

# EPIDEMIOLOGY AND THE EFFECT OF TREATMENT OF SOIL-TRANSMITTED HELMINTHIASIS IN PREGNANT WOMEN IN SOUTHERN THAILAND

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**Abstract.** This study aimed to assess the current situation of STH in pregnant women, explore factors associated with STH and evaluate the effects of its treatment. A cohort study was conducted in four southernmost provinces. All pregnant women who presented at their first prenatal care visit at participating hospitals were interviewed by trained health care providers and their stool specimens were examined for *Ascaris lumbricoides*, *Trichuris trichiura* and hookworm eggs. Women with STH were treated with 400 mg of albendazole after 14 weeks of gestation and treatment outcomes were evaluated three weeks after treatment. Of 1,063 pregnant women, STH were detected in 190 patients (17.9%) without seasonal variation for a combined infection of 21.6%. *Ascaris*, hookworm and *Trichuris* were detected in 10.3, 5.7 and 6.3%, respectively. The cure rate with a single dose was 92% but was 100% when repeated treatment was given as a three-day course. The risk of infection was higher in Muslim women, those with a family income  $\leq$  USD300/month, those bathing outside the house and those with no knowledge of STH. These results showed that southern Thailand is still an endemic area for STH and there appears to be no seasonal variation in incidence. Although the cure rate for treatment with albendazole was good, the low cure rate and egg reduction rate for trichuriasis needs to be considered.

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## INTRODUCTION

Soil-transmitted helminthiasis (STH) is an important public health problem, especially in developing countries, both in Africa and Asia (de Silva *et al*, 2003). Infection in pregnant women is related to loss of appetite, poor nutrient absorption, gastrointestinal impairment, iron deficiency and iron deficiency anemia in mothers resulting in low birth weights and preterm births (Crompton and Nesheim, 2002). Poor socio-economic status and poor sanitation are known to increase the risk of endemic STH (Chongsuvivatwong *et al*, 1994, 1996).

A single dose of oral anthelmintic treatment after the first trimester is recommended for infected pregnant women, and/or mass treatment policy in areas where hookworm is endemic (prevalence >20-30%) and where anemia is prevalent (WHO, 1996a). Mebendazole and albendazole are the most common anthelmintic drugs for treatment during pregnancy (Jongsuksuntigul *et al*, 1993). Treatment of STH during pregnancy is beneficial to maintain hemoglobin and appropriate fetal birth weight (Torlesse and Hodges, 2000; Christian *et al*, 2004); however, anthelmintic resistance has recently been encountered in Africa (Albonico *et al*, 2005), and is now a concern (Adugna *et al*, 2007; Hagel *et al*, 2008).

Southern Thailand is an endemic STH region in Thailand (Brooker *et al*, 2006). A recent report published in 2006 (Piammongkol *et al*, 2006) regarding the prevalence of STH among pregnant women in southern Thailand showed a high prevalence of STH (78%), with 47% having hookworm infection, 48% with ascariasis and 25% with trichuriasis. These data are now out-of-date due to considerable changes in living conditions. According to the Thailand Censuses of 1990 and 2000, the percentage of the population age 6-24 years old not attending school decreased,

and households with modern sanitation and televisions or those cooking with gas or electricity increased (National Statistical Office, 2008). As a result, the epidemiological characteristics of STH in the area may have changed; therefore, the current situation of STH in pregnant women, including residual associated factors and treatment outcomes, remains unclear.

Reliable information is needed in order to effectively monitor the situation and to provide guidance for making decisions regarding treatment of infected cases and mass treatment. This study aimed to assess STH in pregnant women in southern Thailand, explore factors associated with STH and evaluate the effects of its treatment, both in cure rates and egg reduction rates.

## MATERIALS AND METHODS

### Study design and setting

This prospective study was conducted in the four southernmost provinces of Thailand: Songkhla, Pattani, Yala and Narathiwat. Twenty-two hospitals, where 20-30% of the pregnant women have been reported as having anemia during prenatal care during the previous year, were invited to participate, of which nine agreed to join this study. The main reason why the remaining hospitals declined to join was personnel shortage.

