AN UNCEASING PROBLEM: SOIL-TRANSMITTED HELMINTHIASES IN RURAL MALAYSIAN COMMUNITIES

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Abstract. Despite great development in socioeconomic status throughout 50 years of independence, Malaysia is still plagued with soil-transmitted helminthiases (STH). STH continue to have a significant impact on public health particularly in rural communities. In order to determine the prevalence of STH among rural Orang Asli children and to investigate the possible risk factors affecting the pattern of this prevalence, fecal samples were collected from 292 Orang Asli primary schoolchildren (145 males and 147 females) age 7-12 years, from Pos Betau, Kuala Lipis, Pahang. The samples were examined by Kato-Katz and Harada Mori techniques. Socioeconomic data were collected using pre-tested questionnaires. The overall prevalence of ascariasis, trichuriasis, and hookworm infections were 67.8, 95.5 and 13.4%, respectively. Twenty-nine point eight percent of the children had heavy trichuriasis, while 22.3% had heavy ascariasis. Sixty-seven point seven percent of the children had mixed infections. Age >10 years (p=0.016), no toilet in the house (p=0.012), working mother (p=0.040), low household income (p=0.033), and large family size (p=0.028) were identified as risk factors for ascariasis. Logistic regression confirmed low income, no toilet in the house and working mother as significant risk factors for ascariasis. The prevalence of STH is still very high in rural Malaysian communities. STH may also contribute to other health problems such as micronutrient deficiencies, protein-energy malnutrition and poor educational achievement. Public health personnel need to reassess current control measures and identify innovative and integrated ways in order to reduce STH significantly in rural communities.

INTRODUCTION

Soil-transmitted helminthiases (STH) are considered as the most prevalent infections of humankind despite great development in socioeconomic status worldwide. The WHO (1996) estimated that more than one billion of the world's population are infected either by one or more of STH, particularly *Ascaris lumbricoides*, *Trichuris trichiura* and hookworm. These infections together with schistosomiasis represent more than 40% of the disease burden caused by all tropical diseases, excluding malaria.

Unlike blood parasites and *Schistosoma*, STH can live in silence as chronic infections and the greatest morbidity is among children and mothers of childbearing age (Savioli *et al*, 1992; Nurdia *et al,* 2001). The main impact of STH infections is their associations with malnutrition, vitamin A deficiency (VAD) and iron deficiency anemia (IDA), which may have effects at the community level in regard to work and productivity in adults (Gilgen *et al,* 2001) and growth, learning and school performance in children (Nokes and Bundy, 1994; Ramdath *et al,* 1995; Al-Mekhlafi *et al,* 2005).

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According to environmental, socioeconomic and cultural-behavioral factors, the prevalence and distribution of STH may differ from one region to another and sometimes within the country itself (de Silva *et al,* 2003). Data from recent studies revealed that STH are prevalent in Southeast Asia and are still considered as public health problems in Thailand (Tomono *et al,* 2003), Vietnam (Uga *et al,* 2005) and Indonesia (Nurdia *et al,* 2001). Studies indicate there is a web of risk factors associated with the high prevalence and intensity of STH including age, low family income, inadequate sanitation, presence of animals in the house, drinking water from rivers and wells, low levels of education among parents, geophagy and poor personal hygiene (Geissler *et al,* 1998; Anantaphruti *et al,* 2004; Naish *et al,* 2004).

Malaysia is a developing country with a range of parasitic infections. STH continue to have a significant impact on public health in Malaysia, particularly in rural communities (Dissanaike *et al,* 1977; Bundy *et al,* 1988; Norhayati *et al,* 1997; Zulkifli *et al,* 2000; Al-Mekhlafi *et al,* 2006). Through a better understanding of the relationship of risk factors to the dynamics of transmission of STH it should be possible to implement effective control measures. Within this context, the present study was undertaken to determine the current prevalence and distribution of STH among aboriginal children living in rural areas in Peninsular Malaysia and to study the possible risk factors that may affect the pattern of this prevalence in Malaysia.

