THE PREVALENCE OF *TRICHURIS, ASCARIS* AND HOOKWORM INFECTION IN ORANG ASLI CHILDREN

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Abstract. A community study on the age and sex related prevalence, intensity infection and frequency distribution of *Ascaris, Trichuris* and hookworm was carried out in 205 Orang Asli (Aborigines) children (95 boys, 110 girls) aged 1-13 years. The overall prevalence of *Ascaris, Trichuris* and hookworm was 62.9%, 91.7% and 28.8%, respectively. Almost two-thirds of the children were infected with moderate and severe intensity infection of *Trichuris,* 46.3% had moderate to severe intensity infection of *Ascaris.* However only 1.5% had moderate intensity of hookworm infection. The prevalence and mean intensity infection (measured by eggs per g) of *Ascaris* was age-dependent; lower in age group 1-4 years reached peak and stable at age group 5 years and above. The prevalence of *Trichuris* was high in all age groups and it fluctuated with age; the mean intensity of infection of *Trichuris* (measured by eggs per g) was age-dependent. Hookworm infection also rose with age and reached peak at 5-6 years, following that the prevalence declined. The frequency distributions of *Ascaris,* and hookworm were overdispersed. A strong positive correlation ($p < 0.001$) were observed between *Ascaris* and *Trichuris* and between hookworm and *Trichuris.* A positive correlation ($p < 0.01$) were also observed between *Ascaris* and hookworm.

INTRODUCTION

Several studies have demonstrated a high prevalence of *Ascaris, Trichuris* and hookworm (soil-transmitted helminths, STH) infection in Orang Asli (Aborigines) children (Bisseru and Aziz 1970; Che Ghani and Oothuman, 1991; Osman and Zaleha, 1995); where the prevalence of *Ascaris, Trichuris* and hookworm ranged between 30.2-69.0%, 15.8-80.9% and 9.4-51.0%, respectively. Studies on other underprivileged communities in Malaysia also showed a high prevalence of STH infection in children (Sinniah *et al,* 1978; Zahedi *et al,* 1980; Kan and Poon, 1987; Kan, 1989, Bundy *et al,* 1988; Hanjeet *et al,* 1991; Li, 1990; Che Ghani and Oothuman, 1991).

Previous studies have shown a significant association between age and prevalence and intensity of *Ascaris* and *Trichuris* infection; prevalence and intensity of infection is concentrated among children age 4-15 years of age (Kan and Poon, 1987; Bundy *et al,* 1988). However no significant association between gender and prevalence and intensity of *Ascaris, Trichuris* and hookworm infection were found although studies also showed that the prevalences were higher in boys (Kan and Poon, 1987; Bundy *et al,* 1988).

The purpose of this study was to determine the age and sex related prevalence, intensity of infection and frequency distribution of *Ascaris, Trichuris* and hookworm infection among 1-13 years old Orang Asli children.

MATERIALS AND METHODS

This study was conducted in residents of 6 Orang Asli villages in the District of Dengkil, Selangor, Malaysia situated about 50 km from Kuala Lumpur. Each village comprised a very small population and most of the residents worked as palm oil estate laborers, rubber tappers, farmers and persons doing odd jobs such as fishing and selling forest product. Most of them lived in single-roomed houses made of bamboo and wood. Almost all houses in the 6 villages had no electricity, no pipe water and had no toilet facilities. The residents used well or river water for daily use and defecated in open ground among the bushes.

Children who had taken some form of anthelminthic two months prior to stool examination were excluded from this study. In all 205 children aged 1-13 years old (95 boys and 110 girls) participated in this study. Stool specimens were collected and

examined by Kato-Katz method for the presence of STH eggs. Harada-Mori culture was also done on all stool samples to identify hookworm species and also to detect *Strongyloides stercoralis* larvae if present, then examined 7 days later. Egg counts were also done using Kato-Katz technique and the results expressed as eggs per g of stool (epg).

Chi-squared test on proportion, one-way ANOVA and non-parametric test equivalent (Kruskal-Wallis 1-way ANOVA and Mann-Whitney) were used for the analysis of data. Data were analyzed using SPSS for Windows (Version 6.0, 1993).