This study was approved by the Institute Ethics Committee of the Faculty of Medicine, Prince of Songkla University, and received permission from the Directors of the participating hospitals and the Chief Medical Officer of the Provincial Health Office.

### Study subjects

All pregnant women who lived in the service areas of the participating hospitals and attended their first prenatal care visit at one of these hospitals were approached for inclusion in the study. Women, who had a

gestational age of >32 weeks due to a limited follow-up time until delivery, who did not wish to participate or who had a history of anthelmintic drug allergy, were excluded. At least 111 pregnant women per hospital needed to be tested for STH according to the estimated STH prevalence of 15% with a precision of 7% and compensation of incomplete data in 10% thus the total sample of women needed to be at least 1,000 women.

### Preparatory phase

Two main preparations were made before the study carried out: assembling and distributing the materials and supplies for a modified Kato-Katz technique (WHO, 1998) and training health personnel and laboratory technicians. The materials and supplies for the modified Kato-Katz technique were organized by the principal investigator and provided to all study hospitals. Although the laboratory technician at each participating hospital stated that they were experienced in carrying out the modified Kato-Katz technique, a one-day workshop was conducted to ensure the same standard. The workshop consisted of a lecture to refresh their knowledge regarding STH and a hands-on practice of using the Kato-Katz technique to identify and count the eggs of soil-transmitted helminthes, including hookworm, *Ascaris lumbricoides* and *Trichuris trichiura*, in stool specimens. An additional one-day workshop for health personnel and laboratory technicians was organized to emphasize the objectives and data collection process of the study. In addition, a sufficient supply of albendazole 400 mg (manufactured by Nida Pharma) from the same lot, needed to treat all anticipated participants was distributed to all study hospitals.

### Data collection phase

Eligible women according to the inclusion and exclusion criteria were approached consecutively. After they agreed to partici-

pate and provided written informed consent, baseline information regarding demographic and socio-economic factors, home environment, sanitation and knowledge regarding STH was obtained from face-to-face interviews by trained health personnel. The subjects were then given a stool container and instructed how to provide a stool sample. The stool specimens were submitted as soon as possible at their convenience, but not longer than 1 month from their next scheduled prenatal visit. All enrolled women received the same routine prenatal care.

Stool specimens were examined by a modified Kato-Katz technique within 2 hours of being received by a trained laboratory technician. Women who tested positive for hookworm, *Ascaris* or *Trichuris* eggs were given 400 mg of albendazole under observation after 14 weeks of gestation, but women whose stool showed severe *Trichuris* infection were given an additional two days of albendazole 400 mg daily (Urbani and Albonico, 2003). A second stool sample, in the women who tested positive for helminthiasis, was taken and examined using the same method three weeks after treatment. If any woman showed persistent infection, they were re-treated with three days of albendazole 400 mg daily, and again re-evaluated.

### Variable definitions

Demographic characteristics of interest were age, education and religion, and socio-economic characteristics noted were occupation and monthly family income. Home environment and sanitation were defined as type of house, place of defecation, wearing shoes outside the house, frequency of wearing shoes outside the house or for defecation, place of bathing and type of drinking water. Knowledge assessment regarding STH was categorized into route of transmission, mother and baby impact and prevention. Detection of hookworm eggs, ascaris

eggs or trichuris eggs in the stool was considered positive for soil-transmitted helminthiasis. The intensity of hookworm infections, ascariasis and trichuriasis was recorded as the number of eggs per gram of feces and classified as light, moderate and severe according to WHO guidelines (Montresor *et al*, 1998).

The effect of treatment was evaluated by the cure rate (CR) and egg reduction rate (ERR) at 3 weeks after treatment. Cure was defined as no detection of hookworm, *Ascaris* or *Trichuris* eggs after treatment. The number of eggs per gram of feces before and after treatment gave a figure for egg reduction. If the egg reduction rate was less than 70% for *Ascaris* and less than 50% for hookworm or *Trichuris* was detected after treatment, albendazole resistance was diagnosed (WHO, 1996b; Albonico *et al*, 2005).

#### Data processing and analysis

Data were recorded in Epidata 3.1 and analyzed by R software version 2.7.0 (the R Foundation for Statistical Computing 2008, Austria). The prevalence of overall STH and ascariasis, hookworm infection and trichuriasis, intensity of infection, cure rate and egg reduction rate were described as percentages. The factors associated with STH were explored by univariate analysis and multiple logistic regression with a *p*-value of 0.05.

