Original Article

Soil-transmitted Helminthiases and Risk Factors among Thai Hill-Tribe Preschool-Age Children in Remote Area of Thailand

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Background: Soil-transmitted helminthiases (STH), which remain one of the most prevalent health problems in the world, are also present in a remote area of Thailand.

Objective: The present study aimed to determine the prevalence and risk factors of STH among Thai hill-tribe preschool-age children (PSAC) in a remote area of Thailand.

Materials and Methods: A cross-sectional study was conducted between November and December, 2013 in the Omkoi District of Chiang Mai province. The Thai hill-tribe PSAC were selected by a simple random sampling technique. A stool survey of children was conducted in nine child development centers using the formalin-ether concentration technique, and caregivers were interviewed regarding risk factors. A multiple logistic regression analysis was used to identify risk factors of STH among the Thai hill-tribe PSAC.

Results: A total of 282 children provided complete data. The study showed that 18.4% Thai hill-tribe PSAC were infected with one or more species of STH. *Ascaris lumbricoides* was the most prevalent STH (15.9%) followed by *Trichuris trichiura* (1.8%) and hookworm (1.1%), respectively. The significant protective factor of STH among Thai hill-tribe PSAC was ownership of a latrine (AOR = 0.3, $p = 0.04$).

Conclusion: The present study showed that STH is a public health problem among Thai hill-tribe PSAC in the study area. Deworming of preschool children is warranted. Preventive measures should address important factor, and a health educational programme regarding the construction of latrines is an essential elements to prevent re-infection.

Keywords: Soil-transmitted helminthiases, *Ascaris lumbricoides,* Preschool-age children, Hill-tribe group, Risk factors

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Soil-transmitted helminthiases (STH), such as Ascariasis, Trichuriasis and hookworm disease, are highly prevalent in many parts of the world, especially where access to water, sanitation, and hygiene is poor[1]. Globally, more than 1.7 billion people are estimated to be infected with STH, causing an estimated 4.98 million years lived with disability (YLDs). The vast majority of STH and YLDs occur in Asia[2], and as a result, about 300 million people suffer from severe morbidity attributed to STH, resulting in 10,000 to 135,000 deaths annually[3]. The impact of STH on health may result in malnutrition, iron deficiency anemia, vitamin A deficiency, and impairment of physical and mental development, which ultimately retards the educational advancement of children and the economic development of nations[4]. There were an estimated 2,824 deaths attributable to *A. lumbricoides* in 2010. Deaths from STH are all attributable to heavy *A. lumbricoides* infection and are primarily due to intestinal obstruction and biliary or pancreatic disease in children under 10 years of age[2].

Compared with any other age group, preschool-age children (PSAC) and school-aged children (SAC) are the most vulnerable groups. Worldwide, 878 million school-aged children, and an estimated 386 million preschool-age children are at risk[5]. PSAC, defined as aged less than five years, make up between 10 to 20% of the two billion people worldwide who are infected with STHs; 21 million preschool-age children are infected with hookworm; 122 million are infected with *A. lumbricoides*, and 86 million are infected with *T. trichiura*[6].

A national survey in Thailand in 2009 found an overall prevalence of helminthiases among Thai people of 18.1%, and the north and northeastern regions remain high

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risk areas, particularly among the rural population[7]. In remote areas, the prevalence is higher[8,9]. Previous studies exploring the prevalence of STH infection in school-aged children are extensive. Most of the studies conducted in Thailand focused on school-age children, and several have investigated the prevalence of helminth infection in northern Thailand's hill-tribe children. For example, Nithikathkul et al[10] detected pinworm infections in 7.8% of 1 to 12 years old Karen hill-tribe children in Chiang Mai Province, Waikagul et al[11] detected intestinal parasitic infections in 60% of children in Nan Province, Piangjai et al[12] detected intestinal parasitic infections in 48.9% of children in Chiang Mai Province, and Saksirisampant et al[13] showed that the prevalence of intestinal parasitic infections in students aged 3 to 19 years of the Karen hill-tribe in Chiang Mai Province was 42.1%. To date, however, no studies have focused specifically on helminth infections in preschool-aged (2 to 5 years old) hill-tribe children. Perhaps, this maybe the first study to determine the prevalence of STH in Thai hill-tribe preschool-age children in Chiang Mai Province.

