ASCARIASIS, TRICHURIASIS, AND GROWTH OF SCHOOLCHILDREN IN NORTHEASTERN PENINSULAR MALAYSIA

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Abstract. A study to determine the effect of antihelminthic treatment on growth and nutritional status was undertaken on 103 children in the second grade of primary school, 71 of whom were found to be infected with *Ascaris lumbricoides* or *Trichuris trichiura*. The median *Ascaris* and *Trichuris* intensities in the infected group were 19,600 (range; 0 - 488,000) and 2,800 (range; 0 - 84,600) eggs per gram of feces respectively. Forty-three children habored both types of worm. Fourteen weeks after two 400 mg doses of albendazole were administered to infected children, the increases in weight, height, weight for age, height for age and weight for height were significantly higher among infected children than controls who were uninfected at baseline. The observed gains were independent of sex and socioeconomic status. Decrease in log transformed *Trichuris* intensity correlated with increases in weight (r=0.24; p=0.02) and weight for age (r=0.20; p=0.06) but decrease in *Ascaris* intensity did not correlate with increases in any of the anthropometric parameters. The results suggest that antihelminthic treatment has beneficial short-term effects on growth and nutritional status of a modest magnitude among early primary schoolchildren in the area.

INTRODUCTION

It is estimated that a quarter of the world's population is infected with the intestinal geohelminths *Ascaris lumbricoides, Trichuris trichiura* or hookworm, a significant proportion of whom are children of primary school going age (Waren *et al,* 1993). The aim of the current study was to determine the effects of antihelminthic treatment on short term growth and nutritional status among primary schoolchildren in North-eastern Peninsular Malaysia where ascariasis and trichuriasis are endemic but the prevalence of hookworm is relatively low. Given the global scale of intestinal helminth infections, the data on children of school going age in areas endemic for ascariasis and trichuriasis but with little or no hookworm infection is still rather limited and the results variable (Lai *et al,* 1995; Simeon *et al,*1995; Hadju *et al,* 1996; Koroma *et al,* 1996; Watkins and Pollitt, 1996; Hadju *et al,* 1997).

MATERIALS AND METHODS

The subjects consisted of 103 children in the second grade of a primary school located on the outskirts of the town of Kota Bharu, in North-eastern Peninsular Malaysia. All 117 children in the second grade of the school were targetted for the study but stool samples were submitted by only 104 children, one of whom shifted to another area mid-way through the follow-up period. The children were drawn from a community engaged predominantly in small scale farming. Stool samples collected at baseline were examined for helminth eggs. Egg counts were made by a modification of Stoll's method and expressed as eggs per gram (epg) of feces (Garcia and Bruckner, 1988). All infected children were treated with two 400 mg doses of albendazole administered a week apart under direct supervision. Vertical height and weight were measured at baseline and 14 weeks after the second dose of albendazole. Weight was measured using a portable weighing machine (Tanita, model 1567, Japan) which electronically displays a reading to the nearest 0.2 kg. Height was recorded to the nearest 0.1 cm by a single observer who was blind to the infection status of the children and with a single instrument. The coefficient of variation of height readings based on two sets of readings on 30 children repeated in random order was 0.25%. Height for age (HA), weight for age (WA) and weight for height (WH) were computed using the anthropometric program in Epiinfo version 6 (WHO, Geneva and CDC Atlanta, USA); and expressed as a Z-score which is equivalent to the

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standard deviation units from the median of the reference population (Dibley *et al,* 1987). The infected and uninfected groups were compared with respect to increase in the height and weight parameters between the first and second measurements. Stool examination was repeated during a 2 week period after the second measurement.

A socio-economic score was computed for each child based on household income, father's occupation, number of dependents in the household, type of housing, facilities within the house and the type of vehicle owned by the family. This information was volunteered by the parents or guardians and available from the school records. Based on the score, each child was categorized into one of three socio-economic groups, category 3 being the most disadvantaged. Informed consent was obtained from the parents or guardians of all children. The study was approved by the research and ethics committee of the School of Medical Sciences, Universiti Sains Malaysia.

Statistical analysis

The x^2 test was used to test the association between infection and socioeconomic status. The summary statistics used for skewed data were the median and quartile deviation (qd) which is half the interquartile range. The Mann-Whitney U test was used to test differences in anthropometric parameters between infected and uninfected groups. Assessment of the independent influence of treating worm infection on increases in WA, HA and WH was assessed using Mantel Haenzel stratified analysis for which the continuous outcome variables were collapsed into dichotomous string variables by dividing at the 50^{th} percentile value. Significance values were two-tailed in all instances. Simple linear regression analysis was used to examine the extent to which baseline log transformed egg counts (*ie* log *epg* + 1) and decrease in log transformed egg counts predicted the increase in anthropometric parameters. Statistical computations were undertaken with the aid of the Epiinfo version 6 (WHO, Geneva and CDC, Atlanta, USA) and SPSS for Windows software programs.

