INTESTINAL HELMINTHIASIS IN RELATION TO HEIGHT AND WEIGHT OF EARLY PRIMARY SCHOOL CHILDREN IN NORTHEASTERN PENINSULAR MALAYSIA

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Abstract. Stool examination, height and weight measurements were undertaken on 249 early primary school children at two schools in North-eastern Peninsular Malaysia. Helminth infected children were treated and follow-up anthropometric measurements and stool examination undertaken on all (n = 100) children at one of the schools 16 months later; to observe the relationship between acquisition of infection and growth. Baseline *Ascaris* prevalence rates at the two schools were 16.0% (23/144) and 47.6% (50/105) respectively whilst *Trichuris* rates were 33.3% (48/144) and 52.4% (55/105). Hookworm infection was uncommon. There was no difference in weight or height for age between infected and uninfected children at any time. Acquisition of worm infection over the initial 16 month follow-up period was not associated with significant decreases in growth rates. However the small subsets of children with heavy *Ascaris* infection were consistently lighter and shorter at all evaluation times. They also gained significantly less weight and tended to have reduced linear growth rates between measurements. Further interventional studies are required to determine if this association is one of cause and effect or largely incidental.

INTRODUCTION

Intestinal helminthiasis is ubiquitous in the developing world and reportedly causes significant growth stunting among early primary school children (Stephenson *et al,* 1989; 1993a, 1993b; Adams *et al,* 1994; Thein-Hlaing *et al,* 1991). Beneficial effects of treatment on weight and height gain have been shown to occur as early as 9-16 weeks after treatment (Stephenson *et al,* 1993b; Adams *et al,* 1994). However this has not been a universal experience (Lai *et al,* 1995, Watkins and Pollitt 1996). A study on early primary school children was recently undertaken in North-eastern Peninsular Malaysia with the primary aim of studying the effect of helminthiasis on intestinal permeability (Mahendra Raj *et al,* 1996). The study was extended to analyse cross-sectional and longitudinal observations on the association between height, weight and helminthiasis with a view to evaluating the justification for future interventional studies on the effects of treatment on growth. The information may be relevant to other populations with similar patterns, prevalence rates and intensities of infection.

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MATERIALS AND METHODS

The study was conducted on 249 early primary school children at two schools in North-eastern Peninsular Malaysia. Tapang school is within the town limits of Kota Bharu, the major town in the state. Tawang school is on the rural outskirts of Kota Bharu. The design essentially comprised of a cross-sectional study of children at Tapang and a cohort study of children at Tawang.

Stool examination, height and weight measurements were undertaken at Tapang in August 1994 and at Tawang in March 1995. Infected children were treated with a single supervised dose of Albendazole 400 mg and children found to be positive at a second examination 6 weeks later were given another round of treatment.

The Tawang cohort underwent further stool examination, height and weight measurements 16 months after the first visit. As reinfection rates were known to be high, the intention was to observe the relationship between acquisition of infection and growth over this period.

Stools were examined for *Ascaris lumbricoides, Trichuris trichiura* and hookworm eggs, and quantified using a modified Stoll count (Garcia and

Bruckner, 1988). Worm intensity was expressed as eggs per gram of feces (epg). Weight was measured on platform weighing scales with 0.5 kg graduations but the field workers estimated and recorded the weight to the nearest 0.1 kg. Despite the requirement for a degree of estimation, the precision of the weight measurements was surprisingly good. Based on 30 pairs of weight measurements taken independently by two observers, the coefficient of variation was 0.2%. The accuracy of the weighing scales was tested using standard weights issued by the Ministry of trade. Height was measured to the nearest 0.1 cm on a vertical scale. The coefficient of variation of the height measurements also based on 30 paired readings was 0.08%. Measurements were made with the children in school uniform but without shoes. Height for age (HA), weight for age (WA) and weight for height (WH) were calculated based on NCHS reference values (Hamill *et al*, 1979). The study was approved by the Research and Ethics committee of the School of Medical Sciences, Universiti Sains Malaysia and informed parental consent was obtained.

Statistical analysis

Quartile deviation (qd) which is half the interquartile range, was the summary statistic used to indicate the measure of dispersion if distribution was skewed. Non-parametric tests were used to test for differences in anthropometric measurements between groups. All statistical computations including regression analysis were done on the EpiInfo version 6 statistical program (CDC, Atlanta, USA and WHO, Geneva, Switzerland).

