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Original Article

Protein-energy malnutrition and soil-transmitted helminthiases among Orang Asli children in Selangor, Malaysia

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This study aims to determine the prevalence of protein-energy malnutrition and its association with soil-transmitted helminthiases in Orang Asli (Aborigine) children in Selangor, Malaysia. The results obtained from 368 children aged 2-15 years showed that the overall prevalence of mild and significant underweight was 32.1% and 56.5% respectively. The prevalence of mild stunting was 25.6% while another 61.3% had significant stunting. The overall prevalence of mild and significant wasting was 39.0% and 19.5% respectively. The overall prevalence of ascariasis, trichuriasis and hookworm infection were 61.9%, 98.2% and 37.0% respectively and of these 18.9%, 23.5% and 2.5% of the children had severe infection of the respective helminthes. The overall prevalence of giardiasis was 24.9%. The present study vividly shows that stunting and underweight are highly prevalent among Orang Asli children and therefore of concern in this community. In this population intestinal parasitic infections, especially severe trichuriasis and giardiasis, were identified as the main predictors of stunting and wasting respectively, in addition to age between 2 to 6 years.

Key Words: protein-energy malnutrition in children, underweight, stunting, soil-transmitted helminthiases, intestinal parasitic infections, ascariasis, trichuriasis, hookworm infection, giardiasis, Orang Asli, Aborigine, Selangor, Malaysia

Introduction

Malnutrition and intestinal parasitic infections share a similar geographical distribution with the same people experiencing both. It is estimated that 182 million children under 5 years of age, representing 32.5% of all preschool children in developing countries are malnourished and over two-thirds of them live in Asia, especially southern Asia.[1] In Malaysia, studies have shown that the prevalence of malnutrition is still high in rural communities, despite implementation of programs for control and prevention.[2-4] A number of studies in developing countries have investigated the possible determinants of malnutrition in children. The findings show that in developing countries the nutritional status of children has a significant association with socioeconomic factors,[3-5] demographic factors[6], distribution of food in the family,[6,7] immunization status and childhood illness,[8] intestinal parasitoses[9] and childhood nutrition, including prolonged breast feeding.[2,11]

The most important parasites related to malnutrition are intestinal parasites, especially soil-transmitted helminthes and *Giardia duodenalis*, followed by other parasites such as the coccidian, *Schistosomia* sp. and malarial parasites. The impact of intestinal parasitic infections on nutrition, growth and development of children has been studied since the seventies.[12,13] Most of the positive evidence that relates malnutrition and parasitic infections arise from studies that demonstrate the improvement in childrens growth after antihelminthic treatment.[14-21] Some of these findings, however, have remained controversial. This is because of difficulties in controlling confounding variables. For example, difficulties in controlling confounding variables, like diminished food-intake and socioeconomic factors, while determining the real association between the above factors. Against this background we studied the association between malnutrition and intestinal parasitic infections in selected rural areas that are endemic for intestinal parasitic infections.

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Materials and methods

This study was carried out on children aged 2-15 years from eight Orang Asli villages in Selangor, Malaysia. Informed consent was obtained from respective parents or guardians. Detailed standard questionnaires containing biodata of the children (age, date of birth, gender, birth weight, immunization status, breastfeeding history), education level and occupation of parents/guardians and household income were completed by interviewing the relevant adult who signed the informed consent.

The weights of the children were recorded without shoes using the SECA scale which had intervals of 0.5 kg; height was taken by standing the child against a vertical wall, and marking off on the wall with the aid of a clipboard. *Weight-for-age* Z-score was used to denote underweight as an overall indicator for malnutrition while *height-for-age* Z-score was used as an indicator for stunting. *Weight-for-height* Z-score was used as an indicator for wasting (acute malnutrition). The Z-scores were calculated based on the median values of the National Center for Health Statistics United States (NCHS) reference population. For this study, children who had Z-score below –2 standard deviations (SD) of the NCHS reference population median were considered to be significantly malnourished and Z-scores between –1 and –2 SD were considered to be mildly malnourished.

Stool samples were examined by Kato-Katz technique for the presence of *A. lumbricoides*, *T. trichiura* and hookworm eggs. The results of egg counts performed using this technique were expressed as eggs per gram stool (epg). *G. duodenalis* infection was detected using trichrome staining technique. The patient was recorded as having *G. duodenalis* infection if the stool sample contained cysts and/or trophozoites.