MATERIALS AND METHODS

Study area

A cross-sectional study was carried out between February and July 2006 among primary schoolchildren of Pos Betau School, Kuala Lipis, Pahang, Malaysia. The schoolchildren were from 18 villages around the school. Each village is comprised of a small population and most of the residents work as laborers, farmers or rubber tappers. Most of the houses had electricity and piped water as the main source of drinking water while water for domestic needs (bathing, washing clothes and feeding animals) is collected from the rivers located adjacent to the villages. There is no adequate or proper sanitation. There is a clinic in the area for health services equipped with an ambulance to send critical cases to the nearest hospital (50 km).

Subjects

The school had an enrolment of 405 pupils in the age range of 7-12 years. A total of 292 (72.1%) schoolchildren who were present during the visits participated voluntarily in this study and delivered stool samples for examination (universal sampling). Of these children, only 277 children came for interview, filled in the questionnaire to analyze the association between STH and the variables in these children.

Throughout many visits to the villages to observe their activities during daytime, most of the children were noted to play in the soil without wearing shoes or slippers. Some of the children play and swim in the rivers after school and in their leisure time. Besides that, their personal hygienic practices were also poor. The headmaster of the school and the parents of the children consented to take part in this study after a clear explanation was given.

Data collection

Subjects' socioeconomic data and fecal samples were collected during many visits to the school in order to cover those who were absent and hence missed at any visit. A list of all the students' names and classes was collected from the headmaster's office. Each child was coded accordingly and particulars were entered in the data sheet. Information on biodata and socioeconomic status were collected

through a pre-designed questionnaire.

Fresh fecal samples were collected into wide mouth screw-cap 100 ml clean containers. The samples were examined by Kato-Katz technique as described by Martin and Beaver (1968) for the presence of *A. lumbricoides*, *T. trichiura* and hookworm eggs. Egg counts, as a measure of worm burden, were also carried out using this technique and the results were recorded as eggs per gram of stool (epg). The intensity of infection was graded as heavy, moderate or light according to criteria proposed by the WHO (1987). In order to detect hookworm larva in light infections, Harada Mori fecal cultivation technique using a test-tube was also carried out (Jozefzoon and Oostburg, 1994).

Data analysis

Statistical analysis of the data was performed using SPSS 11.5 (SPSS, Chicago, IL, USA). For descriptive data, rate (percentage) was used to assess the prevalence of infections. The egg counts of *A. lumbricoides*, *T. trichiura* and hookworm, examined for normality by the Kolmogorov-Smirnov test, were not normally distributed so the assessment of the variation of egg counts by age and gender were done after log transformation.

A chi-square test on proportions and a Mann-Whitney *U* test were used where appropriate to test for associations between variables. Univariate and multivariate analyses were used to determine risk factors. As a result of the high prevalence of trichuriasis and low prevalence of hookworm infections, which distorted the association with other variables, the dependent variable was ascariasis only as a statistical model, while the independent variables were age, gender, educational levels of the parents, employment status of the mother, household income, family size, presence of toilet in the house, presence of animals in the house and source of drinking water. The correlation of mean epg for *A. lumbricoides*, *T. trichiura* and hookworm in individual children was analyzed using Spearman's correlation coefficient.

Variables that were significantly associated with prevalence of infection were included in a logistic multivariate model (stepwise procedure). Univariate analysis relating ascariasis to each of the variables was done by means of odds ratios (OR) and 95% confidence interval (95% CI) calculated by logistic regression models.

Ethical consideration

This study was approved by the Medical Ethics Committee of the University of Malaya Medical Center, Malaysia. During the visits to the school and the villages community meetings were held with the headmaster of the school, the heads of the villages, the parents and their school-age children before the commencement of the study in order to give a clear explanation of the objectives of the study. Informed verbal consent was obtained from the participants.