RESULTS

The baseline age, sex ratio, infection rates and worm intensities of the study sample is summarised in Table 1. Heavy *Ascaris* infection (>50,000 epg) at baseline was found in 20% (10/49) and 39% (23/59) of worm infected children at Tapang and Tawang respectively. The rates of heavy *Trichuris* infection (>10,000 epg) among infected children at Tapang and Tawang were 33% (16/49) and 29% (17/59) respectively.

Infection rates at the second and third examinations at Tawang school

At the second examination, the *Ascaris, Trichuris* and hookworm infection rates among the previously worm positive group had fallen to 3.4% (2/58), 17.2% (10/58) and 5.2% (3/58) respectively while a third (15/45) of initially uninfected children had become positive.

At the third visit (16 months after the second), the overall infection rate had risen to 73% (73/100); while the *Ascaris* and *Trichuris* infection rates had each risen to 57% (57/100) (Table 4). Hookworm infection was not detected at the third visit. The median *Ascaris* intensity at the third visit (among *Ascaris* positive children) was 24,600 epg (qd 20,800). The median *Trichuris* intensity (among *Trichuris* positives) was 2,400 epg (qd 2,100). Heavy *Ascaris* and *Trichuris* infections were found in 22% (16/73) and 5% (4/73) respectively of children found to be worm positive at the 16 month follow-up.

Height and weight

Baseline data at Tapang school: There was no statistically significant difference in either HA, WA or WH between infected and uninfected children (Table 2). *Ascaris* infection however was associated with a lower height for age (Table 2). The correlation coefficients between worm intensities and baseline anthropometric parameters were generally low and reached statistical significance ($p < 0.05$) only in the case of *Ascaris* intensity and HA (Table 2). The 10 children with heavy *Ascaris* infection had a significantly lower WA (median 69.4% qd 6.4) and HA (median 93.3% qd 3.5) than *Ascaris* negative children ($p = 0.01$). However among the 16 heavy *Trichuris* infected children WA (median 81.0% qd 7.4) and HA (median 95.4% qd 2.2) were no different from that of *Trichuris* negative children, ($p = 0.81$ and $p = 0.54$ respectively). Median WH among children with heavy *Ascaris* and *Trichuris* infections were 86.4% (qd 4.5) and 90.8% (qd 2.0) respectively which were not significantly different from that of *Ascaris* negative and *Trichuris* negative children ($p = 0.28$ and $p = 0.18$ respectively).

Baseline data at Tawang school: There was no difference in baseline HA, WA or WH between infected and uninfected children. Correlation coefficients between baseline intensities and baseline anthropometric parameters were universally weak and did not reach statistical significance (Table 3). The 23 children with heavy *Ascaris* infection had a significantly lower HA (median 91.6% qd 2.0) than *Ascaris* negative children ($p = 0.04$). The difference between the

Table 1

Baseline characteristics in relation to school and infection status.

	Tapang school		Tawang school	
	Worm positive n = 49	Worm negative n = 95	Worm positive n = 59	Worm negative n = 46
Mean age, years (SD)	7.2 (0.3)	7.2 (0.3)	7.8 (0.2)	7.8 (0.3)
Sex ratio (M:F)	1.3 : 1	0.8 : 1	1.2 : 1	0.9 : 1
Ascaris infection rate and median intensity (qd)* epg × 10^3	16%	35.2 (48)	47.6%	40.0 (36.5)
Trichuris infection rate and median intensity (qd)* epg × 10^3	33.3%	4.2 (5.5)	52.4%	6.4 (4.6)
Hookworm infection rate and median intensity (qd)* epg × 10^3	0.7%	20.4	16/2%	2.0 (0.8)

qd = quartile deviation; epg = eggs per gram of faeces.
*Median intensity in children positive for the particular helminth

WA (median 77.1% qd 7.3) of this group and that of *Ascaris* negative controls did not reach statistical significance (p = 0.18). The WA (median 77.1% qd 6.1) and HA (median 91.6% qd 1.2) of the 17 heavy *Trichuris* infected children were not statistically significantly different from that of *Trichuris* negative subjects (p = 0.18 and 0.16 respectively). WH among heavily *Ascaris* and *Trichuris* infected children were 94.6% (qd 6.3) and 91.4% (qd 5.6) respectively which were not significantly higher than that of uninfected children (p = 0.73 and p = 0.90 respectively).