Chi-squared test on proportion, one-way ANOVA and non-parametric test equivalent (Kruskal-Wallis 1-way ANOVA) were used for the data analysis. Univariate analysis relating malnutrition to each of the variables was done by means of odds ratios (OR) calculated by logistic regression models. All variables that individually presented a significant association with underweight, stunting and wasting were included in a logistic multivariate model (stepwise procedure). Statistical analysis of the data was performed using *Statistical Package for Social Sciences for Windows* SPSS (version 11.5, March 2002). The Z-scores for weight-for-age, height-for-age and weight-for-height were derived using EpiNut Anthro-pometery (Epi Info, Version 6, 2002). This study was approved by the Research and Ethical Committee, Faculty of Medicine, Universiti Kebangsaan Malaysia, Malaysia.

Results

Demographic characteristics

Three hundred and sixty eight children (178 boys; 190 girls) aged between 2-15 years with mean age of 7.1 (SD 3.47) participated in this study. The mean monthly household income was MR 411.81 (SD 375.72). Almost 73% of all the heads of the family had formal education of at least 6 years. On the other hand only 43.4% of the mothers had similar formal education. The general characteristics of the children according to age and gender are presented in Table 1.

Table 1. General characteristics of children aged 2-15 years in Orang Asli villages in Selangor, Malaysia.

	Age (years)			
	2-6 Mean (SD)	7-12 Mean (SD)	13-15 Mean (SD)	*P*
Males				
Weight (kg)	13.02 (2.96)	21.6 (6.4)	34.7 (6.3)	0.000[ac]
Height (cm)	94.5 (10.3)	119.7 (11.2)	144.6 (8.9)	0.000[bc]
Mean Z-score				
Weight-for-age	-2.3 (1.0)	-2.1 (0.9)	-1.8 (1.1)	0.090[a]
Height-for-age	-2.4 (1.4)	-2.4 (1.2)	-1.7 (1.7)	0.291[a]
Weight-for-height	-1.2 (1.0)	-0.9 (0.9)	–	0.040[bc]
Females				
Weight (kg)	12.1 (2.5)	23.4 (8.7)	33.4 (8.5)	0.000[ac]
Height (cm)	92.1 (8.8)	122.2 (11.2)	141.1 (8.3)	0.000[bc]
Mean Z-score				
Weight-for-age	-2.4 (1.0)	-1.5 (1.1)	-1.9 (1.1)	0.000[ac]
Height-for-age	-2.4 (1.1)	-2.0 (1.1)	-2.7 (1.3)	0.029[ac]
Weight-for-height	-1.3 (1.0)	-0.6 (0.9)	–	0.000[bc]

[a]one-way ANOVA; [b]Kruskal-Wallis 1-way ANOVA; [ab,ac] significant (P<0.05)

Anthropometric measurements and parasitological examinations

The prevalence of malnutrition based on the Z-scores of *weight-for-age*, *height-for-age* and *weight-for-height* is presented in Table 2. The overall prevalence of mild and significant underweight was 32.1% and 56.5% respectively. The prevalence of significant underweight was higher in toddlers as well as in children aged up to 6 years. However, the prevalence decreased significantly with further increase in age (X^2=25.67, P=0.000). The mild underweight was significantly higher in children aged between 7-12 years (X^2=19.24, P=0.000). The prevalence of mild stunting was 25.6% while another 61.3% had significant stunting. As in underweight, a similar pattern of prevalence was also seen in stunting. However, there was no significant difference in the prevalence of stunting among the various age groups. The overall prevalence of mild and significant wasting was 39.0% and 19.5%, respectively. There was no significant difference in the prevalence of mild wasting among the age groups. Thus, the marked wasting was significantly higher in children aged 2-6 years (X^2=9.065, P=0.003). There was no significant difference in the prevalence of underweight, stunting and wasting between genders.

The overall prevalence of ascariasis, trichuriasis and hookworm infection was 61.9%, 98.2% and 37.0% respectively. Severe trichuriasis and ascariasis was found in 23.5% and 18.9% of these children respectively. However, only 2.5% of the children had severe hookworm infection. The overall prevalence of giardiasis was 24.9%.