## RESULTS

One thousand sixty-three pregnant women who came for prenatal care at participating hospitals submitted a stool sample for examination. Of the women who registered for the study, carried out March and October 2006, 40% had a pregnancy with a gestational age of 5-13 weeks, 54% had a pregnancy at 14-28 weeks, and 6% had a pregnancy of 29-32 weeks. The subject ages ranged from 13 to 46 years (mean age  $\pm$  SD = 27.3  $\pm$  6.1); the most common occupation

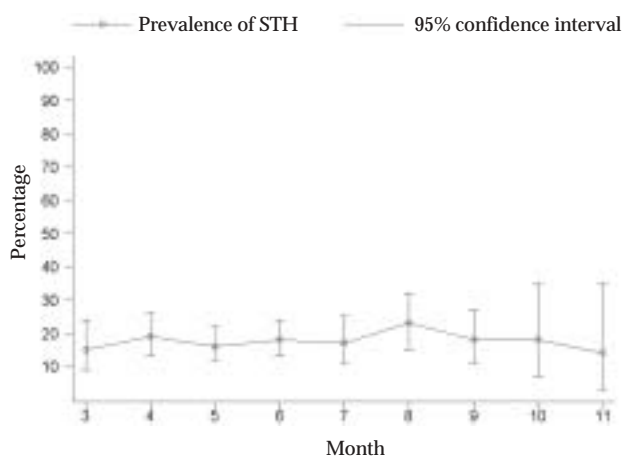


Fig 1—Prevalences and 95% confidence intervals for STH in pregnant women.

was housewife (41.8%). Three-fourths had attended primary or secondary school, half had a family income of USD150-300/month. The subject had a first pregnancy in 35.3%. A history of previous abortion or stillbirth was noted in 17.0%. Only 5.3% of subjects had no latrine in their house and 2.1% defecated outside the latrine.

STH were found in 190 women (17.9%; 95% CI=15.6-20.3), of which a double or triple infection was detected in 21.6%. The prevalence of infection by month is shown in Fig 1. Overall, ascariasis, trichuriasis and hookworm infection were found in 10.3, 5.7 and 6.3%, respectively. The intensity of each STH is presented in Table 1. Compared to single infection, higher intensities of the three types of helminthes were detected in combined infection.

On univariate analysis the rate of STH was significantly higher in Muslim women, those with a low level of education, low family income, living in a single house, defecating outside a latrine, bathing outside the house, drinking pipe water and those lacking a knowledge of the route of transmission, impact of STH on mother and baby and prevention (Table 2). On multiple logistic

tic regression, there were four factors associated with higher risk of STH: Muslim women, women with a monthly family income ≤USD300, those bathing outside the house and those with a lack of knowledge regarding the impact of STH on mother and baby (Table 3).

Of the 190 infected women, 177 (93.2%) agreed to take a single dose of 400 mg albendazole after 14 weeks of gestation or more. Of 16 women whose infections persisted after initial treatment, three women who refused to take their original dose of albendazole in front of the researcher but said they would take it at home revealed later that they did not actually take it; these three also refused re-treatment. Overall, the cure rate with a single-dose of 400 mg albendazole was 92% (161/174): for ascariasis 97% (3/109), hookworm infection 95% (3/61) and trichuriasis 90% (7/67). The egg reduction rate with a single-dose of albendazole was 94.2%: for ascariasis 99.1%, hookworm infection 95.1%, and trichuriasis 91.0%. Of the remaining 13 infected women, 8 agreed to be re-treated with three daily doses of albendazole, all were cured.

DISCUSSION

Soil-transmitted helminthiasis in pregnant southern Thai women was consistently detected throughout the study period with no seasonal variation. Muslim women, those with a monthly family income ≤USD300, those bathing outside the house or lacking knowledge of the impact of STH on mother and baby had a significant risk for STH. Although the cure rate for STH following treatment was high, a lower cure rate was observed in *Trichuris* infection.