RESULTS

Demographic and worm infection data

As Table 1 shows, infected and uninfected groups were comparable in terms of age and sex ratio. Only one child (an uninfected subject) fell into the first socioeconomic category; the rest being in either group 2 or 3. Infection was associated with lower socioeconomic status (Table 1). The infection prevalence rates and intensities at baseline and on follow-up are summarized in Table 1. Mixed infections were found in 43 children. Eleven children had heavy trichuriasis (> 10,000 epg) and 22 had heavy ascariasis (>50,000 epg). The median *Ascaris* intensity among the children infected with *Ascarsis* per se was 44,000 epg (range 400-488,000); while the median *Trichuris* intensity among *Trichuris* infected subjects was 4,000 epg (range 400-84,000). All but 8 subjects submitted stool for re-examination at follow-up. Twelve initially uninfected children were found to be infected at follow-up, although the intensity of infection was generally lighter. In the treated subset, reduction in *Ascaris* prevalence and intensity was more marked than that of *Trichuris* infection (Table 1). No hookworm infection was detected.

Baseline nutritional status and subsequent growth

There was no significant difference in baseline HA, WA or WH between the infected and control groups (Table 2). Infected children however experienced significantly higher changes in HA, WA, WH and raw weight than controls (Table 2). Stratified analyses (after scaling changes in WA, HA and WH into dichotomous variables) showed that treatment was associated with relative gains in WA, and WH independent of socioeconomic status and sex while the gain in HA approached significance (Table 3). Serial simple linear regression analyses showed that log transformed baseline *Trichuris* egg counts predicted increases in HA ($r = 0.20$; $p=0.04$), raw height ($r=0.19$; $p=0.06$) and WA ($r=0.18$; $p=0.07$). The decrease in log transformed *Trichuris* intensity between examinations predicted increases in raw weight ($r=0.24$; $p=0.02$) and WA ($r=0.20$; $p=0.06$). Baseline *Ascaris* intensity and decrease in intensity did not significantly predict increases in any of the anthropometric parameters.

DISCUSSION

It is acknowledged that the ideal design for a study of this nature would have been randomized,

Table 1

Demographic data, infection prevalence and intensity.

Group	Uninfected (n=32)	Infected (n=71)
Mean age (SD), years	8.2 (0.2)	8.2(0.2)
Number of girls (%)	17 (53.1%)	35 (49.3%)
Number in social class 3 (%)	3 (9.4%)	28 (39.4%)*
Ascaris prevalence rate, %:		
baseline	-	53/71 (74.6%)
follow-up	2/29 (6.9%)	26/66 (39.4%)
Trichuris prevalence rate, %:		
baseline	-	61/71 (85.9%)
follow-up	11/29 (37.9%)	52/66 (78.8%)
Median *Ascaris* intensity (range), epg x 10^3 :		
baseline	-	19.6 (0.0 - 488.0)
follow-up	0.0 (0 - 1.6)	0.0 (0.0 - 226.4)
Median *Trichuris* intensity (range), epg x 10^3 :		
baseline	-	2.8 (0.0 - 84.6)
follow-up	0.0 (0 - 6.4)	1.6 (0.0 - 20.4)

epg = eggs per gram of feces.
* Significant difference; p=0.005 (x^2 test)

Table 2

Baseline nutritional status and growth over 3 months.

Group	Uninfected (n=32)	Infected (n=71)	pb value
Baseline HA [a]	-1.60(0.56)	-1.56(0.54)	0.37
Baseline WA [a]	-1.19(0.51)	-1.25(0.46)	0.47
Baseline WH [a]	0.16(0.49)	0.22(0.54)	0.66
ΔHA [a]	0.02 (0.08)	0.10 (0.10)	0.03
ΔWA [a]	-0.14 (0.09)	-0.04(0.11)	0.003
ΔWH [a]	-0.20(0.19)	-0.15 (0.20)	0.03
Δht cm [a]	1.7 (0.5)	2.0 (0.4)	0.07
Δwt kg [a]	0.2 (0.4)	0.6 (0.5)	0.008

HA= height for age z-score. WA=Weight for age z-score. WH=Weight for height z-score. ht=height wt=weight
Δ indicates increase in parameter between baseline and follow-up.
[a] Medians (quartile deviations in parentheses)
[b] Mann-Whitney U test

Table 3

Association between treatment of infection and the upper half of values of change in growth parameters after adjusting for sex and socioeconomic status.