Potential factors associated with malnutrition

Potential factors associated with significant underweight, stunting and wasting were analyzed by univariate analysis and the findings are presented in Table 3, Table 4 and Table 5 respectively. Univariate analysis showed that the predictors of significant underweight in this study population were young age (i.e children aged 2-6 years) and parasitic infection (i.e giardiasis). The prevalence of significant underweight was higher in children aged 2 to 6 years compared to normal and mild underweight. The prevalence of significant underweight was also higher in children infected with *G. duodenalis* than normal children and those with mild underweight. Severe trichuriasis and low birth weight were predictors of significant stunting in this population. The prevalence of significant stunting was higher among children with severe trichuriasis and also those who had low birth weight than normal children and those with mild stunting. Children aged 2-6 years, giardiasis and children who were breastfed for ≤ 4 months were the predictors of significant wasting. Logistic regression analysis confirmed that the children aged 2-6 years was the risk factor of significant underweight (β=1.044; *P*=0.000), severe trichuriasis as a significant risk factor of significant stunting (β=0.881; *P*=0.021) and children aged 2-6 years (β=1.163; *P*=0.013) and giardiasis (β=0.823; *P*=0.050) as significant predictors of significant wasting respectively.

Discussion

Although World Health Organization (WHO) has estimated that an overall prevalence of stunting has fallen in developing countries from 47% in 1980 to 33% in 2000, protein-energy malnutrition (PEM) is still a major public health problem in poor communities in these countries including Malaysia.[1,3,22-24] The present study is consistent with the earlier findings in Malaysia - that the prevalence of stunting and underweight was high while the prevalence of wasting was low. On the other hand, the overall prevalence of underweight, stunting and wasting in this present study was higher than previous studies in Orang Asli[2] and rural villages in peninsular Malaysia.[3] However, it was lower when compared with the report on rural areas in Sarawak.[25] Comparison with global estimates showed that the prevalence of stunted and wasted children in this study is almost similar to that reported for Pakistan,[26] but is much higher than many regions in Eastern Asia, Latin America and parts of Africa.[27]

Significant stunting (an indicator of chronic malnutrition) was the most common PEM (61.3%) observed in the current study, followed by significant underweight (56.5%). A very high prevalence of stunting among children in this study population, as compared to wasting (15.1%), suggests that the nature of PEM is chronic and probably of long duration. Similarly, a study from China also reported stunting as the most common PEM[22] which was further supported by a study among children aged less than 3 years in Pakistan.[26] It is interesting to note that underweight, stunting and wasting occurred in early life in these children, with almost one third of them being malnourished. Almost 60% of significant wasting was observed in this age group. The prevalence of marked underweight and wasting (but not stunting) significantly decreased with age. All these observations are in agreement with a previous study carried out in Malaysia.[3] A study in China, however, noted that stunting was commonly seen in children aged 2 years.[22] A population-based cohort study among young children in Malawi reported that the underweight and wasting incidence peaked between 6 and 18 months of age, whereas stunting incidence was highest during the first 6 months of age.[24] A study in western Kenya observed stunting and underweight to be greatest among children aged 18-23 months (44% stunted and 34% underweight).[28] On the other hand, studies among rural children in Peru and China found that most of the children became stunted in the first two years of life.[22,29]

In contrast with the findings highlighted by other studies, this study observed that PEM was significantly higher among children aged between 2 to 4 years. Most of the previous studies reported that the prevalence of PEM was higher in children less than 2 years; thus if children less than 2 years were included in this study a similar result would be expected.

Weaning (which was usually started at age 4-6 months), late introduction of solid foods, introduction of adult foods and non-nutritious snacks were a few other reasons why children aged 2 years and less were more susceptible to developing PEM. Stunting may also be due to impaired growth in the uterus during which the fetus is deprived of essential nutrients. A study in Malawi concluded that the intrauterine period and the first 6 months

Table 2. Prevalence of malnutrition among children aged 2-15 years in Orang Asli villages in Selangor, Malaysia.