Soil-transmitted helminthiasis in pregnant Thai women has previously reported in only one study using data collected in 1997 (Piammongkol *et al*, 2006). Compared to that study (Piammongkol *et al*, 2006), we found a lower prevalence of STH, which is probably related to improved socio-economic status, sanitation and environment in the study areas (National Statistical Office, 2008). The predominant helminth infection changed from hookworm a decade ago (Chongsuvivatwong *et al*, 1994) to ascariasis in our study. Most subjects in our study could correctly answer the questions related

Table 1  
Intensity of soil-transmitted helminthiasis (STH).

Type of STH	Intensity classification	Intensity	N (%)	
			Single infection	Combined infection
<i>Ascaris</i> N= 109	<5,000	Light	79 (72.5)	30 (27.5)
	5,000-49,999	Moderate	74 (93.7)	25 (83.3)
	≥50,000	Severe	5 (6.3)	5 (16.7)
Hookworm N= 61	<2,000	Light	0	0
	2,000-3,999	Moderate	35 (57.4)	26 (42.6)
	≥4,000	Severe	34 (97.1)	24 (92.3)
<i>Trichuris</i> N= 67	<1,000	Light	1 (2.9)	2 (7.7)
	1,000-9,999	Moderate	0	0
	≥10,000	Severe	35 (52.2)	32 (47.8)
			35 (100.0)	27 (84.4)
			0	4 (12.5)
			0	1 (3.1)

Table 2  
Factors associated with soil-transmitted helminthiasis in pregnant women on univariate analysis.

Factor	Soil-transmitted helminthiasis		p-value
	No (N=873) n (%)	Yes (N=190) n (%)	
Soil-contacting occupation			0.17
Low risk	541 (62.0)	107 (56.3)	
High risk	332 (38.0)	83 (43.7)	
Religion			< 0.001
Non-Muslim	262 (30.0)	13 (6.8)	
Muslim	611 (70.0)	177 (93.2)	
Level of education			< 0.001
< Secondary school	294 (33.7)	91 (47.9)	
Secondary or diploma	434 (49.7)	85 (44.7)	
≥ Bachelor	145 (16.6)	14 (7.4)	
Family income			< 0.001
≤ USD300/month	621 (71.1)	168 (88.9)	
> USD300/month	252 (28.9)	21 (11.1)	
Type of house			0.04
Row	211 (24.2)	30 (15.8)	
Garden	148 (17.0)	37 (19.5)	
Single house	514 (58.9)	123 (64.7)	
Place of defecation			0.01
Inside latrine	860 (98.5)	181 (95.3)	
Outside latrine	13 (1.5)	9 (4.7)	
Wearing shoes outside house			0.39
No	8 (0.9)	0	
Yes	865 (99.1)	190 (100.0)	
Frequency of wearing shoes outside house			0.32
Not always	123 (14.1)	21 (11.1)	
Always	750 (85.9)	169 (88.9)	
Frequency of wearing shoes for defecation			0.06
Not always	474 (54.5)	87 (46.5)	
Always	396 (45.5)	100 (53.5)	
Place of bathing			< 0.001
Inside house	731 (83.8)	131 (68.9)	
Outside house	141 (16.2)	59 (31.1)	
Drinking water			<0.01
Boiled	131 (15.0)	32 (16.8)	
Filtered	377 (43.2)	60 (31.6)	
Well/River	258 (29.6)	58 (30.5)	
Pipe	107 (12.3)	40 (21.1)	
Knowledge on route of transmission			<0.001
No	617 (70.7)	161 (84.7)	
Yes	245 (28.0)	29 (15.3)	
Not answer	11 (1.3)	0	
Knowledge on mother and baby impact			<0.001
No	741 (84.9)	180 (94.7)	
Yes	127 (14.5)	10 (5.3)	
Not answer	5 (0.6)	0	
Knowledge on prevention			0.02
No	840 (96.2)	190 (100.0)	
Yes	30 (3.4)	0	
Not answer	3 (0.4)	0	



Table 3

Logistic regression of factors related to soil-transmitted helminthiasis in pregnant women.