Age-related prevalence and intensity of *Ascaris, Trichuris* and hookworm are shown in Fig 1a, 1b. *Ascaris* infection occurred in young children, aged 1-2 years and there was an increase in the prevalence with age until it peaked and stabilized at 5 years and above. Hookworm infection also occurred in young children aged 1-2 years. There was an increase in the prevalence with age until it peaked at 5-6 year-old children and a decline in older groups. Compared to *Ascaris* and hookworm infection the prevalence of *Trichuris* in 1-2 year-old was high with 70.5% of the children infected. The prevalence of *Trichuris* in subsequent groups fluctuate with age; with prevalence ranging be-

Table 1

Prevalence of intensity of infection by individual species of *Ascaris, Trichuris* and hookworm.

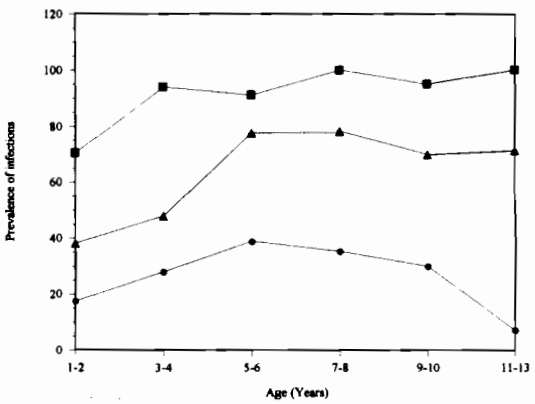
Intensity of infection	Species			
	Ascaris[a] n (%)	*Trichuris*[b] n (%)	Hookworm[c] n (%)	Hookworm[d] n (%)
Negative	76 (38.5)	17 (8.3)	155 (75.6)	146 (71.2)
Mild infection/Positive	48 (23.4)	49 (23.9)	47 (22.9)	59 (28.8)
Moderate infection	34 (23.4)	77 (37.6)	3 (1.5)	-
Severe infection	47 (22.9)	62 (30.2)	-	-

[a,b,c] : According WHO (1987) classification
[d] : Identification using Harada-Mori

RESULTS

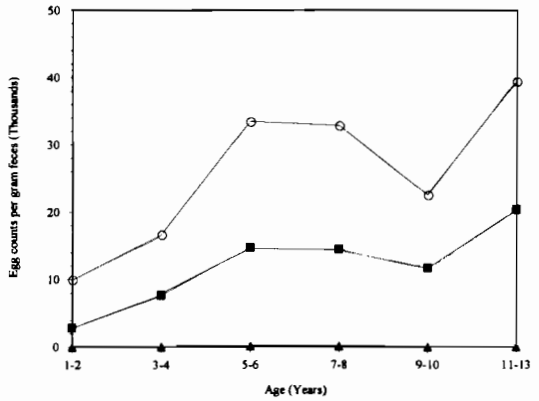
Table 1 shows the prevalence of STH infection in the population by individual species according to intensity of infection. Overall prevalence of *Ascaris, Trichuris* and hookworm infection was 62.9%, 91.7% and 28.8%, respectively. Following the criteria proposed by the World Health Organization (WHO, 1987), 22.9% and 30.2% of the children had severe infection of *Ascaris* and *Trichuris* respectively. All children infected by hookworm had mild to moderate infection.

Almost one quarter (22.4%) of the children were infected either by *Ascaris* or *Trichuris*. The most prevalent of mixed infection was a combination of *Ascaris* and *Trichuris* (36.1%), followed by a combination of *Ascaris, Trichuris* and hookworm (25.9%). The least prevalent mixed infection was a combination of *Trichuris* and hookworm (7.3%).



Type of STH infections: ▲ *Ascaris*; ■ *Trichuris*; ● Hookworm

Fig 1a–Prevalence of soil transmitted helminths with age.



Type of STH infections:⊖*Ascaris*;■ *Trichuris*;▲ Hookworm

Fig 1b–Intensity infection of soil transmitted helminths with age.

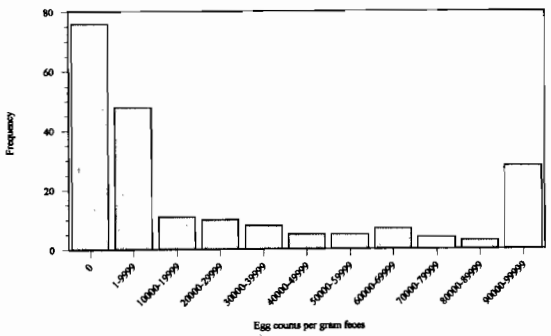


Fig 2a–Frequency distribution of infection (measured by epg) of *Ascaris* in the total sample of Orang Asli children (n = 205).

