INTRODUCTION

The World Health Organization has estimated that more than one billion people and almost 10% of the world population are chronically affected by soil-transmitted helminthes (STH) or infected with Entamoeba histolytica (WHO, 1987). In Malaysia, Ascaris lumbricoides, Trichuris trichiura, hookworm, Giardia duodenalis and E. histolytica are the most common intestinal parasitic infections. Although the incidence of clinical consequences associated with these infections is very low, these infections are still a matter of public health concern in Malaysia because the prevalence and the intensity of these infections are still high. Furthermore, in Malaysia, the prevalence of intestinal parasitic infections is worse in low-income communities, which include aboriginal groups (Norhayati et al., 1997; Rahmah et al., 1997), rural poor Malays (Rahman, 1994; Norhayati et al., 1998a), children in estates (Oothuman et al., 1995) and squatter areas (Chan et al., 1992; Rajeswary et al., 1994; Rahman, 1998). An earlier study of Orang Asli villages in Selangor reported that the overall prevalences of ascariasis, trichuriasis and hookworm infection were 62.9, 91.7 and 28.8%, respectively (Norhayati et al., 1997). In the study, almost two-thirds of the children were infected with moderate to severe trichuriasis, 46.3% had moderate to severe ascariasis. In highly endemic areas of ascariasis, trichuriasis and hookworm infection, reinfection occurred as early as 2 months after treatment (Norhayati et al., 1995) and children remained predisposed to these infections over a number of reinfection periods (Norhayati et al., 2000). Moreover, intestinal parasitic infections interfere with nutrition, growth, cognitive function and educational performances in children.
The aim of this present study was to determine whether ascariasis, trichuriasis and hookworm infections are still prevalent in Orang Asli children in Selangor and to examine the distribution of these infections in this community.

MATERIALS AND METHODS

Subjects and study areas

This study was conducted among residents of 8 Orang Asli villages in the Districts of Gombak, Kuala Kubu Baru and Hulu Selangor in Selangor, Malaysia. Each village was comprised of a small population and the number of children in each village was estimated between 20 and 100. Most of the residents worked as laborers, farmers, or rubber tappers, and some did odd jobs, such as selling forest products. Most of the houses had electricity and piped water. A total of 281 children aged between 2 and 15 years (143 males and 138 females) participated in this study. Parents of all participating children consented to take part in this study after a clear explanation.

Fecal examination

Fecal samples were collected and examined by Kato-Katz technique for the presence of A. lumbricoides, T. trichiura and hookworm eggs. Egg counts were also done using this technique and the results were expressed as eggs per gram stool (epg).

Statistical analysis

Data obtained were analyzed using SPSS for windows (version 11.5, March 2002). Chi-squared test on proportion, one-way ANOVA and non-parametric test equivalent (Kruskal-Wallis 1-way ANOVA) were used for the data analysis.

Ethical aspects

This study was approved by the Research and Ethics Committee, Faculty of Medicine, Universiti Kebangsaan Malaysia, Malaysia.

RESULTS

Fecal smears from 281 Orang Asli children aged between 2 and 15 years were examined. The prevalences of ascariasis, trichuriasis and hookworm infection in these children according to intensity of infection are shown in Table 1. The overall prevalences of ascariasis, trichuriasis and hookworm infection were 61.9, 98.2 and 37.0%, respectively. Severe trichuriasis and ascariasis were found in 23.5% and 18.9% of these children, respectively. However, only 2.5% of the children had severe hookworm infection. The frequency of distribution by egg counts per person (estimated by epg) for hookworm was markedly broad with 88.6% of these children either not infected or having mild infection. However the frequency of distribution by egg counts per per-

Table 1

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

<table>
<thead>
<tr>
<th>Intensity of Infection</th>
<th>Ascariasis</th>
<th>Trichuriasis</th>
<th>Hookworm infection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. (%)</td>
<td>No. (%)</td>
<td>No. (%)</td>
</tr>
<tr>
<td>Negative</td>
<td>107 (38.1)</td>
<td>5 (1.8)</td>
<td>177 (63.0)</td>
</tr>
<tr>
<td>Mild infection</td>
<td>68 (24.2)</td>
<td>84 (29.9)</td>
<td>72 (25.6)</td>
</tr>
<tr>
<td>Moderate infection</td>
<td>53 (18.9)</td>
<td>126 (44.8)</td>
<td>25 (8.9)</td>
</tr>
<tr>
<td>Severe infection</td>
<td>53 (18.9)</td>
<td>66 (23.5)</td>
<td>7 (2.5)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>90 (62.9)</td>
<td>142 (99.3)</td>
<td>51 (35.7)</td>
</tr>
<tr>
<td>Female</td>
<td>84 (60.9)</td>
<td>134 (97.1)</td>
<td>53 (38.4)</td>
</tr>
<tr>
<td>Total</td>
<td>174 (61.9)</td>
<td>276 (98.2)</td>
<td>104 (37.0)</td>
</tr>
</tbody>
</table>
son for A. lumbricoides and T. trichiura was not widely dispersed with 62.3% and 31.7% of these children had either no infection or a mild infection, respectively.