Factor	Odds ratio (95% confidence interval)	
	Crude	Adjusted
Muslim religion	5.8 (3.2-10.4)	4.6 (2.5-8.2)
Family income $\leq$ USD 300/month	3.2 (2.0-5.3)	2.5 (1.5-4.0)
Bathing outside house	2.4 (1.6-3.4)	1.7 (1.2-2.4)
No knowledge regarding impact on mother and infant	3.0 (1.6-5.9)	2.4 (1.1-4.5)

to risk factors for hookworm transmission. The routes of transmission for hookworm and ascariasis are different, thus the hookworm control program in Thailand targeting hookworms naturally had a greater impact on hookworm infection than ascariasis (Crompton and Nesheim, 2002). Our study indicates that a similar education program for ascariasis and trichuriasis transmission, explaining the fecal-soil-oral route could be very beneficial. We found no seasonal variation of STH in our study. This may be because it rains throughout the year in this part of Thailand.

Soil-transmitted helminthes are uncommon in pregnant women in developed countries, but common in pregnant Asian and African women. The prevalence of hookworm, *Ascaris lumbricoides* and *Trichuris trichiura* infection in pregnant women was reviewed (Table 4). There is variation in the prevalences and types of soil-transmitted helminthes among countries. It is difficult to elucidate whether this is a real difference in prevalence or simply related to different study areas (Navitsky *et al*, 1998; Dreyfuss *et al*, 2000; Shah and Baig, 2005).

Associated risk factors for STH infection in our study indicate that poor economic conditions increase the risk for infection. Muslim women may also have routine lifestyle behaviors which place them at increased risk which have not yet been clari-

fied. Bathing outside the house is associated with an increased risk for STH, possibly through a higher chance of exposure to helminthic eggs and larvae in contaminated soil (Chongsuvivatwong *et al*, 1999).

The cure rate and egg reduction rate after treatment with 400 mg of albendazole among infected pregnant women in our study were similar to a previous study among the general population in Thailand (Jongsuksuntigul *et al*, 1993). For ascariasis, the cure rate and egg reduction rate were 97.0% and 99.1%, respectively which was slightly lower than 100% found for both parameters in the previous study. There has been no policy of mass treatment of reproductive age or pregnant women in southern Thailand during the past 6-12 months. Although the response to treatment was quite high, the slight reduction in cure rate and egg reduction rate should be followed, since recently the issues of antibody response and resistance of *Ascaris lumbricoides* have been raised (Hagel *et al*, 2008). Mebendazole and albendazole are still effective in combating helminthes, especially *Ascaris*, hookworm and *Trichuris* (Jongsuksuntigul *et al*, 1993); however, caution must be exercised in the use of anthelmintic treatment to prevent the problem of drug resistance (Albonico *et al*, 2005; Adugna *et al*, 2007; Hagel *et al*, 2008).

The strengths of this study were that it was well-planned for good quality assurance in the preparatory phase, the number of

Table 4  
Review of previous studies regarding prevalence of hookworm infection, ascariasis and trichuriasis among pregnant women.

Author and year	Country	Study design	Setting	Subjects for stool specimens	Methods for helminthic detection	Prevalence (%)		
						Hookworm	Ascaris	Trichuris
Constantine et al, 1988	England	Cross-sectional study	Dudley Road Hospital, Birmingham	Asian pregnant women attending antenatal clinic (n= 178)	Fecal concentration	3.4	0.1	5
Villar et al, 1989	Guatemala	Prospective study Apr 1984-Jan 1986	Hospital of Guatemalan Social Security Institute, Guatemala city	Pregnant women attending antenatal clinic (n= 14,914)	Direct fecal smears (saline and iodine wet mount)	1.5	14.5	3.9
Navitsky et al, 1998	Nepal	Cross-sectional study Jun 1995-Jul 1996 (substudy of the Nutrition Intervention Nepal Project-Sarlahi)	Sarlahi District plains of Nepal	Pregnant women in community (n=292)	Kato-Katz	78.8	56.2	7.9
Dreyfuss et al, 2000	Nepal	Prospective study Aug 1994-Mar 1997 (substudy of vitamin A or beta-carotene supplementation)	Sarlahi District plains of Nepal	Pregnant women in community (n= 190)	Kato-Katz	74.2	58.9	5.3
Nurdiati et al, 2001	Indonesia	Prospective study Apr 1996-Aug 1998	Purworejo District, Central Java	Pregnant women in community (n= 442)	Kato-Katz	23.3	21.2	49.7
Egvyunyenga et al, 2001	Nigeria	Cross-sectional study Feb 1997-Jan1998	University of Jos Teaching Hospital, Bauchi Specialist Hospital and Eku Baptist Hospital	Pregnant women delivered at hospitals (n= 816)	Fecal concentration	14.3	19.1	7.0
Massawe et al, 2002	Tanzania	Cross-sectional study Aug-Sep 1998	Temeke District	Pregnant women attending antenatal clinic (n= 76)	No data available	26.0	NA	NA
Glover-Amengor et al, 2005	Ghana	Cross-sectional study Feb 2000-Jan2001	Sekyere West District of the Ashanti region	Pregnant women attending antenatal clinic (n= 86)	Direct fecal smears (saline and iodine wet mount)	8.0	NA	NA