RESULTS

Demographic characteristics

Two hundred ninety-two primary schoolchildren (145 males and 147 females) age 7-12 years with a median age of 9.6 years (Interquartile range 3.0) participated in this study. Thirty-four point three percent of fathers had a formal education of at least 6 years. Only 22.4% of mothers had a similar level of formal education. Characteristics of study subjects including their socioeconomic status are presented in Table 1.

Prevalence and distribution of STH

The prevalence of STH infections in these children according to intensity of infection and gender is shown in Table 2. The overall prevalence of ascariasis, trichuriasis, and hookworm infections were 67.8, 95.5 and 13.4%, respectively. Almost one third (29.8%) of children had

heavy trichuriasis, while 22.3% had heavy ascariasis. All hookworm infections in this population were light infections. There were no significant differences in the prevalence of STH and mean eggs/gram feces (worm burden) between males and females. Almost two third (67.7%) of the infected children had mixed infections, while 32.3% had single infections. The most prevalent mixed infections were ascariasis and trichuriasis (54.2%).

Table 1
General characteristics of Orang Asli children participating in this study.

Characteristics	Frequency (%)
Age groups (years) (n=292)	
≤10 years	30.8
>10 years	69.2
Gender	
Males	49.7
Socioeconomic status	
Paternal education level (at least 6 years)	34.3
Maternal education level (at least 6 years)	22.4
Low household income (<RM450)	81.2
Working fathers	51.4
Working mothers	58.1
Large family (≥8 members)	35.0
Supplied with piped water	87.4
No toilet in house	68.6
Parasitology	
Mixed STH infections	67.7
Ascariasis+trichuriasis+hookworm infections	11.3

A positive correlation (r_s=0.221, p<0.001) between the egg counts of *A. lumbricoides* and *T. trichiura,* and *T. trichiura* and hookworm (r_s=0.325, p<0.01) passed by the same individual was observed. The same correlation was also seen when the data were stratified by age (≤ 10 years and > 10 years). A positive correlation between mean epg for *A. lumbricoides* and *T. trichiura* was seen in males (p<0.01) but not in females when the data were stratified by gender. A weak correlation (p<0.05) between *T. trichiura* and hookworm was also detected among males only.

Univariate and multivariate analysis for risk factors

Risk factors that may be associated with ascariasis were analyzed using univariate analysis (Table 3). Age >10 years (p=0.016), absence of toilet in the house (p=0.012), working mother (p=0.040), low household income (p=0.033) and large family size (p=0.028) were identified as the risk factors for ascariasis. Results of logistic regression (stepwise forward)

Table 2
Prevalence of ascariasis, trichuriasis and hookworm infections according to intensity of infection and gender.

	Type of infections		
	Ascariasis No. (%)	Trichuriasis No. (%)	Hookworm infection No. (%)
Intensity of infection			
Negative	94 (32.2)	13 (4.5)	253 (86.6)
Light infection	74 (25.3)	110 (37.6)	39 (13.4)
Moderate infection	59 (20.2)	82 (28.1)	0
Severe infection	65 (22.3)	87 (29.8)	0
Gender			
Male	93 (64.1)	138 (95.2)	19 (13.1)
Female	105 (71.4)	141 (95.9)	20 (13.6)
Total	198 (67.8)	279 (95.5)	39 (13.4)

Table 3
Odds ratios for potential risk factors with ascariasis among Orang Asli children.

Variables	Prevalence of ascariasis		
	N	OR (95% CI)	p
Paternal education		0.96 (0.842-1.22)	0.898
≥6 years formal education	67		
No formal education	127		
Maternal education		0.77 (0.93-1.21)	0.417
≥6 years formal education	46		
No formal education	148		
Maternal employment status		1.8 (1.03-3.01)	0.040[a,b]
Working	105		
Not working	89		
Low household income		2.0 (1.1-3.7)	0.033[a,b]
<RM450/month	164		
>RM450/month	30		
Family size		1.9 (1.30-1.93)	0.028[a]
≥ 8 members (large)	76		
< 8 members	118		
Age		2.02 (1.14-3.6)	0.016[a]
≤10 years	128		
>10 years	70		
Toilet in house		2.0 (1.2-3.4)	0.012[a,b]
Yes	52		
No	142		
Source of drinking water		0.81 (0.64-2.33)	0.550
Piped	171		
Others (river, rain, well)	23		
Have animals in house		0.95 (0.66-1.41)	0.851
Yes	63		
No	131		
Gender		1.4 (0.65-1.1)	0.182
Male	93		
Female	105		