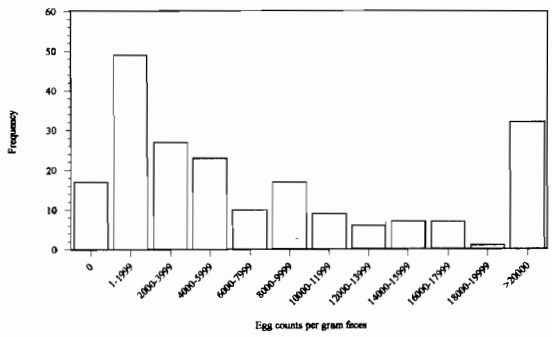


Fig 2b–Frequency distribution of infection (measured by epg) of *Trichuris* in the total sample of Orang Asli children (n = 205).

tween 90.0-100.0%. There was a significant difference in the prevalence of *Ascaris* and *Trichuris* among age groups ($X^2_s = 35.012$, p = 0.00245; X^2 =

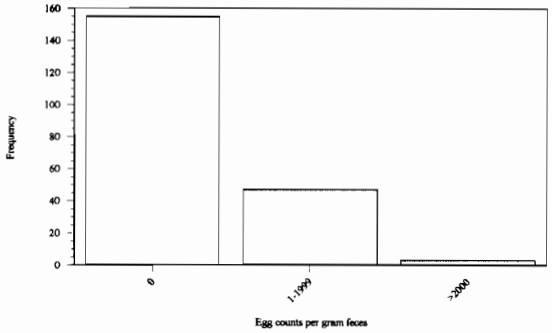


Fig 2c–Frequency distribution of infection (measured by epg) of hookworm in the total sample of Orang Asli children (n = 205)

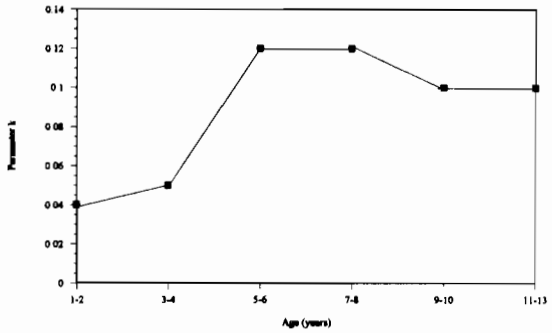


Fig 3a–Aggregation parameter, k, of *Ascaris* egg counts (epg) within groups stratified by age.

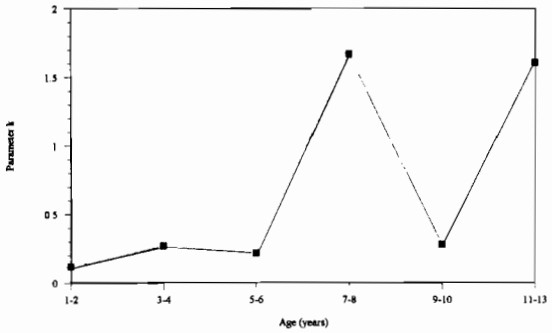


Fig 3b–Aggregation parameter, k, of *Trichuris* egg counts (epg) within groups stratified by age.

54.477, p = 0.0000). However there was no significant difference in the prevalence of *Ascaris* and *Trichuris* in males and females. There was no significant difference in the prevalence of hookworm among the various age groups and between genders.

Mean intensity (epg) of *Ascaris* was low in the age group 1-2 years. The mean intensity increase

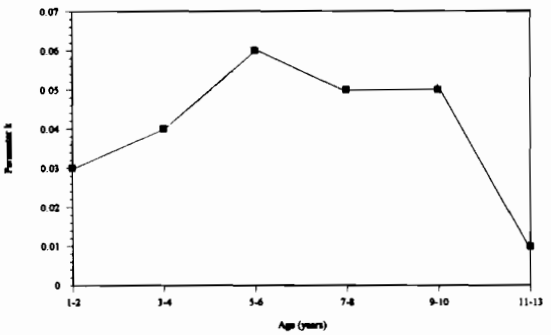


Fig 3c–Aggregation parameter, k, of hookworm egg counts (epg) within groups stratified by age.

with age until it peaked at 5-6 year-old then declined and reached a peak at 11-13 year-old. Mean intensity (epg) of *Trichuris* also showed the same trend as *Ascaris*. The mean intensity infection of *Ascaris* showed a significant increase with age (Kruskal-Wallis 1-way ANOVA F = 22.1330, p = 0.0005). A significant increase of mean intensity of *Trichuris* with age was also seen in this study (ANOVA of log 10 transformed egg counts F = 6.0518, p = 0.0000). However there was no significant difference in the mean intensity of *Ascaris* and *Trichuris* between gender and these was no significant difference in the mean intensity of hookworm with age and gender.