Thailand Ministry of Public Health launched the medical treatment in positive cases. There is intervention for primary school aged children. There is paucity of information about strategies prevention in PSAC. The implication is very serious for this age group because this infection affects the growth and brain development[1]. The preventive chemotherapy in this area is insufficient because of the financial burden barrier. Previous study[14] revealed that helminthic infections in hill-tribe groups were higher than those experienced by people in plain areas. The traditional lifestyle, behaviors, and sanitation of Thai hill-tribe groups may increase their risk of infection by helminthes. The purpose of the present study is to determine the prevalence and risk factors of STH among Thai hill-tribe PSAC in the Omkoi District of Chiang-Mai Province in order to develop appropriate preventative measures to reduce the risk of infection.

Materials and Methods

Study population was 919 Thai hill-tribe PSAC. The child development centers (CDCs) were randomly selected from a total of 33 centers. The Thai hill-tribe PSAC and their caregivers in nine CDCs were recruited for this study using simple random sampling. A total of 318 Thai hill-tribe PSAC took part in this study using simple random sampling.

A total of 282 Thai hill-tribe PSAC provide complete data (socio-demographic information and a stool sample) between November and December, 2013. For each child, data was collected on age, sex, height (by standard measuring tape), and weight (UNICEF scales). All of the caregivers were interviewed by the author and research assistants regarding the presence of potential risk factors using questionnaires. For hill-tribe people who cannot speak Thai, the data were collected by health workers and teachers who can speak both Thai and the local or tribal languages. Then the author and research assistants explained how to collect children's stools in Thai, the local language and tribal languages. Labeled stool containers were provided to each child, and the filled containers were collected the following morning and transported in a cooled ice-box to the parasitology laboratory of the Department of Biology, Faculty of Science, Chiang Mai University. Stool specimen was performed within 24 hours after collection. The stool samples were examined for helminthic eggs and larva using the formalin-ether concentration technique. The formalin-ether concentration technique is more efficiency than the Kato Katz method[7].

SPSS for Windows version 19 was used for data analysis. The prevalence of STH was calculated as the ratio of children found positive for any STH species to the total number of children who provided complete data. A multiple logistic regression analysis was used to identify risk factors of STH among the Thai hill-tribe PSAC. A *p*-value less than 0.05 were considered statistically significant.

The study protocol was reviewed and approved by the Mahasarakham University Ethical Review Board. Prior to the study, permission was sought and obtained from the Authority of the Provincial Public Health Office, the sheriff of Omkoi District, the director of Omkoi Hospital, the head of the Omkoi Public Health Office, the Chief Executive of the sub-district municipality, and the Chief Executive of the sub-district administrative organizations. The head teacher and teachers of each child development center were contacted and informed of the purpose of the study. The author had a parents and caregivers' meeting at each child development center to explain the purpose and benefits of the study, and a consent letter was written by the parents after the meetings. Moreover, parents provided informed written consent in Thai for their children. Data collected from each child and the results of laboratory tests were kept confidential. Children with positive stools for any STH infections were treated with anthelminthic drugs based on the national guidelines.

Results

The present study was conducted in Omkoi District in the Chiang Mai Province of Northern Thailand between November and December, 2013. The Omkoi District of Chiang Mai province is located 875 kms north of the capital city of Bangkok, at approximately 17° 48'N latitude and 98° 21'E longitude, and is one of the remotest areas in Thailand. Most of the area is mountainous, located at an average altitude of 1,000 meters above sea level. The mean maximum and minimum annual temperature of the town is 0°C and 25°C, respectively, and the average temperature is 22.4°C. The average annual rainfall is 929.8 mm, and two rivers, Mae Tom and Mae Tuen, flow through the region.