[a]Significant ($p<0.05$); [b]Confirmed as significant predictors by logistic regression analysis

confirmed that working mother, low household income and absence of toilet in the house were the predictors of ascariasis in this community.

DISCUSSION

Soil-transmitted helminthiases (STH) are worldwide infections and still considered as public health problems in rural areas of developing countries and may be considered as "the cancers of developing nations" according to Egger *et al* (1990). In a recent study on the global prevalence of STH infections, de Silva *et al* (2003) indicated that almost 560 million people in Southeast Asia were at risk for STH infections. The WHO (2004) reported that STH together with protein-energy malnutrition, VAD and IDA thrive in communities

where poverty prevails, where sanitation is inadequate or non-existent and where more health awareness and care are needed and recommended to deliver anthelmintics together with vitamin A supplements.

Since the 1970s, several studies in Malaysia have demonstrated a high prevalence of ascariasis, trichuriasis and hookworm infections in Orang Asli children, where the prevalences range between 30.2-69.0%, 15.8-98.2% and 6-51.0%, respectively (Dissanaike *et al,* 1977; Bundy *et al,* 1988; Norhayati *et al,* 1997; Zulkifli *et al,* 2000; Sagin *et al,* 2002; Al-Mekhlafi *et al,* 2006). The findings of the present study confirmed that ascariasis, trichuriasis and hookworm infections are still endemic in the Orang Asli community in Malaysia with almost all of the children studied (98.6%) infected by either one or more STH. The prevalence was similar with the results reported recently among Orang Asli children in Selangor, Malaysia (Al-Mekhlafi *et al,* 2006) and higher than the prevalences reported by previous studies (Norhayati *et al,* 1997; Zulkifli *et al,* 2000), this may indicate the continuance of this problem. The present study also confirms previous findings that the prevalence and mean epg for STH were not significantly different between genders (Chan *et al,* 1992; Norhayati *et al,* 1997). This may suggest that there is no difference in socio-behavioral activity or immune status between males and females.

Trichuriasis proved to be the most common STH infection in Malaysia and this observation is in agreement with previous local studies (Norhayati *et al,* 1997; Rahman, 1998; Sagin *et al,* 2002; Al-Mekhlafi *et al,* 2006). Ascariasis is the predominant infection in China where about 600 million people are infected (Xu *et al,* 1995). It has also been found to be the most common in Indonesia (Widjana and Sutisna, 2000), Yemen (Azazy *et al,* 2002), Brazil (Scolari *et al,* 2000) and Africa (Crompton and Tulley, 1987). Hookworm infection had a higher prevalence (93.9%) in Nigeria (Adenusi *et al,* 2003) and also in aboriginal communities in northern Australia with a prevalence reaching 93% in children 5-14 years of age (Thompson *et al,* 2001). Resistance of moderate and severe trichuriasis to antihelminthic drugs which has been reported to be prevalent in Malaysia (Rajeswary *et al,* 1994; Norhayati *et al,* 1998a) may be one of the possible reasons.