Age/Gender	Underweight		Stunting		Wasting	
	Mild N (%)	Significant N (%)	Mild N (%)	Significant N (%)	Mild N (%)	Significant N (%)
2-4	20 (18.5)	71 (37.4)	29 (33.7)	59 (28.6)	40 (37.7)	24 (58.5)
5-7	28 (25.9)	59 (31.1)	18 (20.9)	67 (32.5)	36 (34)	12 (29.3)
8-10	35 (32.4)	39 (20.5)	23 (26.7)	47 (22.8)	27 (25.5)	5 (12.2)
11-13	21 (19.4)	15 (7.9)	13 (15.1)	25 (12.1)	3 (2.8)	-
>13	4 (3.7)	6 (3.2)	3 (3.5)	8 (3.9)	-	-
Male	50 (46.3)	101 (53.2)	42 (48.8)	103 (50)	59 (55.7)	21 (51.2)
Female	58 (53.7)	89 (46.8)	44 (51.2)	103 (50)	47 (44.3)	20 (48.8)
Total	108 (32.1)	190 (56.5)	86 (25.6)	206 (61.3)	106 (39)	41 (15.1)

Table 3. Univariate analysis of potential factors associated with underweight among children aged 2-15 years

Variables	Prevalence of underweight (%)			
	Normal + Mild	Significant	OR (95% CI)	*P*
Age 2-6 years	32.2	60.0	3.16 (2.01-4.9)	0.000*
Female	56.8	46.8	0.67 (0.43-1.03)	0.069
Birth weight ≤ 2.5 kg	23.7	34.2	1.67 (0.97-2.88)	0.063
Breast feeding ≤ 4 months	19.2	17.5	0.9 (0.51-1.6)	0.687
Prolonged breast feeding> 2 years	26	18	0.62 (0.37-1.05)	0.076
Incomplete immunization	5.5	4.7	1.1 (0.41-3.0)	0.846
Severe ascariasis	23.9	32.9	1.6 (0.76-3.2)	0.221
Severe trichuriasis	19.5	25.4	1.4 (0.77-2.6)	0.270
Severe hookworm infection	7.0	6.3	0.85 (0.16-4.4)	0.845
Mixed infection worm score ≥ 7	4.4	4.3	1.4 (0.50-4.0)	0.520
Giardiasis	18.4	30.4	1.7 (1.07-3.5)	0.041*
Low fathers' education	24.7	26.3	1.1 (0.67-1.8)	0.687
Low mothers' education	56.2	57.9	1.1 (0.7-1.7)	0.752
Low household income	67.1	70	1.14 (0.71-1.8)	0.594
Family size≥ 8	40.4	32.6	0.71 (0.46-1.1)	0.142
Working mother	12.3	15.3	1.3 (0.70-2.4)	0.442

* Significant (*P*<0.05)

Table 4. Univariate analysis of potential factors associated with stunting among children aged 2-15 years

Variables	Prevalence of stunting (%)			
	Normal + Mild	Significant	OR (95% CI)	*P*
Age 2-6 years	42.3	51.6	1.4 (0.92-2.3)	0.103
Female	53.1	50	0.8 (0.6-1.4)	0.584
Birth weight ≤ 2.5 kg	21	34.9	2.01 (1.13-3.6)	0.016*
Breast feeding ≤ 4 months	16.2	19.5	1.23 (0.7-2.2)	0.439
Prolonged breast feeding >2 years	23.1	20.5	0.86 (0.5-1.5)	0.575
Incomplete immunization	4.6	5.3	1.2 (0.42-3.2)	0.768
Severe ascariasis	25.5	31.0	1.3 (0.62-2.8)	0.470
Severe trichuriasis	14.7	28.3	2.3 (1.2-4.4)	0.012*
Severe hookworm infection	5.2	7.7	1.5 (0.27-8.9)	0.626
Mixed infection worm score ≥ 7	2.9	5.4	1.9 (0.5-7.3)	0.350
Giardiasis	24.3	25.5	1.1 (0.6-1.9)	0.883
Low fathers' education	26.9	24.8	0.9 (0.54-1.5)	0.659
Low mothers' education	56.9	57.3	1.0 (0.65-1.6)	0.949
Low household income	63.8	71.8	1.4 (0.9-2.3)	0.128
Family size≥ 8	35.8	36.4	1.1 (0.66-1.65)	0.850
Working mother	10.8	16	1.6 (0.81-3.1)	0.177

* Significant (*P*<0.05)

Table 5. Univariate analysis of potential factors associated with wasting among children aged 2-15 years