Socio-demographic characteristics

A total of 282 (with an 88.7% compliance rate) Thai hill-tribe PSAC were involved in the present study. The age of the children ranged from 2 to 5 years. The age-group

distribution showed that the majority (51.1%) were in the age group of 2 to 3 years. Half (50.3%) of the children were males and 83.3% had a standard body mass index (BMI). For their caregivers, the majority (84.8%) were females and more than half (51.1%) had an age of ≤30 years. The majority of their caregivers (61.3%) does not have any formal education and had only primary education. More than half (54.3%) of the caregivers were farmers (Table 1).

For households' data, 73.8% of the households had four or more members. The majority of households (76.6%) had income ≤10,000 baht/month. The majority of the households use water from the village tap (51.1%) and drink water from the mountain water supply without boiling or treating (40.8%). The majority of the households (86.5%) had latrines, had both pets (73.8%) and a cattle pen (56.4%) (Table 2).

Prevalence of STH infections

Overall, at least one species of intestinal helminthes was detected in 59 (20.9%) of the children, of which 18.4% (52/282) had one or more species of STH. The most frequently encountered STH was *A. lumbricoides* (15.9%) followed by *T. trichiura* (1.8%) and hookworms (1.1%). However in this study, in addition to the three mentioned STH infections, other parasite eggs were also detected, such as 3 cases of *Taenia spp.* (1.1%), 3 cases of *Strongyloides stercoralis* (1.1%), and 3 cases of minute intestinal fluke (1.1%) (Table 3).

Risk factors for STH infections

The authors also investigated aspects of both individual and household factors that might increase the risk of STH infections. Individual factors of Thai hill-tribe PSAC investigated were sex, age, and body mass index (BMI). Individual factors of their caregivers investigated were sex, age, education, and occupation. Household factors investigated were number of household members, household income, source of using and drinking water, ownership of a latrine, and whether there were pets and cattle pens.

A multiple logistic regression analysis indicated that the only significant protective factor of STH among Thai hill-tribe PSAC was ownership of a latrine (adjusted OR = 0.3, 95% CI: 0.1 to 1.0, $p = 0.04$) (Table 4).

Table 1. The socio-demographic characteristics of the Thai hill-tribe preschool-age children and their caregivers

Variables	n (%)	Infection status	
		No. positive (%)	No. negative (%)
Children			
Sex			
Male	142 (50.3)	32 (22.5)	110 (77.5)
Female	140 (49.7)	20 (14.3)	120 (85.7)
Age (years)			
2 to 3	144 (51.1)	36 (25)	108 (75)
4 to 5	138 (48.9)	16 (11.6)	122 (88.4)
BMI			
Lower standard	23 (8.2)	6 (26.1)	17 (73.9)
Standard	235 (83.3)	42 (17.9)	193 (82.1)
Overweight	24 (8.5)	4 (16.7)	20 (83.3)
Caregivers			
Sex			
Male	43 (15.2)	6 (14)	37 (86)
Female	239 (84.8)	46 (19.2)	193 (80.8)
Age (years)			
≤30	144 (51.1)	36 (25)	108 (75)
>30	138 (48.9)	16 (11.6)	122 (88.4)
Tribe			
Pwo	114 (40.4)	29 (25.4)	85 (74.6)
Sgaw	86 (30.5)	16 (18.6)	70 (81.4)
Lahu and Northerners	82 (29.1)	7 (8.5)	75 (91.5)
Education			
No formal education and Primary school	173 (61.3)	38 (22)	135 (78)
Secondary school and Higher	109 (38.7)	14 (12.8)	95 (87.2)
Occupation			
Farmer	153 (54.3)	27 (17.6)	126 (82.4)
Employee and others[a]	129 (45.7)	25 (19.4)	104 (80.6)

