PATTERN AND PREDICTORS OF SOIL-TRANSMITTED HELMINTH REINFECTIONS AMONG ORANG ASLI (ABORIGINE) SCHOOLCHILDREN IN MALAYSIA

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Abstract. Data on soil-transmitted helminth (STH) infections and reinfections among Orang Asli schoolchildren and their nutritional and socioeconomic status were analyzed to investigate the pattern and the possible predictors of STH reinfections. In this longitudinal study, 120 (60 males and 60 females) Orang Asli primary schoolchildren aged 7-12 years and living in remote areas in Pos Betau, Kuala Lipis, Pahang were screened for the presence of STH using Kato-Katz and Harada Mori techniques. After complete deworming with 3-days course of 400 mg/daily of albendazole tablets, children were re-examined at 3 and 6 months from baseline. The overall prevalence of ascariasis, trichuriasis and hookworm infections were 65.8, 97.5 and 10.8%, respectively. The reinfection rate at 3 months after deworming was high (48.9%) while 80.3% of the children were reinfected by one or more of STH species at 6 months after deworming. Logistic regression analyses showed that females, stunted children and those living in houses without toilets had significantly higher reinfection rates than others at 3 months ($p<0.05$). At 6 months, maternal employment status joined the web of predictors and children of working mothers had significantly higher reinfection rates ($p=0.026$). In conclusion, reinfection rate of STH is high and thus necessitate frequent and periodic deworming among children. Public health personnel need to re-look at the current control measures and identify innovative and integrated ways in order to reduce STH significantly in the rural communities.

INTRODUCTION

Despite many control measures and deworming programs implemented by public and private sectors, the prevalence and reinfection rates of soil-transmitted helminth (STH) are still high among poor and rural communities especially children in developing countries. High reinfection rate with STH reveals continuous presence of sources of infections in these communities. Studies carried out in rural communities reported that STH reinfection can occur as early as two months after complete deworming (Norhayati *et al*, 1995; Luoba *et al*, 2005). Moreover, Haswell-Elkins *et al* (1988) reported that reinfection with hookworm can occur soon after treatment. Subjects who became negative after anthelmintics treatment, but who were found to be positive again in the subsequent examinations were considered to be reinfected with STH (Olsen *et al*, 2003).

A study among Orang Asli population in Malaysia showed that by four months, after deworming, almost half and one-tenth of the treated population becomes reinfected with *Ascaris* and hookworm, respectively (Norhayati *et al*, 1997a). This study also reported that almost one third of *Ascaris*-infected people had the same pre-treatment intensity by four months after treatment. Similarly, studies in other parts of the world reported that by six months after treatment the intensity of infection of *Ascaris* and *Trichuris* were similar to pre-treatment levels (Albinco *et al*, 2003; Olsen *et al*, 2003).

In Malaysia, the prevalence of STH among

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rural children is still very high (Norhayati *et al*, 1997b; Zulkifli *et al*, 2000; Al-Mekhlafi *et al*, 2006), and no study deals with the predictors of STH reinfections among rural children. Thus, this study was carried out to investigate the pattern and predictors of STH reinfections among Orang Asli schoolchildren in Pahang, Malaysia. It is hoped that findings of this study will assist public health officials to develop innovative and integrated control measures in order to reduce STH significantly in the rural communities.

MATERIALS AND METHODS

Study area and subjects

This longitudinal study was based on repeated cross-sectional surveys, and carried out among primary schoolchildren in the National Primary School of Betau (Sekolah Kebangsaan Betau), (200 km from Kuala Lumpur), Pahang, Malaysia. The schoolchildren come from 18 Orang Asli villages located around the school. Each village comprised of a small population. The villages have homogenous nature of the populations with respect to their socio-cultural and daily economic activities. Most of the residents work as laborers, farmers or rubber tappers. Most of the houses had electricity and piped water supply as the main source of drinking water while water for domestic needs (bathing, washing and feeding animals) is collected from the rivers located adjacent to the villages. There is no adequate or proper sanitation.