Variables	Prevalence of wasting (%)			
	Normal + Mild	Significant	OR (95% CI)	*P*
Age 2-6 years	55.4	80.5	3.32 (1.5-7.5)	0.003*
Female	45.9	48.8	1.1 (0.58-2.2)	0.733
Birth weight ≤ 2.5 kg	27.9	42.9	1.9 (0.86-4.4)	0.109
Breast feeding ≤ 4 months	4.9	18.7	0.22 (1.15-1.9)	0.029*
Prolonged breast feeding> 2 years	20.9	29.3	1.6 (0.74-3.3)	0.234
Incomplete immunization	4.8	0	0	0.154
Severe ascariasis	25.0	28.6	1.2 (0.40-3.4)	0.734
Severe trichuriasis	20.8	27.6	1.4 (0.6-3.5)	0.416
Severe hookworm infection	6.8	10.0	1.5 (0.15-15.3)	0.555
Mixed infection – worm score ≥ 7	2.4	6.7	2.3 (0.60-9.0)	0.241
Giardiasis	22.9	46.7	2.9 (1.3-6.6)	0.007*
Low fathers' education	23.4	34.1	1.7 (0.83-3.5)	0.143
Low mothers' education	55.4	58.5	1.14 (0.6-2.2)	0.712
Low household income	70.4	68.3	0.91 (0.44-1.86)	0.792
Family size≥ 8	30.7	34.1	1.2 (0.58-2.4)	0.666
Working mother	11.7	14.6	1.3 (0.50-3.4)	0.594

* Significant (*P*<0.05) *** Cornfield 95% confidence interval for odds ratio is not accurate due to small numbers.

of life are critical for the development of stunting whereas the subsequent year was more critical for the development of underweight and wasting.[24]

The current study also showed that there is no significant difference in the prevalence of underweight, stunting and wasting with gender. This is in agreement with earlier studies in Malaysia and Turkey.[3,30] However, studies in Tanzania and Yemen reported that males were nutritionally better than females[8,23] and conversely, a study in the Lao PDR showed that females were less malnourished than males.[5] In addition, a study in China reported that males were more likely to suffer from malnutrition.[22]

Previous studies have revealed a wealth of data on the determinants of childhood malnutrition. Demographic, socioeconomic and genetic factors, breastfeeding (including duration), immunization status, birth weight and childhood illnesses, particularly infectious diseases, have all been described as predictors of childhood malnutrition. The effects of individual factors on marked PEM showed that age 2 to 6 years and giardiasis were significant risk factors for underweight and wasting. Furthermore, breastfeeding of ≤4 months was a significant risk factor for wasting. These findings also support and explain the high percentage of underweight and wasting among toddlers as a result of early weaning and the relatively high prevalence of giardiasis. The association of giardiasis with PEM will be discussed further in another paper to be published.

The benefits of breastfeeding in reducing the risk of infection and mortality and improving growth have been known for sometime.[31-33] A study by Osman and Zaleha showed that malnutritition was associated with short duration of breastfeeding in Orang Asli children.[2] In contrast, several studies reported that children who were breastfed beyond the first year of life were shorter and lighter compared with non-breastfed children.[11,34,35]

This present study also showed that low birth weight and severe trichuriasis were significant risk factors of stunting. Low birth weight has been found as a significant risk factor of stunting.[24,36,37] Severe and chronic trichuriasis, was mainly associated with iron deficiency anaemia (IDA)[38,39] and has been reported as a significant predictor of malnutri-tion.[16,17,40-42] It is important to note that severe and chronic trichuriasis may affect growth in different ways, for example infection may result in anorexia, competition for nutrients and colonization of the large intestine by the adult worms causing severe colitis and chronic bleeding that lead to IDA and stunting. After the adjustment of the effect of confounders, the result of multivariate analysis confirmed that age 2 to 6 years was a predictor of under-weight. Two important observations in this study were that severe trichuriasis and giardiasis remained predictors of stunting and wasting respectively. Age 2 to 6 years also remained significantly associated with wasting while short duration of breastfeeding balked.