Table 2 shows the distribution according to the type of infection. All children were infected with A. lumbricoides, T. trichiura or hookworm. Almost 27.0% of the children had single infection, while 73.0% of them had mixed infection. The most prevalent mixed infection was a combination of ascariasis and trichuriasis (35.6%), followed by a combination of ascariasis, trichuriasis and hookworm infection (24.5%), and trichuriasis and hookworm infection (12.1%). The least prevalent mixed infection was a combination of ascariasis and hookworm (0.4%).

The age-related prevalences and mean epg counts for ascariasis, trichuriasis and hookworm infection are shown in Figs 1 and 2. Ascariasis occurred in young children, with no significant change in the prevalence until age 8-10 years and reached a peak at 11-13 years. After that the prevalence declined slightly with age. Hookworm infection also occurred in young children age 2-4 years. There was a significant increase in the prevalence of hookworm infection with age that reached maximum at age 13 years and above ($\chi^2=11.476; p=0.022$). Compared to ascariasis and hookworm infection, the prevalence of trichuriasis was high in all age groups, ranging from 95.6% to 100.0%. Thus, there was no significant difference in the prevalence of ascariasis and trichuriasis in the different age groups. There was also no significant difference in the prevalence of ascariasis, trichuriasis and hookworm infection in males and females.

The overall mean epg counts for A. lumbricoides, T. trichiura and hookworm were 39,501.9 ± 51,458.1, 6,209.0 ± 7,106.3 and 1,688.7 ± 2,843.0, respectively. The mean epg
count for A. lumbricoides was low in the age group 2-4 years and rose steadily until age group 8-10 years. Following that the mean epg count stabilized. The mean epg count for T. trichiura was similar for all age groups. However the mean epg count for hookworm rose with age and reached a peak at age 8-10 years. Following that, the mean epg count decreased steadily with age. The mean epg count for hookworm was significantly related to age (Kruskal Wallis 1 way ANOVA $\chi^2=13.172$, $p=0.010$). However, the mean epg count for A. lumbricoides and T. trichiura did not show a significant change with age (ANOVA of log 10 transformed egg counts $F=0.569$, $p=0.689$; $F=1.465$, $p=0.123$). The mean epg count for A. lumbricoides, T. trichiura and hookworm were higher in females than males but the difference was not significant.

The correlation of the mean epg count for A. lumbricoides, T. trichiura and hookworm in individual children were analyzed using Kendall's rank correlation. The relationship is shown in Table 3. A strong positive correlation ($r_s=0.185$, $p<0.01$) between the mean epg counts for A. lumbricoides and T. trichiura passed by the same individual was observed. The same correlation was also seen when the data were stratified according to gender. A weak positive correlation ($r_s=0.100$, $p<0.05$) between mean epg count for T. trichiura and hookworm was also observed in this study but not between A. lumbricoides and hookworm. A positive correlation between mean epg counts for A. lumbricoides and T. trichiura was only seen in age groups of 2-4 and 8-10 years.

**DISCUSSION**

Ascariasis, trichuriasis and hookworm infection are still a major public health problem in poor communities in developing countries (Carla et al, 2000; J anabhai et al, 2001; Kabatereine et al, 2001; Raja'a et al, 2001; Azazy et al, 2002; Steven et al, 2003; Verla et al, 2003). The findings in this study confirm that ascariasis, trichuriasis and hookworm infection still remains endemic in Orang Asli communities in Malaysia, with all the children studied being infected by at least one species soil-transmitted helminthes (STH). The prevalence of STH in this present study is similar to the observations seen in Orang Asli children in Malaysia in an earlier study (Norhayati et al, 1997). However the prevalence of these infections in the present study was higher than recent studies carried out in other parts of the world (Carla et al, 2000; J anabhai et al, 2001; Kabatereine et al, 2001; Azazy et al, 2002; Steven et al, 2003; Verla et al, 2003).

Trichuriasis was found to be the commonest infection, with almost 98% of children being infected. This observation is in agreement with previous studies in Malaysia (Chan et al, 1992; Norhayati et al, 1997; Rahman, 1998). Observations in other parts of the world have recorded that ascariasis and hookworm infections are more common than trichuriasis (WHO, 1987; Gagandeep et al, 1998; Brooker et al, 1999;
Lwambo et al., 1999; Carla et al., 2000; Kabatereine et al., 2001; Steven et al., 2003; Verla et al., 2003). Resistance of moderate and severe trichuriasis to anthelmintic drugs, which are known to be prevalent in Malaysia (Norhayati et al., 1997, 1998b) may be one of the possible reasons for this.