Frequency distribution of egg counts per person (estimated by epg) of *Ascaris* and hookworm was markedly overdispersed. The arithmetic means for infected and non-infected children estimated by epg for *Ascaris* and hookworm were 24,682 epg and 111 epg, respectively. However, for *Trichuris* infection, the frequency distribution of egg counts per person (estimated by epg) was not overdispersed; the arithmetic means for infected and non-infected children estimated by epg was 11,074 epg; this indicated that an overall the children had severe infection of *Trichuris* infection (Fig 2a, 2b, 2c). Estimation of the exponent (k), indicated that, frequency distribution of egg counts for *Ascaris, Trichuris* and hookworm infection was age-dependent; for *Ascaris* infection, the highest aggregation was seen in 1-4 years age group; in contrast, for hookworm infection the parasites is highly aggregated in the older age group. For *Trichuris* infection highest aggregation was seen in the 1-4 years age group and the 9-10 years age group. (Fig 3a, 3b, 3c).

The relationship between the mean intensities of *Ascaris, Trichuris* and hookworm in individual children was investigated by analysis of egg counts using Kendall's rank correlation (Table 2). A strong positive correlation ($r_s = 0.2783$, $p < 0.0001$) between epg of *Ascaris* and *Trichuris* passed by the same individual was observed. The correlation persisted even when stratification by gender was done. A strong positive correlation ($r_s = 0.2268$, $p < 0.0001$) between *Trichuris* and hookworm was seen; a significant correlation was also seen when stratification by gender was done. There was a less significant correlation between *Ascaris* and hookworm than those *Ascaris* and *Trichuris* ($r_s = 0.1955$, $p < 0.01$). This correlation remained significant when stratification by gender was done.

DISCUSSION

This study indicates that *Ascaris, Trichuris* and hookworm infection in Orang Asli children remains prevalent, with almost one-quarter and one-third of the children had severe infection of *Ascaris* and *Trichuris*, respectively. Bisseru and Aziz (1970) studied 1-12 year-old Orang Asli children, recording prevalences of 69.0%, 80.0% and 51.0% for *Ascaris, Trichuris* and hookworm, respectively. In another study on preschool Orang Asli children the prevalence of *Ascaris, Trichuris* and hookworm was 41.9%, 53.6% and 11.7%, respectively (Che Ghani and Oothuman, 1991). In a recent study among 2-6 year-old Orang Asli's prevalence of 30.2%, 30.2% and 9.4% for *Ascaris, Trichuris* and hookworm respectively was recorded (Osman and Zaleha, 1995). Studies of children 0-15 year-old in urban slums indicated that the prevalence of *Ascaris, Trichuris* and hookworm was 49.6%, 62.8% and 5.3%, respectively (Bundy *et al*, 1988) and 45.6%, 60.8% and 44.4% (Kan and Poon, 1987).

The high prevalence and intensity of STH in this study suggested that intestinal helminthiases were important to the health of Orang Asli children. Poor environmental sanitation, unsatisfactory level of knowledge on health care and personal hygeine and poverty may be important factors why the prevalence and intensity of STH is persistently high in Orang Asli, as shown by this finding and previous studies. Studies in Sri Lanka showed that prevalence of STH tended to increase as the socioeconomic class and mothers education level declined

Table 2

Correlation applied to fecal egg-counts (egg per g) of *Ascaris, Trichuris* and hookworm according to gender and age groups.