On the other hand, the present study showed that socioeconomic factors such as parents' education were not correlated with PEM. A study in the Lao PDR showed that children whose mothers had completed primary education were less stunted and wasted than children whose mothers had never been to school.[5] This present study also showed that a working mother was not a risk factor for malnutrition. A similar finding was reported in a study among Malaysian children and among Brazilian children.[3,36] It was reported that the person who takes care of the child is much more important than is the mother's employment status in determining the nutritional status of the children.[30] Large families were also more prone to having malnourished children[4]. However, this study did not prove this association and this was in agreement with a previous study by Norhayati *et al.*[3] The present study also showed that low household income had no significant association with malnutrition. In this population more than two thirds of the children belonged to low household income families; thus this high proportion may affect the association. Several local studies[3,4] and studies from abroad (e.g Bangladesh, China) showed significant association between low household income and PEM.[22,43]

Jodjana and Eblen reported that malnutrition was the most widespread problem among children aged 6-17 months in Indonesia and was primarily caused by food shortages and unsatisfactory traditional feeding practices.[44] Saldiva *et al.,* in their study among Brazilian children aged 1-12 years, reported that stunting was significantly associated with estimators of low economic income, inadequate protein intake and polyparasitism, especially mixed infection of *A. lumbricoides* and *T. trichiura.*[42] In China, socioeconomic factors (low family income), poor maternal child-rearing behaviour and genetic factors (such as lower parental height) were significantly related to stunting.[22]

Besides socioeconomic factors, childhood illnesses (such as infectious diseases) and immunization status were identified as significant predictors of nutritional status.[8,37] In this present study, immunization status had no significant association with malnutrition. This could be due to the fact that children are seldom non-immunized in this community. Surprisingly, this study did not show significant associations between severe ascariasis and PEM although the prevalence of severe ascariasis was high (19%) in this population. Ascariasis has been reported frequently as a predictor of malnutrition in several other studies.[9,16-18,42,45] Low prevalence of severe hookworm infection (2.5%) in this population may explain a non-significant association with PEM.

In this study the daily energy and protein intake, type of food and frequency of food given during the first year of life were not measured. However, a study among rural children in Malaysia showed that daily energy and protein intake among rural children were below recommended daily intake (RDI) but were not significantly associated with PEM[3]. Similar findings were reported in a study among Tanzanian children.[8] In contrast, a study in China reported inadequate protein intake as one of the predictors of stunting.[22]

In conclusion, the present study emphasizes the fact that stunting and underweight are prevalent to a level that is of concern in Orang Asli communities. In this population, intestinal parasitic infections, especially severe trichuriasis and giardiasis, were identified as the main predictors of stunting and wasting respectively, besides age.