One hundred and twenty schoolchildren (60 males and 60 females) children aged between 7 to 12 years who attended the school during the visits have agreed to participate in this study (universal sample). Throughout many visits to the villages to observe their activities during daytime, most of the children play with the soil without wearing shoes or slippers. Some of the children play and swim in the rivers after school and in their leisure time. Personal hygienic practices were also poor. The headmaster of the school and parents of children consented to take part in this study after a clear explanation.

Data collection

Subjects' socioeconomic data and fecal samples were collected during many visits to the school. 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 bio-data and socioeconomic status were collected through a pre-designed questionnaire.

Fecal samples were collected from the children 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). Intensity of infections was graded as heavy, moderate or light according to the criteria proposed by WHO (1987). In order to detect the hookworm larva in light infections, Harada Mori fecal cultivation technique using test-tube was also used (Jozefzoon and Oostburg, 1994).

Albendazole tablets were used in this study as the anthelmintic treatment. Each white chewable tablet contains 400 mg albendazole as the active ingredient. These tablets were produced by GlaxoSmithKline (London, UK). Tablets were provided into white and well sealed plastic bottles of 100 tablets each. The regime used was a 400 mg albendazole tablet per day admistered for three days and observed by a researcher, medical officer, and a teacher (Direct Observed Therapy). A list of student's names who found to be infected ater 6 months was submitted to the headmaster office and clinic Pos Betau staff (20 meters from the school) to be dewormed. Anthelmintics were also delivered.

All children underwent anthropometric measurements as follows: children were weighed wearing school uniforms, without belts or shoes and with empty pockets using a calibrated SECA scale with 0.1 kg intervals; height was measured to the nearest 0.1 cm using the same device that has a scale and a sliding head piece. The precision of the scales were checked regularly to ensure the scale calibration. To reduce intra-individual errors, weight and height were measured twice by different persons and the mean value was used for the analysis. Weight-for-age *Z*-score was used to denote underweight as an overall indicator for malnutrition. Height-for-age *Z*-score was used as an indicator for stunting (chronic malnutrition). Weight-for-height *Z*-score was used as an indicator for wasting (acute malnutrition). For this study, children who had *Z*-score below –2 standard deviations (SD) of the NCHS Reference Population median values were considered to be significantly malnourished and *Z*-scores between –1 and –2 SD were considered to be mildly malnourished. The *Z*-scores were calculated based on the median values of the National Center for Health Statistics (NCHS) Reference Population, United States. The *Z*-scores for weight-for-age, height-for-age and weight-for-height were derived using EpiNut Anthropometery (Epi Info, Version 6, 2002).

Data analysis

Statistical analysis of data was done using Statistical Package for Social Sciences for Windows SPSS (version 11.5, March 2002). 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 Kolmogorov-Smirnov test, were not normally distributed so the assessment of the variation of egg counts were done after log transformation.

Reinfection rates (RR), cure rates (CR) and egg reduction rates (ERR) of STH were calculated using the formulae below (Olsen *et al*, 2003; Saathoff *et al*, 2004):

$$RR = \frac{\%\ \text{prevalence after treatment}}{\%\ \text{prevalence before treatment}} \times 100$$

$$CR = \frac{\%\ \text{prevalence before treatment} - \%\ \text{prevalence after treatment}}{\%\ \text{prevalence before treatment}} \times 100$$

$$ERR = \frac{\text{mean epg before treatment} - \text{mean epg after treatment}}{\text{mean epg before treatment}} \times 100$$

The association between STH reinfection and the possible predictors was examined by univariate analysis and multiple logistic regression model; a p-value of 0.02 as elimination criterion was used as suggested by Bendel and Afifi (1977). These authors showed that used of more traditional level such as 0.05 oflen eliminated variables that later proved to be important.

Ethical consideration

This study was approved by the Medical Ethics Committee of University of Malaya Medical Centre, Malaysia. During the visits to the school and the villages, small community meetings were held with the headmaster of the school, teachers, staff of the clinic, 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 about their involvement and the objectives of the study. During the meetings, parents and their children were informed that their participation is voluntarily and they can withdrawal from the study at any time without assigning any reason whatsoever. Informed verbal consents were obtained from the participants themselves, their parents and from the headmaster.