Age groups (years)	n	*Ascaris* & *Trichuris*	*Ascaris* & cacing kait	Hookworm & *Trichuris*
All	205	0.2783[d]	0.1955[b]	0.2268[d]
Gender				
Males	95	0.2445[b]	0.2203[b]	0.2149[b]
Females	110	0.3086[d]	0.1774[a]	0.2290[b]
Age groups				
1-2	34	0.3086[b]	0.2758	0.2198
3-4	50	0.1346	-0.0191	0.1421
5-6	36	0.4362[d]	0.3866[a]	0.2263
7-8	51	0.1501	0.2276[a]	0.1219
9-10	20	0.2687	0.1646	0.0987
11-13	14	-0.0796	-0.1439	0.5255[a]

[a]: Significant correlation $p < 0.05$
[b]: Significant correlation $p < 0.01$
[c]: Significant correlation $p < 0.001$
[d]: Significant correlation $p < 0.0001$

(de Silva *et al,* 1996). Similar findings were also reported by Kan *et al* (1992).

Our data showed that the prevalence and intensity infection of *Ascaris* and *Trichuris* was significantly associated with age. The prevalence and intensity of infection of *Ascaris* rose with age, was lower in the 1-4 years age group and remained high at the age of 5 years and above. Similar observations were also seen in slum urban communities in Malaysia (Kan and Poon, 1987; Bundy *et al,* 1988). As for *Trichuris* infection, the prevalence fluctuated and persistently high (>70.0%) in all age groups. This finding was different from the report of Bundy *et al* (1988), which showed age-prevalence convexity. The high prevalence of *Trichuris* in the 1-4 years age group was the reason why the age-prevalence convexity was not seen in this data. However, age-intensity infection of *Trichuris* showed some convexity with age. Although *Ascaris* and *Trichuris* have similar modes of infection and infectious stages, the prevalence and intensity of infection of *Trichuris* in this community was much higher. The long life span of *Trichuris* compared to *Ascaris* and resistance of *Trichuris* to many anthelminthic drugs (Foo *et al*, 1989; Albonico *et al*, 1994) may be the reasons for the difference. The prevalence and intensity of infection of hookworm also rose with age, being lower in the 1-4 years age group, peaking in the 5-8 years age group and declining at the age of 9 years and above. In other studies where all age groups were included, it was shown that the prevalence of hookworm increased rapidly with age and stabilized or became lowered in the older groups (Haswell-Elkins *et al*, 1988; Pritchard *et al*, 1990; Bradley *et al*, 1992).

This study show that, the prevalence and intensity of infection of *Ascaris, Trichuris* and hookworm were not significantly different between genders. This indicates that there is no difference in socio-behavioral activity and may be immune status between boys and girls in this community. Similar findings on prevalence were also reported by Kan (1982, 1989), Kan and Poon (1987) and Bundy *et al* (1988) and on intensity of infection by Bundy *et al* (1988). Findings similar to ours were reported earlier from the West Indies, Panama, Macau, Brazil and Saudi Arabia (Bundy *et al*, 1987; Holland *et al*, 1987; Chan, 1992; Ferreira *et al*,

1994; Al-Eissa *et al*, 1995) but other different reports have come from studies in southern India (*Ascaris* and hookworm) and Zimbabwe (hookworm) (Elkins *et al*, 1988; Haswell-Elkins *et al*, 1988; Bradley *et al*, 1992; Gnana Mani *et al*, 1993).

This study suggested that the frequency distribution of *Ascaris* and hookworm is overdispersed and highly aggregated. The current estimate of k for *Ascaris* and hookworm is much lower than in previous studies (Croll *et al*, 1988; Chai *et al*, 1985; Elkins *et al*, 1988; Bundy *et al*, 1988) which indicates that aggregation occurred in this study population. The estimate k for *Trichuris* is consistent with other studies (Bundy *et al*, 1985, 1987, 1988).

A strong positive correlation between egg counts (epg) of *Ascaris, Trichuris* and hookworm within individual children was seen. It was not surprising to observe a strong significant correlation between *Ascaris* and *Trichuris* due to the similar mode of infection and high prevalence and egg counts of the both species in the community. However despite the different mode of transmission between hookworm and *Trichuris* a strong and positive correlation was also seen. This suggests that both prevalence and intensity of an infection are important factors in this correlation. The correlation of *Ascaris* and hookworm was weak and this may reflect the low prevalence and intensity of hookworm infection in this community. A strong positive correlation between *Ascaris* and *Trichuris* and between *Trichuris* and hookworm was reported by Holland *et al* (1989). A similar correlation between *Ascaris* and *Trichuris* was also reported by Ferreira *et al*, (1994), but not by Bundy and Cooper (1989).