Growth parameter	Odds ratio[b]	95% CI
ΔHA[a]	2.4	0.9 - 6.3
ΔWA[a]	4.0	1.5 - 10.5
ΔWH[a]	3.9	1.4 - 10.5

ΔHA[a]= Increase in height for age; ΔWA[a] = Increase in weight for age; ΔWH[a]= Increase in weight for height
[a]The parameters were converted into dichotomous variables by dividing arbitrarily at the 50th percentile.
[b]Mantel Haenzel odds ratio indicating association between worm infection and the upper 50% of values of ΔHA, ΔWA and ΔWH after adjusting for sex and socioeconomic status.

double blind and placebo controlled. However reservations about the acceptance by the community of receiving placebo treatment precluded such a design. A compromise was struck by using uninfected children as controls and blinding the observer. This was essentially a study of the effect of treating ascariasis and trichuriasis. Although the frequency of *Trichuris* infection changed little in the treated cohort, there was a significant reduction in the intensity. Even allowing for some underestimation of light hookworm infections, it is clear that hookworm is not a major infection in the area.

The association between infection and lower socioeconomic status is not unexpected. Perhaps the absence of an association at baseline between infection and stunting is also not entirely surprising. As has been pointed out by Stephenson (1984), different children in a community may contract infection at different times. The latter is illustrated by the observation that 45%(13/29) of initially uninfected children in this study were found to be infected at follow-up. As stunting is a chronic process, a cross-sectional observation may fail to capture an association between infection and stunting (Stephenson, 1984).

The results are quite clear however that treatment of infected children was associated with modest gains in growth and nutritional status, a finding which is notable given the short follow-up period and the socioeconomically disadvantaged status of infected children. The benefits were obvious even after adjusting for sex and socioeconomic status. Given the short follow-up, it is not surprising that the gains in weight, weight for age and weight for height were more impressive than the gains in linear growth.

In the presence of a high prevalence of mixed infections, it is difficult to determine the relative importance of *Trichuris* and *Ascaris* infections on growth and nutritional status. The analytical attempts at unravelling what is potentially a complex interaction would almost inevitably be simplistic. These limitations notwithstanding, it is noteworthy that baseline *Trichuris* intensity and fall in *Trichuris* intensity were better predictors of growth than the corresponding *Ascaris* intensities; even if the correlation coefficients were rather small. It is tempting to postulate that in North-eastern Peninsular Malaysia at least, the degree of reduction of the *Trichuris* worm burden may be a more important determinant of improvements in growth and nutritional status than reductions in *Ascaris* intensity. However given the limitations inherent in the interpretation of the results of regression analyses, further evidence is required before the postulate can be accepted. Treatment of intense trichuriasis which causes the *Trichuris* dysentery syndrome has certainly been associated with dramatic growth spurts (Cooper *et al,* 1995) and it is conceivable that even modest burdens of *Trichuris* infections adversely affect growth.

In a previous study on the same population, periodic antihelminthic treatment did not produce a beneficial outcome in terms of growth as assessed at one year (Mahendra Raj *et al,* 1998). In that study however, the baseline intensities particularly of *Trichuris* infection were substantially lower due to previous interventions. Furthermore single 400mg doses of albendazole were employed as opposed to the dual dose used in the present study.

The most impressive published results in terms of the growth enhancing effects of antihelminthic treatment have been derived from studies on schoolchildren in an area of Kenya with a high prevalence of hookworm infection in addition to ascariasis and trichuriasis Stephenson *et al,* 1989; 1993a, 1993b, Adams *et al,* 1994). In contrast, the results of similar studies undertaken in areas with high prevalence rates of *Ascaris* and *Trichuris* but little hookworm infection have been discordant and the growth gains generally less impressive (Lai *et al,* 1995; Simeon *et al,* 1995; Hadju *et al,* 1996; Koroma *et al,* 1996; Watkins and Pollitt, 1996; Hadju *et al,* 1997).

Differences in the relative prevalence rates and intensities of the three worm infections and the dosage schedules used may partly explain the variability of the results. The short term post-treatment growth gains observed in this study are modest and the reproducibility of the findings clearly has to be assessed by further trials. If the findings of the present study are indeed found to be reproducible, the implications in Northeastern Peninsular Malaysia are significant given the ubiquity of helminthiases among primary schoolchildren. It is plausible that an infection which is sufficiently noxious to affect growth could have other adverse effects on general well being and development which may not be as easily measured. While long term solutions involve improved sanitation and health education both of which are tied to economic development, periodic mass chemotherapy may be a justifiable interim option in the area as the cost of such programs to a rapidly developing country like Malaysia may not be prohibitive.