Table 4 (Continued).

Author and Year	Country	Study design	Setting	Subjects for stool specimens	Methods for helminthic detection	Prevalence (%)		
						Hookworm	Ascaris	Trichurias
Shah and Baig, 2005	Nepal	Cross-sectional study May-Jul 2001	Dhankuta District Hospital	Pregnant women attending antenatal clinic (n=92)	Direct fecal smears (saline wet mount)	20.0	26.0	5.0
Larocque et al, 2005	Peru	Cross-sectional study Apr-Nov 2003	Hospital Apoyo de Iquitos, Hospital Regional de Iquitos, health centers	Pregnant women attending antenatal clinic (n=1,042)	Kato-Katz	47.2	63.9	82.2
Piammongkol et al, 2006	Thailand	Cross-sectional study Mar-Oct 1997	Pattani Province (five randomly selected districts)	Pregnant women in selected districts (n=166)	Kato-Katz	46.8	48.4	24.6
Ayoya et al, 2006	Mali	Cross-sectional study Jun-Aug 2002	Barconi, capital city of Bamako	Pregnant women attending antenatal clinic (n=131)	Kato-Katz	8.0	NA	NA
Larocque et al, 2006	Peru	Randomized controlled trial Apr-Nov 2003	Hospital Apoyo de Iquitos, Hospital Regional de Iquitos, health centers	Pregnant women attending antenatal clinic (n=950)	Kato-Katz	46.4	64.2	82.1
Aikawa et al, 2006	Vietnam	Cross-sectional study Jul 2003	Yen Thanh District of Nghe An Province	Pregnant women in communities (n=391)	Fecal concentration	21.2	96.2	30.7
Belachew and Legesse, 2006	Ethiopia	Cross-sectional study May-Jun 2005	Jimma University Hospital, Oromia region	Pregnant women attending antenatal clinic (n=168)	Direct fecal smears (saline wet mount)	38.0	NA	NA
Muhangi et al, 2007	Uganda	Cross-sectional study Apr-Nov 2005	Entebbe Hospital	Pregnant women attending antenatal clinic (n=2,498)	Kato-Katz	44.5	2.3	9.1
Ndyomugenyi et al, 2008	Uganda	Cross-sectional study Jan 2003-May 2004	Masindi District	Pregnant women attending antenatal clinic (n=832)	Kato-Katz	66.6	0.5	4.6

study subjects was sufficient for highly reliable figures for both prevalence and effect of treatment, and the study used settings from different areas having various characteristics to better identify the factors associated with soil-transmitted helminthiasis. However, we could not identify certain potentially important behaviors which may be related to religious customs and low family income apart from the broad factors collected. All infected women were treated in our study, thus the negative effects of untreated STH on maternal and infant health could not be evaluated. Recruitment at the different hospitals varied in duration. Some hospitals recruited only during the last two months which resulted in smaller sample sizes and wider confidence intervals for STH prevalence.

In conclusion, pregnant women are a vulnerable group who can be affected by soil-transmitted helminthiasis. Southern Thailand is still an endemic area for STH with no seasonal variation in endemicity. Other lifestyle factors which may be associated with STH need further study in an attempt to develop effective education and mitigation programs. Although high cure rates were seen, the slightly lower cure rates and egg reduction rates for ascaris and trichuris are of concern.

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