Our study has shown that the prevalence and intensity of infection of *Ascaris, Trichuris* and hookworm in this community was high compared to earlier studies in other underprivileged communities (Kan, 1982; Kan and Poon, 1987; Bundy *et al*, 1988; Che Ghani and Oothuman, 1991; Oothuman *et al*, 1992). *Trichuris* is the most prevalent infection with almost two-thirds of children having moderate to severe infection. This will have important implications in the control of STH, as moderate to heavy infections of trichuriasis show resistance to many broadspectrum anthelminthics (Foo *et al*, 1989; Albonico *et al*, 1994). The prevalence and intensity of infection of *Ascaris* and *Trichuris* were age-dependent; intensity of infection was low in the younger age group (1-4 years old) and high in the older age group (5-13 years old). Studies in India and Myanmar reported that 65% of the worm in the community were harbored by children aged 4-15 years old (Elkins *et al*, 1986; Elkins *et al*, 1988; Thein-Hlaing, 1985). Periodic targeted treatment of preschool and primary school children in the Orang Asli community using effective broadspectrum anthelminthics will reduce the worm burden and give maximum impact to the control of STH in this community.

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REFFERENCES

Al-Eissa YA, Assuhaimai SA, Abdullah AMA, Abo Bakar AM, Al-Husain MA, Al-Nasser MN, Al-Borno MK. Prevalence of intestinal parasites in Saudi Arabia; a community base-study. *J Trop Pediatr* 1995; 41 : 47-9.

Albonico M, Smith PG, Hall A, Hababu MC, Alawi KS, Savioli L. A randomized controlled trial comparing mebendazole and albendazole against *Ascaris, Trichuris* and hookworm infections. *Trans R Soc Trop Med Hyg* 1994; 88 : 585-9.

Bisseru B, Aziz AA. Intestinal parasites, eosinophilia, haemoglobin and gamma globulin of Malay, Chinese and Indian school children. *Med J Malay* 1970; 25 : 29-33.

Bradley M, Chandiwana SK, Bundy DAP, Medley GF. The epidemiology and population biology of *Necator americanus* infection in a rural community in Zimbabwe. *Trans R Soc Trop Med Hyg* 1992; 86 : 73-6.

Bundy DAP, Cooper ES. *Trichuris* and trichuriasis in human. *Adv Parasitol* 1989; 28 : 107-73.

Bundy DAP, Thompson DE, Cooper ES, Golden MHN, Cooper ES, Anderson RM. Population dynamics and chemotherapeutic control of *Trichuris trichiura* infection in Jamaican and St Lucia. *Trans R Soc Trop Med Hyg* 1985; 79 : 759-64.

Bundy DAP, Cooper ES, Thompson DE, Anderson RM, Didier JM. Age related prevalence and intensity of

Trichuris trichiura infection in St Lucian community. *Trans R Soc Trop Med Hyg* 1987; 81 : 85-94.

Bundy DAP, Kan SP, Rose R. Age related prevalence, intensity and frequency distribution of gastrointestinal helminths infection in urban slum children from Kuala Lumpur, Malaysia. *Trans R Soc Trop Med Hyg* 1988; 82 : 289-94.

Chai JY, Kim KS, Hong ST, Lee SH, Seo BS. Prevalence, worm burden and other epidemiological parameters of *Ascaris lumbricoides* infection in rural communities in Korea. *Korean J Parasitol* 1985; 23 : 241-6.

Chan C-T. Family influence on the prevalence of soil-transmitted helminthiasis among Chinese children in Macao. *Trop Biomed* 1992; 9 : 9-14.

Che Ghani BM, Oothuman P. Patterns of soil-transmitted helminth infection in relation to types of water supply, housing facilities and availability of latrines in rural areas of peninsular Malaysia. In: Yokogawa M *et al*, eds. Collected Papers on the Control of Soil-transmitted Helminthiasis Vol V. Tokyo: APCO, 1991: 64-71.

Croll NA, Anderson RM, Gyorkos TW, Ghadirian E. The population biology and control of *Ascaris lumbricoides* in a rural community in Iran. *Trans R Soc Trop Med Hyg* 1982; 76 : 187-99.

de Silva NR, Jayapani VPP, de Silva HJ. Socioeconomic and behavioral factors affecting the prevalence of geohelminths in preschool children. *Southeast Asian J Trop Med Public Health* 1996; 27 : 36-42.

Elkins DB, Haswell-Elkins MR, Anderson RM. The epidemiology and control of intestinal helminths in the Pulikat Lake region of Southern India 1. Study design and pre- and post-treatment observation on *Ascaris lumbricoides* infection. *Trans R Soc Trop Med Hyg* 1986; 80 : 774-92.