Trichuriasis, with or without concomitant ascariasis has also been associated with malnutrition, iron deficiency anemia and growth stunting (Robertson *et al,* 1992; Saldiva *et al,* 1999; Al-Mekhlafi *et al,* 2005). Severe ascariasis has been associated with malnutrition (Stephenson *et al,* 1993; Saldiva *et al,* 1999) and has been considered as one of the causes of acute abdominal pain in tropical countries (Kamiya *et al,* 1993). In Malaysia, clinical features of severe trichuriasis have been described in few previous studies (McKay *et al,* 1971; Kamath, 1973). It has also been reported that ascariasis was responsible for 42.0% and 41.0% of all acute abdominal emergencies and intestinal obstruction, respectively, in children aged 7 years and under admitted to Kuala Lumpur Hospital (Mahmud, 1973).

It is not surprising to observe a positive significant correlation between *A. lumbricoides* and *T. trichiura* due to the similar mode of infection and high prevalence and mean epg for both species in the community. There was no correlation between *A. lumbricoides* and hookworm and this may reflect the low prevalence and mean epg for hookworm in the community. A similar trend in correlation has been reported previously in Malaysia (Norhayati *et al*, 1998a) as well as in studies conducted in other countries (Ferreira *et al*, 1994).

The findings of this study show the prevalence of heavy infection is high and that almost one third of children had heavy worm burdens. In the case of hookworm infection,

all the infected children had light infections, and this may be due to the different mode of transmission. WHO (2006) indicated that STH may have a negative impact on the economic development of communities and nations, resulting from failure to treat school-age children who are infected. These children are often physically and intellectually compromised by anemia, leading to attention deficits, learning disabilities, school absenteeism and higher dropout rates and this may yield a generation of adults disadvantaged by the irreversible sequelae of infections. Proper attention should be given to these infections, especially in endemic areas. Both the intensity and continuance of infection are the key factors for the pathological changes and long-term complications.

In our study we identified low household income and large family size as significant risk factors in the prevalence of ascariasis and this was in accordance with previous studies (Rajeswari *et al,* 1994). This may be attributed to the horizontal spread of infection among family members where poverly prevails. Working mothers and low household income have been also reported as predictors of malnutrition among Orang Asli children (Al-Mekhlafi *et al,* 2005). Sanitation is a key factor in parasitic infections. Information from the questionnaire showed that most of the participants prefered the rivers as a defecation site. Defecation around the house and playing places was also observed among young children. This practice is likely to enhance the transmission of infection. In this study, the absence of a toilet in the house was identified as a contributing factor for ascariasis in accordance with previous studies (Muller *et al,* 1989; Rai *et al,* 2000). Personal hygiene can play a crucial role in protection from STH. During the visits to the villages, we observed that toddlers and young children were playing in groups outside the houses barefoot and eating unwashed vegetables and fruits contaminated with soil. Although there were a large number of domestic animals (dogs, cats and hens) this factor was not significantly associated with the high prevalence of ascariasis in our study.

Interestingly, the presence of domestic animals was significantly associated with the worm burden where the mean egg/g of those having animals was significantly higher than others. This observation was in contrast to other studies which documented an association between the presence of domestic animals and STH (Traub *et al,* 2002; Neisum *et-al,* 2005). A working mother was one of the major risk factors for ascariasis in this community, this in agreement with studies in Thailand (Tomono *et al,* 2003) and India (Naish *et al,* 2004). We observed a significantly higher prevalence of ascariasis in children under 10 years of age. This may be attributed to the greater exposure to STH as a result of excessive mobility of children of this age. In our model, there was no significant association between source of drinking water and parental education and prevalence of STH. Significant associations for these factors were observed by Norhayati *et al* (1998b).

In conclusion, this study showed that ascariasis, trichuriasis and hookworm infections are still prevalent and therefore of a public health concern in Orang Asli communities in Malaysia. The high prevalence of severe ascariasis and trichuriasis may contribute to other health and medical problems which are also prevalent in these communities such as micronutrient deficiency (IDA and VAD), protein-energy malnutrition, poor school performance and other acute illnesses among children. Public health personnel need to reassess current control measures and identify innovative and integrated ways in order to reduce STH significantly in rural communities. Improvement of socioeconomic status, sanitation, health education together with periodic mass deworming should prove to be a better strategy to control STH.

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