[a] Businessman, Unemployed, Government officer

Table 2. The households of the Thai hill-tribe preschool-age children

Variables	n (%)	Infection status	
		No. positive (%)	No. negative (%)
No. of household members			
1 to 3	74 (26.2)	16 (21.6)	58 (78.4)
≥4	208 (73.8)	36 (17.3)	172 (82.7)
Household Income (Baht/month)			
≤10,000	216 (76.6)	39 (18.1)	177 (81.9)
>10,000	66 (23.4)	13 (19. 7)	53 (80.3)
Source of Using Water			
Mountain water supply			
Yes	136 (48.2)	30 (22.1)	106 (77.9)
No	146 (51.8)	22 (15.1)	124 (84.9)
Village tap water			
Yes	144 (51.1)	19 (13.2)	125 (86.8)
No	138 (48.9)	33 (23.9)	105 (76.1)
Source of drinking water			
Mountain water supply			
Yes	115 (40.8)	29 (25.2)	86 (74.8)
No	167 (59.2)	23 (13.8)	144 (86.2)
Village tap water			
Yes	100 (35.5)	14 (14)	86 (86)
No	182 (64.5)	38 (20.9)	144 (79.1)
Boiled, bottle or filtration water			
Yes	81 (28.7)	8 (9.9)	73 (90.1)
No	201 (71.3)	44 (21.9)	157(78.1)
Ownership of a latrine			
Yes	244 (86.5)	40 (16.4)	204 (83.6)
No	38 (13.5)	12 (31.6)	26 (68.4)
Pets			
Yes	208 (73.8)	34 (16.3)	174 (83.7)
No	74 (26.2)	18 (24.3)	56 (75.7)
Ownership of a cattle pen			
Yes	159 (56.4)	24 (15.1)	135 (84.9)
No	123 (43.6)	28 (22.8)	95 (77.2)

Table 3. The prevalence of STH infections in Thai hill-tribe preschool-age children in Northern Thailand (n = 282)

Parasites	Number positive	%
Ascaris lumbricoides	45	15.9
Trichuris trichiura	5	1.8
Hookworm	3	1.1
Taenia spp.	3	1.1
Strongyloides stercoralis	3	1.1
Minute intestinal fluke	3	1.1
Total helminth	59	20.9
STH infection	52	18.4
Single infection	56	19.9
Multiple infection	3	1.1

Table 4. Risk factors of STH infections among Thai hill-tribe preschool-age children

Factors	Adjusted OR (95% CI)	*p*-value
Tribe	3.5 (0.8 to 14.9)	0.09
Occupation of caregivers	2.9 (0.5 to 16.6)	0.23
Using village tap water	1.0 (0.4 to 2.1)	0.93
Drinking mountain water supply	1.7 (0.8 to 3.8)	0.16
Drinking boiled water or bottle water or filtration water	1.0 (0.3 to 2.5)	0.90
Ownership of a latrine	0.3 (0.1 to 1.0)	0.04*
Cattle pen	1.5 (0.7 to 3.2)	0.28

* significant association
AOR = adjusted odd ratio, 95% CI = 95% confidence interval

Discussion

The present study attempted to determine the prevalence of, and risk factors of STH among PSAC in a remote area of Thailand. This cross-sectional study included 282 preschool children aged 2 to 5 years living in remote districts of Chiang Mai Province in northern Thailand.

The prevalence of STH infections in Thai hill-tribe

preschool-age children was 18.4%. However in addition to the three mentioned STH infections, other parasite eggs were also detected, such as 3 cases of *Taenia spp.* (1.1%), 3 cases of *Strongyloides stercoralis* (1.1%) and 3 cases of minute intestinal fluke (1.1%). According to WHO, STH endemic areas classifications, there are three categories of risk in line with the application of mass drug administration: i) high-risk areas (where prevalence is ≥50%), ii) moderate-risk areas (where prevalence is between ≥20% and <50%), and iii) low-risk areas (where prevalence is <20%)[15]. Accordingly, the study area would be classified as a low-risk area, and therefore large-scale preventive chemotherapy interventions are not recommended. Affected individuals should be treated on a case-by-case basis[15]. However, the present study will be the first report of prevalence of minority group in remote area. Therefore our outcome supported the health promotion concerned.