Elkins DB, Haswell-Elkins MR, Anderson RM. The importance of host age and sex to patterns of reinfection with *Ascaris lumbricoides* following mass anthelmintic treatment in a South Indian fishing community. *Parasitology* 1988; 96 : 171-84.

Ferreira CS, Ferreira MU, Noguera MR. The prevalence of infection by intestinal parasites in an urban slum in Sao Paulo, Brazil. *J Trop Med Hyg* 1994; 97 : 121-7.

Foo LC, Lai PF, Khalid H. Efficacy of albendazole against the three common soil-transmitted helminthiasis. *Trop Biomed* 1989; 6 : 133-6.

Gnana Mani G, Tata Rao S, Modhavi R. Estimation of hookworm intensity by anthelminthic expulsion in primary school children in a rural community in Zimbabwe. *Trans R Soc Trop Med Hyg* 1993; 87 : 634-5.

Haswell-Elkins MR, Elkins D, Anderson RM. An investigation of hookworm infection and reinfection following mass anthelminthic treatment in the South Indian fishing community of Vairavankuppam. *Parasitology* 1988; 98 : 565-77.

Hanjeet K, Lai PF, Ow Yang CK, Mathias RG. Soil-transmitted helminthiases in squatter populations around Kuala Lumpur by ethnic distribution. *Trop Biomed* 1991; 8 : 33-7.

Holland CV, Crompton DWT, Taren DL, Neshiem MC, Sanjur D, Barbeau I, Tucker K. *Ascaris lumbricoides* in preschool children from Chiriqui Province, Panama. *Parasitology* 1987; 95 : 615.

Holland CV, Asaolu SO, Crompton DWT, Stoddart RC, MacDonald R, Torimiro SEA. The epidemiology of *Ascaris lumbricoides* and other soil-transmitted helminths in primary school children from Ife-Ife, Nigeria. *Parasitology* 1989; 99 : 275-85.

Kan SP. Soil-transmitted helminthiasis in Selangor. *Med J Malay* 1982; 37 : 180-90.

Kan SP, Poon GK. Prevalence, distribution and intensity of soil-transmitted helminthiasis among Malaysian children. *Public Health* 1987: 101 : 243-51.

Kan SP. Soil-transmitted helminthiasis among habitants of an oil palm plantation in West Malaysia. *J Trop Med Hyg* 1989; 92 : 263-9.

Li CF. Hookworm infection and protein energy malnutrition: Transverse evidence from two Malaysian ecological groups. *Trop Geogr Med* 1990; 42 : 8-12.

Oothuman P, NoorHayati MI, Mohammod CG, *et al*. The prevalence and reinfection of intestinal helminthiases among primary schoolchildren in Cocoa Estate - 1991. In: Yokogawa M, *et al*., eds. Collected Papers on the Control of Soil-transmitted Helminthiasis 1992; Vol V. Tokyo: APCO, 1992; 258-64.

Osman A, Zaleha M.I. Nutritional status of women and children in Malaysia rural population. *Asia Pacific J Clin Nutr* 1995; 4 : 319-24.

Pritchard DI, Quinnell RJ, Slater AFG, *et al*. Epidemiology and immunology of *Necator americanus* infection in community in Papua New Guinea: humoral responses to excretory-secretory and cuticular collagen antigens. *Parasitology* 1990; 100 : 317-26.

Sinniah B, Sinniah D, Manmohan S, Poon GK. Prevalence of parasitics infection in Malaysian oil palm estate workers. *Southeast Asian J Trop Med Public Health* 1978; 9 : 272-6.

Statistical Package for Social Science, for Windows (Release 6.0). SPSS Inc Chicago, Illinois, 1993.

Thein-Hlaing. *Ascaris lumbricoides* infection in Burma. In: Crompton DWT, Neshiem MC, Pawlowski ZS,

eds. Ascariasis and its public health significance. London: Taylor and Francis 1985 : 83-112.

WHO. Prevention and control of intestinal parasitic infections. Geneva: World Health Organization. *WHO Tech Report Ser* 1987; 749.

Zahedi M, Oothuman P, Sabapathy NN, Bakar NA. Intestinal nematode infections and efficacy study of oxantel-pyrantel pamoate among plantation workers. *Med J Malay* 1980; 35 : 31-7.