be poor due to the lack of water supply. *Ascaris* infection in this area was high. On the other hand, in the villages located near the river, there is a more common practice of eating raw fish, and *Haplorchis* infection is more common. We examined a few cyprinoids fish caught from the river at Ban Dan village, and found that the fish was heavily infected with *Haplorchis taichui* metacercariae. However, some villages such as Huai Sai Khao, Huai Fong and Nam Ri Phathana are in the highlands, but there is access to fish, as fish from Ban Dan are occasionally sold there by the village's mobile vendor. Therefore, haplorchiasis and ascariasis are both presented in these three villages.

The effects of benzimidazole carbamate on trematodes have been studied in the small liver fluke, *Opisthorchis viverrini.* Multiple doses of mebendazole, 30 mg/kg for 3-4 weeks, achieved a 96.3% cure rate (Charoonvesma *et al,* 1981) and albendazole, 400 mg bid for 3-7 days, showed 12 and 33% cure rates, respectively (Pungpak *et al,* 1984). Two doses of albendazole (200 mg/kg body weight) obtained 100% cure in mice infected with *Haplorchis taichui* (Waikagul *et al,* 2003). However, a single dose of albendazole 400 mg obtained a cure rate of 42.5% and mebendazole 500 mg yielded 32.4% cure for haplorchiasis in humans (Waikagul *et al,* 2005). Adult heterophyid flukes have a short life span of about 5 days in white rats for *Haplorchis* (Waikagul, unpublished data), though the life span in

humans is still not known. If stool examination prior to treatment can not be done, mass treatment with a single dose of albendazole is recommended, together with stop consuming raw meat campaign.

Mass treatment should be continued in children until moderate and heavy infections were no longer existed in children. A campaign to stop consuming raw fish must be conducted in all villagers who live along the river and the highland villages where fluke infection was present. Pitted latrines (non-water-usage type) construction and usage must be promoted in the highland villages. Although it is unsanitary, but pitted latrine can stop eggs of parasites from contaminated open soil around the village. All stakeholders include local government, health officers, teachers, parents and community people concerned, to promote health and behavior change among children, must initiate preventive education on improving personal hygiene and food consumption behavior in schools. The control program must be closely monitored, as full coverage of children participation is a key to success.

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