There is a paucity of information on STH infection and risk factors of STHs in preschool-age children in general, and in Southeast Asia and Thailand in particular. To our knowledge, this maybe the first study in Thailand focusing on STH infection in this age category. Previous studies have targeted intestinal parasitic infections among school-aged children, and in general they have diagnosed higher infection prevalence than in the present study[11,12]. By comparison with previous surveys conducted over the past 15 years[16], the prevalence rates have decreased. The prevalence of STH in the present study is less than in neighboring and other countries. For example, STH prevalence is 27.4% in Lao PDR[17]; 21.2% in Southwest China[18], and 23.3% in South-Central Ethiopia[19].

Moreover, the present study was located in a mountainous area where many caregivers or parents are farmers in the plantation sectors who work mainly as manual laborers engaged in planting and harvesting. Their work involves handling soil, and they could have easily come into contact with the infective stage of the parasites, making their chances of STH infections extremely high. At the worksite, these workers have no access to water or sanitary latrines so they have no alternative but to defecate behind bushes or trees in the forest. The women returning from their work in the late afternoon start preparing their meals without changing their clothes or washing their hands. Eating food and feeding their children without washing their hands properly first are a major source of acquiring STH infections. The situation in the agriculture communities is further aggravated when caregivers or parents go to work early in the morning, leaving the children unattended. With no parental supervision, these PSAC find it easy to defecate around the houses, and this can be a source of infection to others.

In the present study, *A. lumbricoides* was the most prevalent infection of STH (15.9%), which is in alignment with previous studies in other parts of the world[17-21]. This may be due to the poor socio-economic status, poor hygienic habits and lack of sanitation in remote area. *T. trichiura* and hookworm infection were identified at lower prevalence rates. However, most of preschool-age children had single infection (19.9%). This may be due to preschool-age children were very young and their caregivers tried to took care them with close supervision.

Multiple logistic regression analysis showed that ownership of a latrine was the only significant protective factor of STH among Thai hill-tribe PSAC. Other studies have identified the ownership of a latrine as a determinant for STH in PSAC[22]. Places of defecation such as pit latrines, bushes and water closets have been identified as potential risk factors contributing to the high infection rates of helminthic parasites among Nigerian preschool-age children[23]. Moreover, a study in Nigeria revealed that the risk of Ascaris infection is 1.7 times higher among PSAC that used the bushes indiscriminately than those who had access to a water closet, while those who used latrines are 0.4 times less likely to be infected[21].

In addition, availability of sanitation facilities was associated with significant protection against infection with soil-transmitted helminthes. A strong association between toilet usage and decreased STH infections has been demonstrated in developing countries. A systematic review of 36 studies revealed a significant overall protective effect of 51% for STH infections in general and 60% for hookworm infections[24].

In conclusion, the present study showed that soil-transmitted helminthiases is endemic and a public health concern among Thai hill-tribe PSAC in remote areas of Thailand, and that individuals should be treated on a case-by-case basis to control morbidities associated with STH.

The ownership of a latrine was the protective factor significantly associated with STH infections among Thai hill-tribe PSAC. Therefore, preventive measures should address this important factor. Further advance research development should be developed a health educational programme regarding the construction of latrines and proper usage to prevent re-infection.

What is already known on this topic?

Most of the studies exploring the prevalence of STH infection conducted in Thailand focused on school-age children, and the helminthic infections in hill-tribe groups were higher than those experienced by people in plain areas. To date, however, no studies have focused specifically on helminth infections in preschool-aged (2 to 5 years old) hill-tribe children in remote areas. Also what are the risk factors of STH among Thai hill-tribe PSAC in remote areas in order to develop appropriate preventative measures to reduce the risk of infection.

What this study adds?

The present study showed that soil-transmitted helminthiases is endemic and a public health concern among Thai hill-tribe PSAC in remote areas of Thailand. The ownership of a latrine was the protective factor significantly associated with STH infections among Thai hill-tribe PSAC. Therefore, preventive measures should address this important factor. Further advance research development should be

developed a health educational programme regarding the construction of latrines and proper usage to prevent re-infection.

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Potential conflicts of interest

The authors declare no conflict of interest.

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