Data at Tawang on 16 month follow-up: There was no difference in HA or WA between infected and uninfected children at 16 months (Table 4). There was also no difference between the groups in net weight or height increase over the period (Table 4). *Ascaris* infection however was associated with a signiticantly lower WA (Table 4). HA and WA at 16 months correlated weakly with worm intensities at that point but the correlations were statistically significant (Table 4).

There was also a weak but statistically significant correlation between *Ascaris* intensity and weight increase over the preceding 16 months (Table 4). The 16 children found to have heavy *Ascaris* infection had a significantly lower WA (median 71.3% qd 4.7) and HA (median 90.5% qd 2.1) than *Ascaris* negative children (p = 0.003 and 0.007 respectively). The difference between WH of the heavily *Ascaris* infected group (median 93.7%, qd 3.3) and *Ascaris* negative controls approached statistical significance (p = 0.09).

Children with heavy ascariasis gained less weight (median 2.5 kg, qd 0.4) and grew less in height (median 6.0 cm, qd 1.1 cm) over the preceding 16 months than *Ascaris* negative children (p = 0.005 and 0.08 respectively). WA among children with heavy ascariasis fell by a larger amount (median 3.9%, qd 2.7) than *Ascaris* negative subjects (p =

Table 2

Anthropometric parameters at baseline in relation to baseline infection status and worm intensity at Tawang school.

Infection status	Worm			Ascaris			Trichuris		
	positive	negative	P value	positive	negative	p value	positive	negative	p value
No. of children	49	95		23	121		48	96	
Median weight for age (qd), %	79.0 (8.7)	80.1 (6.2)	0.65	74.4 (8.2)	80.1 (6.2)	0.20	78.9 (8.7)	80.1 (6.2)	0.64
Median height for age (qd), %	95.4 (3.1)	95.4 (2.6)	0.44	95.0 (3.3)	95.5 (2.6)	0.07	95.3 (3.3)	95.5 (2.5)	0.40
Median weight for height (qd), %	88.9 (4.0)	87.7 (4.6)	0.50	89.4 (5.3)	87.9 (4.2)	0.81	88.9 (4.1)	87.6 (4.6)	0.45
Correlation coefficients between intensity and:		-		-0.13 (-0.29, 0.03)			0.01 (-0.15, 0.14)		
Weight for age[a]									
Height for age[a]		-		-0.19 (-0.35, -0.03)			0.01 -0.15, 0.14)		

qd-quartile deviation. a- correlation coefficient, 95% confidence intervals in parentheses

Table 3

Anthropometric parameters at baseline in relation to baseline infection status and worm intensity at Tawang school.

Infection status	Worm			*Ascaris*			*Trichuris*		
	positive	negative	p value	positive	negative	p value	positive	negative	p value
No. of children	59	46		50	55		55	50	
Median weight for age (qd), %	81.2 (7.2)	81.4 (5.7)	0.98	81.2 (7.3)	81.5 (5.7)	0.55	81.5 (8.2)	81.3 (5.1)	0.77
Median height for age (qd), %	93.1 (2.2)	93.8 (2.9)	0.90	92.6 (2.2)	94.1 (2.9)	0.28	93.6 (2.2)	93.4 (2.7)	0.80
Median weight for height (qd), %	94.6 (6.3)	93.4 (5.1)	0.65	94.3 (6.2)	93.8 (5.1)	0.92	94.6 (6.3)	93.4 (5.1)	0.61
Correlation coefficients between intensity and:									
Weight for age[a]	-			-0.11 (-0.30, 0.08)			-0.07 (-0.26, 0.12)		
Height for age[a]	-			-0.16 -0.35, 0.03)			-0.11 (-0.30, 0.08)		

qd-quartile deviation, a- correlation coefficient, 95% confidence intervals in parentheses

Table 4

Anthropometric parameters in relation to infection status and worm intensity at 16 month follow-up Tawang school.