In conclusion, the results of this study suggest that antihelminthic treatment has beneficial short-term effects on growth and nutritional status of a modest magnitude among primary schoolchildren in North-eastern Peninsular Malaysia.

ACKNOWLEDGEMENTS

The authors thank Mr Roslan Mustapha and Ms Roziyani Hashim who assisted in the field work, and the pupils, parents and teachers of Tawang primary school for their cooperation. The study was funded by a grant from the government of Malaysia.

REFERENCES

Adams EJ, Stephenson LS, Latham MC, Kinoti SN. Physical activity and growth of Kenyan schoolchildren with hookworm *Trichuris trichiura* and *Ascaris lumbricoides* infections are improved after treatment with albendazole. *J Nutr* 1994; 124: 1199-206.

Cooper ES, Duff EMW, Howell S, Bundy DAP. 'Catch-up' growth velocities after treatment for *Trichuris* dysentery syndrome. *Trans R Soc Trop Med Hyg* 1995; 89: 653.

Dibley MJ, Goldsby JB, Staehling NW, Trowbridge FL. Development of normalized curves for the international growth reference: historical and technical considerations *Am J Clin Nutr* 1987;46: 736-48.

Garcia LS, Bruckner DA. Diagnostic Medical Parasitology. New York: Elsevier Science Publishing, 1988; 395-6.

Hadju V, Stephenson LS, Abadi K, Mohammed HO, Bowman DD, Parker RS. Improvements in appetite and growth in helminth-infected schoolboys three and seven weeks after a single dose of pyrantel pamoate. *Parasitology* 1996; 113: 497-504.

Hadju V, Satriono, Abadi K, Stephenson LS. Relationship between soil-transmitted helminthiases and growth in urban slum schoolchildren in Ujung Pandang, Indonesia. *Int J Food Sci Nutr* 1997; 48: 85-93.

Koroma MM, Williams RAM, De La Haye R, Hodges M. Effects of albendazole on growth of primary school children and the prevalence and intensity of soil transmitted helminths in Sierra Leone. *J Trop Pediatr* 1996; 42:371-2.

Lai KPF, Kaur H, Mathias RG, Ow-Yang CK. *Ascaris* and *Trichuris* do not contribute to growth retardation in primary schoolchildren. *Southeast Asian J Trop Med Public Health* 1995; 26: 322-8.

Mahendra Raj S. Intestinal helminthiases and growth among pre-adolescent primary schoolchildren in North-eastern Peninsular Malaysia. *Southeast Asian J Trop Med Public Health* 1998; 29: 112-7.

Simeon DT, Grantham-McGregor SM, Callender JE, Wong MS. Treatment of *Trichuris trichiura* infections improves growth, spelling scores and school attendance in some children. *J Nutr* 1995; 125: 1875-83.

Stephenson LS. Methods to evaluate nutritional and economic implications of *Ascaris* infection. *Soc Sci Med* 1984; 19: 1061-5.

Stephenson LS, Latham MC, Kurz KM, Kinoti SN, Brigham H. Treatment with a single dose of albendazole improves growth of Kenyan schoolchildren with hookworm. *Trichuris trichiura* and *Ascaris lumbricoides* infections. *Am J Trop Med Hyg* 1989; 41: 78-87.

Stephenson LS, Latham MC, Adams EJ, Kinoti SN, Pertet A. Physical fitness, growth and appetite of Kenyan school boys with hookworm, *Trichuris trichiura* and *Ascaris lumbricoides* infections are improved four months after a single dose of albendazole. *J Nutr* 1993a; 123: 1036-46.

Stephenson LS, Latham MC, Adams EJ, Kinoti SN, Pertet A. Weight gain of Kenyan schoolchildren infected with with hookworm, *Trichuris trichiura* and *Ascaris lumbricoides* is improved following once- or twice-yearly treatment with albendazole. *J Nutr* 1993b; 123: 656-65.

Warren KS, Bundy DAP, Anderson RM, *et al.* Helminth infection. In: Jamison DT, Mosley WH, Measham AR, Bobadilla JL, eds. Disease Control Priorities in developing countries. New York: Oxford University Press, 1993: 131-60.

Watkins WE, Pollitt E. Effect of removing *Ascaris* on the growth of Guatemalan schoolchildren. *Pediatrics* 1996; 97: 871-6.