RESULTS

General characteristics

The schoolchildren participated in this study were from Orang Asli villages in Pos Betau, Kuala Lipis, Pahang. They comprised of 120 children (60 males; 60 females) aged between 7-12 years with median age of 10 years (interquartile range 9-11). Almost 36.7% of the fathers had formal education of at least 6 years. On the other hand, only 20.8% of the mothers had similar formal education.

Pattern and predictors of soil-transmitted helminth reinfections

After a complete and successful deworming (fecal samples examined after 12 days of receiving anthelminitics found to be negative for STH), Orang Asli schoolchildren were re-examined at 3 and 6 months from baseline to determine the STH reinfection rates and to investigate the potential predictors of the reinfections. Findings of this longitudinal investigation showed that the reinfection rates of STH were high (Table 1). In relation to pre-treatment infection levels, STH reinfection rate at 3 months after deworming 48.9%. Very close to the baseline figure, 80.3% of the children were reinfected by one or more of STH species by 6 months after deworming. Individually, the reinfection rate of *A. lumbricoides* was very high where almost three quarters of the children positive at baseline were reinfected by 6 months. Similarly, the egg count of *A. lumbricoides* infections at 6 months was close to the baseline situation. The reinfection rates of *T. trichiura* and hookworm were 66.5% and 51.8% whereas the reinfection intensities were 71.8% and 42.8% of baseline situation, respectively.

Potential predictors associated with STH reinfections - univariate and multivariate analysis

The potential predictors of STH reinfections were investigated and the results are presented in Table 2. For these analyses, a child was considered to be re-infected if his/her fecal sample was found to be positive for any of the STH three species after 10-14 days after deworming. The results of univariate and multivariate analyses showed that females (χ^2=15.153, p=0.001), stunted children

Table 1
Reinfection rates and reinfection intensities of STH over a period of 6 months after deworming among Orang Asli schoolchildren in Pos Betau, Pahang (*n*=120).

	Ascaris	*Trichuris*	Hookworm
Baseline	65.8	97.5	10.8
3 months	18.9	38.7	3.6
6 months	48.1	65.7	5.6
Reinfection rates (%)[a]			
3 months	28.7	39.7	33.3
6 months	73.1	67.4	51.8
Reinfection intensities[b]			
Baseline	2.58	3.30	0.28
3 months	0.68	1.16	0.07
6 months	2.10	2.37	0.12

[a] Number of infected children after deworming/ number of infected children before deworming.
[b] Geometric mean counts of egg per gram feces.

Table 2
Potential predictors associated with STH reinfections among Orang Asli.

Variables	Reinfection rates of STH	
	At 3 months *n* (%)	At 6 months *n* (%)
Age		
≤10 years	40 (46.0)	67 (79.8)
>10 years	15 (62.5)	19 (79.2)
Gender		
Male	17 (30.9)	37 (68.5)
Female	38 (67.9) [a, b]	49 (90.7) [a, b]
Fathers' educational levels		
≥6 years formal education	20 (48.8)	31 (77.5)
No formal education	35 (50.0)	55 (80.9)
Mothers' educational levels		
≥6 years formal education	11 (50.0)	19 (90.5)
No formal education	44 (49.4)	67 (77.0)
Mothers' employment status		
Working	31 (57.1)	48 (90.5) [a, b]
Not working	24 (44.9)	38 (72.7)
Low household income		
<RM450/month	38 (45.8)	63 (78.8)
≥RM450/month	17 (60.7)	23 (82.1)
Family size		
≥8 members (large)	14 (56.0)	20 (80.0)
<8 members	41 (47.7)	66 (79.5)
Toilet in house		
Yes	10 (30.3)	23 (71.9)
No	45 (57.7) [a, b]	63 (82.9)
Source of drinking water		
Piped	48 (50.0)	77 (81.1)
Others (river, rain, well)	7 (46.7)	9 (69.2)
Have animals in house		
Yes	9 (37.5)	18 (78.3)
No	46 (52.9)	68 (80.0)
Nutritional status		
Stunted children	30 (61.2) [a]	42 (87.5)
Non-stunted children	25 (40.3)	44 (73.3)
Underweight children	26 (50.6)	37 (86.0)
Non-underweight children	29 (42.6)	49 (75.4)

n Represents the number of subjects
[a] Significant association ($p < 0.05$)
[b] Confirmed as significant predictors by logistic regression analysis