Infection status at 16 month follow-up	Worm		p value	Ascaris		p value	Trichuris		p value
	positive	negative		positive	negative		positive	negative	
No of children with complete data at 16 month follow up	73	27		56	44		57	43	
Median weight for age (qd),%	78.8 (6.6)	80.7 (7.1)	0.24	77.3 (6.6)	82.2 (5.5)	0.02	78.8 (6.7)	80.7 (8.1)	0.12
Median height for age (qd), %	92.3 (2.8)	93.8 (1.8)	0.54	91.1 (3.2)	93.4 (2.3)	0.06	91.2 (2.5)	93.5 (2.8)	0.13
Median weight for height (qd), %	95.3 (4.5)	97.3 (6.5)	0.30	95.4 (4.4)	96.9 (6.0)	0.30	95.1 (3.3)	97.3 (6.5)	0.32
Median δWA, (qd), %	-1.2 (3.3)	-0.6 (3.8)	0.63	-1.5 (3.8)	-0.2 (3.6)	0.20	-1.1 (3.2)	-1.2 (3.9)	0.78
Median δHA, (qd), %	-0.8 (0.9)	-0.4 (0.9)	0.50	-0.9 (1.0)	-0.4 (0.8)	0.25	-0.8 (0.9)	-0.4 (1.1)	0.36
Median δWH, (qd), %	2.6 (4.3)	3.4 (4.5)	0.33	2.0 (4.8)	3.9 (3.4)	0.28	2.5 (4.1)	2.7 (4.8)	0.42
Median δwt, (qd), kg	3.1 (1.0)	3.5 (0.8)	0.66	2.9 (1.2)	3.6 (1.0)	0.10	3.0 (1.0)	3.5 (1.0)	0.42
Median δht, (qd), cm	6.5 (1.1)	7.0 (0.9)	0.73	6.3 (1.3)	7.0 (0.9)	0.18	6.3 (1.0)	7.0 (1.2)	0.33
Correlation coefficients between intensity and:									
Weight for age[a]		-		-0.23 (-0.43, -0.03)			-0.10 (-0.30, 0.10)		
Height for age[a]		-		-0.21 (-0.41, -0.01)			-0.12 (-0.32, 0.08)		
δWA[a]		-		-0.15 (-0.35, 0.5)			-0.06 (-0.26, 0.14)		
δHA[a]		-		-0.06 (-0.26, 0.14)			0.01 (-0.19, 0.21)		
δWH[a]		-		-0.19 (-0.41, 0.01)			-0.07 (-0.27, 0.13)		
δwt[a]		-		-0.20 (-0.39, -0.01)			-0.10 (-0.30, 0.10)		
δht[a]		-		-0.08 (-0.28, 0.12)			-0.04 (0.24, 0.16)		

qd - quartile deviation, δwt and δht- increase in weight and height between first visit and 16 month follow-up.
δWA, δHA, & δWH - increase in weight for age, height for age & weight for height between first visit and 16 month follow-up.
a- correlation coefficient, 95% confidence intervals in parentheses.

0.04). Although HA in children with heavy ascariasis also fell by a greater amount (median 1.45%, qd 1.2), it was not significantly different from that of *Ascaris* negative children (p = 0.10). The change in weight for height in heavily *Ascaris* children (median 0.4%, qd 3.6%) was lower than *Ascaris* negative children (p = 0.03).

DISCUSSION

The primary objective of this study was simply to determine if helminthiasis was associated with lower height and weight parameters. It has to be reiterated that the purpose of the 16 month post-treatment follow-up was not to determine the effect of anti-helminth treatment on growth but rather to determine if acquisition of infection over this period was associated with a reduction in weight gain and linear growth.

Worm infection as a whole was not significantly associated with lower baseline height or weight. Acquisition of worm infection *per se* was not associated with a lower rate of height and weight increase over the 16 month follow-up period. Ascariasis however was inconsistently associated with lower baseline parameters and a trend towards reduced rates of weight and height increase over the 16 month follow-up. The association was more consistent in the case of heavy *Ascaris* infection.

This study does not answer the question as to whether the relationship between heavy *Ascaris* infection and impaired nutritional status and growth is one of cause and effect. It is notable however that the coefficient of determination (r^2) between the observed anthropometric parameters and *Ascarsis* intensity was universally low (<0.05) suggesting that in North-eastern Peninsular Malaysia at least, ascariasis may not be a critical independent determinant of growth among children of this age group.

In summary the results of this study show that heavy *Ascaris* infection is associated with reduced growth among early primary school children in North-eastern Peninsular Malaysia. Further interventional studies are required to determine if this association is cause and effect or largely incidental.

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