The results of this study also confirm the prevalence of STH was higher among Orang Asli children living in peripheral Malaysia than those living in the interior part of this country (Rahmahn et al., 1997). Regular deworming, as part of the primary health care activities carried out in the interior settlement of Orang Asli, may be the reason for the observed difference. As expected, mixed infection was the commonest STH infections observed in this study (73.0%); 36% of the children were infected with a combination of trichuriasis and ascariasis and 25% were infected with a combination of trichuriasis, ascariasis and hookworm infection. The present study also confirms previous findings that the prevalence and mean epg counts for STH were not significantly different between genders (Chan et al., 1992; Al-Eissa et al., 1995; Norhayati et al., 1997). This suggests that there is no difference in socio-behavioral activity or immune status between males and females.

Another interesting finding of this present study was the high prevalence (37.0%) and proportion of severe hookworm infection cases (2.5%) compared to previous studies in Malaysia (Chan et al., 1992; Norhayati et al., 1997; Rahman, 1998). This present study also demonstrated a high percentage of children with severe trichuriasis (23.5%) and severe ascariasis (18.9%), which is in agreement with the study carried out in Orang Asli children before (Norhayati et al., 1997). The high percentage of children with severe infection with STH is clinically important because problems associated with this infection are proportional to the worm burden. Overt complications of soil-transmitted helminthiases, such as intestinal obstruction in severe ascariasis, or dysentery and rectal prolapse in severe trichuriasis, have been reported. It is well established that severe hookworm infection can lead to iron deficiency anemia (Hopkins et al., 1997; Stoltzfus et al., 1997; Brooker et al., 1999; Dreyfuss et al., 2000; Guyatt, 2000; Stoltzfus et al., 2000). Trichuriasis, with or without concomitant ascariasis, has been associated with malnutrition, iron deficiency anemia and growth stunting (Layrisse et al., 1967; Cooper et al., 1990; Robertson et al., 1992; Stephenson et al., 1993; Saldiva et al., 1999). Severe ascariasis has been associated with malnutrition (Thein-Hlaing et al., 1991, 1994; Stephenson et al., 1993; Saldiva et al., 1999). It is considered as a cause of acute abdominal pain in tropical countries (Anonymous, 1989; Thein-Hlaing et al., 1990; Kamiya, et al., 1993). In Malaysia, clinical features of severe trichuriasis have been described in a few studies (MacKay 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 below admitted to Hospital Kuala Lumpur (Mahmud, 1978).

The present study shows that the age-related prevalence of A. lumbricoides and T. trichiura is not significantly dependent on age and therefore these infections do not show age-prevalence convexity. This is because the prevalence of these infections was high in the younger age groups. The age-related mean epg count for T. trichiura also showed a similar pattern. Although age-related mean epg count for A. lumbricoides showed some convexity with age, the differences in the mean epg count in different age groups was not significant. This finding is in contrast to the results of previous studies carried out in Malaysia, (Bundy et al., 1988; Chan et al., 1992; Norhayati et al., 1997). The high prevalence and mean epg counts for ascariasis and trichuriasis in the younger age group was the reason why age-prevalence convexity and age-mean epg convexity were not seen in this study. Thus, in endemic areas where infection occurs at a very early age and reinfection is continuous throughout life, the prevalences and mean epg counts tend to be very high. Therefore, age-prevalence and age-mean epg convexity were not seen in this data. In contrast, the prevalences and mean epg counts for hookworm showed a significant increase with age and convexity with age. The differences in mode of infec-
tion and infectious stages with A. lumbricoides and T. trichiura may explain why hookworm infection tends to occur in older age groups and shows convexity with age.

A positive correlation in mean epg counts for A. lumbricoides, T. trichiura and hookworm within individuals was seen. It was not surprising to observe a strong significant correlation between A. lumbricoides and T. trichiura due to the similar mode of infection and high prevalence and mean epg counts for both species in the community. However, a weak positive correlation was also seen between hookworm and T. trichiura despite the different mode of transmission. This suggests that both the prevalence and mean epg counts in an infection are important factors in this correlation. There was no correlation between A. lumbricoides and hookworm. This may reflect the low prevalence and mean epg counts for hookworm in the community. A similar trend in correlation has been reported before in Malaysia (Norhayati et al, 1997) as well as in studies conducted in other countries (Holland et al, 1989; Ferreira et al, 1994).

In conclusion, this study shows that ascariasis, trichuriasis and hookworm infection are still prevalent, and are of public health concern in Orang Asli communities living in the periphery of this country. The high prevalence of children with severe ascariasis and trichuriasis may lead to other health and medical problems, such as micronutrient deficiency (iron deficiency anemia, vitamin A deficiency), protein-energy malnutrition, poor school performance and other acute illnesses among the children. Trichuriasis, which affected almost all the children in this community, has important implications for the control of STH because of its resistance to many anthelmintics.

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