(χ^2=4.783, p=0.029) and those living in houses without toilets (χ^2=6.958, p=0.008) had significantly higher reinfection rates than others at 3 months following initial treatment. At 6 months, mothers' employment status joined the web of significant predictors where children of working mothers had significantly higher reinfection rates than other children (χ^2=4.984, p=0.026). In the output of logistic regression analysis, these factors were retained as significant risk factors of high reinfection rates while stunting was removed.

DISCUSSION

WHO (2006) estimated that more than two billion people are infected either by one or more of STH particularly *A. lumbricoides*, *T. trichiura* and hookworm. The prevalence is high among children in rural areas of developing countries in which the 400 million school-age children who are infected are often physically and intellectually compromised by malnutrition, leading to cognitive deficits, learning disabilities and high school absenteeism.

As is common in endemic areas, the STH reinfection rates reported by this study were very high and could be as high as 50% of the pre-treatment situation by the period of three months. By six months, the figure was very close to the pre-treatment situation. This may reflect the continuance of these infections in such areas as a result of the wide distribution of the infective stages of these parasites, continuing poor personal hygiene and lack of personal protection. In the same vein, the intensities of infections after 6 months were very close to the initial intensities and this reflect the magnitude of the problem in this community.

Studies carried out in Orang Asli communities reported that *Ascaris*, *Trichuris* and hookworm reinfections can occur as early as two months after treatment (Norhayati *et al*, 1995) and by four months almost half and one-tenth of the population treated become reinfected with *Ascaris* and hookworm, respectively (Norhayati *et al*, 1997a). Furthermore, studies in other part of the world reported that by six months the intensities of infection with *Ascaris* and *Trichuris* were similar to pre-treatment levels (Elkins *et al*, 1988; Albinco *et al*, 2003).

With STH the lack of sanitation may play an important role in the spread and transmission of the infections. Findings of the present study confirmed that the absence of a toilet in the house was identified as a significant predictor of STH reinfections. During the visits to the study areas, we observed that the personal hygiene of the children was poor as they swim in the rivers very closed to the defecation sites, play bare-footed, eat unwashed vegetables and fruits dropped onto the ground, eat without washing their hands and young children eat soil (geophagy). All these practices have been reported as risk factors of parasitic infections and reinfections elsewhere (Nishiura *et al*, 2002; Nematian *et al*, 2004; Saathoff *et al*, 2004; Quihui *et al*, 2006).

Employment status of mothers (working mother) was also identified as a significant predictor of high reinfection rate and this was compatible with the identified risk factors of STH among these children and abroad (Quihui *et al*, 2006). Absence of mothers during the daytime causes the loss of many child health care and hygiene provided by the mothers and gives more opportunities for young children to get exposed and infected as they play outdoors.

Although there was no significant difference in the prevalence of STH between males and females at baseline prior to deworming, the findings of this study showed that females were at higher risk of reinfection than males. Responsibilities of females in chores such as cleaning and washing the ground could make them more susceptible to be reinfected.

Malnutrition and parasitic diseases have a strikingly similar geographical distribution

with the same people experiencing both insults together for much of their lives (Crompton, 1986). In this study, we found that stunted children were more prone to be reinfected by STH than children with normal anthropometric measurements. This finding was in harmony with previous studies that ascariasis and trichuriasis are more prevalent among malnourished children (Hughes *et al*, 2004; Ulukanligil and Seyrek, 2004; Al-Mekhlafi *et al*, 2005).

In conclusion, the finding of high reinfection rates reported by this present study necessitate frequent and periodic (every 4 months) deworming among children to reduce parasitic loads, to alleviate morbidity and to reduce transmission. There is no doubt that reduction of intestinal parasitic reinfections would have a positive impact on health, nutrition and education of these children.

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