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References

1. World Health Organization. Nutrition for health and development: A global agenda for combating malnutrition. WHO Progress Report, Geneva, 2000.
2. Osman A, Zaleha MI. Nutritional status of women and children in Malaysian rural population. Asia Pac J Clin Nutr 1995; 4: 319-324.
3. Norhayati M, Noorhayati MI, Mohammod CG, Oothuman P, Azizi O, Fatimah A, Fatmah MS. Malnutrition and its risk factors among children 1-7 years old in rural Malaysian communities. Asia Pac J Clin Nutr 1997; 6 (4): 260-264.
4. Zamaliah M, Mohd N, Khor G, Siong T. Socio-economic determinants of nutritional status of children in rural Peninsular Malaysia. Asia Pac J Clin Nutr 1998; 7 (3/4): 307-310.
5. Phimmasone K, Douangpoutha I, Fauveau V, Pholsena P. Nutritional status of children in Lao PDR. J Trop Pediatr 1997; 43 (1): 5-11.
6. Lima M, Figueria F, Ebrahim GJ. Malnutrition among children of adolescent mother in a squatter community of Recife, Brazil. J Trop Pediatr 1990; 36: 14-19.
7. Brugha R, Kevany J. Determinants of nutrition status among children in Eastern Region of Ghana. J Trop Pediatr 1994; 40: 307-311.
8. Mbago MCY, Namfua PD. Some determinants of nutritional status of one-to-four-year-old children in low income urban areas in Tanzania. J Trop Pediatr 1992; 38: 299-306.
9. Egger RJ, Hofhuis EH, Bloem MW, Chusilp K, Wedel M, Intarakhao C, Saowakontha S, Schereurs WHP. Association between intestinal parasitoses and nutritional status in 3-8-year-old children in Northeast Thailand. Trop Georgr Med 1990; 42: 312-323.
10. Ordonez LE, Angulo ES. Malnutrition and its association with intestinal parasitism among children from a village in the Colombian Amazonian region. Biomedica 2002; 22 (4): 486-498.
11. Fawzi WW, Herrera MG, Nestel P, El Amin E, Mohamed KA. A longitudinal study of prolonged breastfeeding in relation to child undernutrition. Intern J Epidemiol 1998; 27: 255-260.
12. Tripathy K, Gonzalez F, Lotero H, Mayoral LG. Effects of *Ascaris* infection on human nutrition. Am J Trop Med Hyg 1971; 20 (2): 212-223.
13. Kamath KR. Severe infection with *Trichuris trichiura* in Malaysian children. Am J Trop Med Hyg 1973; 20 (5): 600-605.
14. Stephenson LS, Crompton DWT, Latham MC, Schulpen TWJ, Neshiem MC, Jansen AAJ. Treatment with a single dose of albendazole improves growth of Kenyan schoolchildren with hookworm, *Trichuris trchiura* and *Ascaris lumbricoides*. Am J Trop Med Hyg 1989; 41 (1): 78-87.
15. Thein-Hlaing, Thane-Toe, Than-Saw Y, Myat-Lay-Kyin. A control chemotherapeutic intervention trial on the relationship between *Ascaris lumbricoides* infection and malnutrition in children. Trans R Soc Trop Med Hyg 1991; 85: 523-528.
16. Stephenson LS, Latham MC, Adams EJ, Kinoti SN, Pertet A. Weight gain of Kenyan school children infected with hookworm, *Trichuris trchiura* and *Ascaris lumbricoides* is improved following once or twice yearly treatment with albendazole. J Nutr 1993a; 123: 656-665.
17. Stephenson LS, Latham MC, Adams EJ, Kinoti SN, Pertet A. Physical fitness, growth and appetite of Kenyan school boys with hookworm, *Trichuris trchiura* and *Ascaris lumbricoides* infections are improved four months after a single dose albendazole. J Nutr 1993b; 123: 1036-1046.
18. Thein-Hlaing. The effect of targeted chemotherapy against ascariasis on the height of children in rural Myanmar. Trans R Soc Trop Med Hyg 1994; 88: 433.
19. Simeon DT, Grantham-McGregor SM, Wong MS. *Trichuris trichiura* infection and cognition in children: results of a randomized clinical trial. Parasitol 1995; 110: 457-464.
20. Watkins WE, Pollitt E. Effect of removing *Ascaris* on the growth of Guatemalan schoolchildren. Pediatr 1996; 97: 871-876.
21. Stoltzfus RJ, Albonico M, Tielsch J, Chwaya H, Savioli L. School-based deworming program yields small improvement of Zanzibar school children after one year. J Nutr 1997; 127: 187-193.
22. Li Y, Guo G, Shi A, Li Y, Anme T, Ushijima H. Prevalence and correlates of malnutrition among children in rural minority areas of China. Pediatr Intern 1999; 41 (5): 549-556.
23. Raja'a YA, Suliman SM, Elkarib SA, Mubarak JS. Nutritional status of Yemeni schoolchildren in Al-Mahweet governorate. Eastern Mediterranean Health J 2001: 7 (1/2): 204-210.
24. Maleta K, Virtanam SM, Espo M, Kulmala T, Ashorn P. Childhood malnutrition and its predictors in rural Malawi. Paediatr Perinat Epidemiol 2003; 17 (4): 384-390.
25. Kiyu A, Teo B, Hardin S, Ong F. Nutritional status of children in rural Sarawak, Malaysia. Southeast Asian J Trop Med Public Health 1991; 22 (2): 211-214.
26. Syed MS, Beatrice JS, Stephen L, Anwar M, Rashida B. Prevalence and correlates of stunting in rural Pakistan. Pediatr Inter 2003; 5 (1): 49-55.
27. de Onis M, Monteiro C, Akre J, Glugston G. The worldwide magnitude of protein-energy malnutrition: an overview from the WHO Global Database on Child Growth. Bull WHO 1993; 71: 703-712.
28. Kwena AM, Terlouw DJ, de Vlas SJ, Phillips-Howard PA, Hawley WA. Friedman JF, Nahlen BL, Sauerwein RW, Kuile FO. Prevalence and severity of malnutrition in preschool children in a rural area of western Kenya. Am J Trop Med Hyg 2003; 68(4): 94-99.
29. Berkman DS, Lescano AG, Gilman RH, Lopez SL, Black MM. Effects of stunting, diarrhoeal disease and parasitic infection during infancy on cognition in late childhood: a follow-up study. Lancet 2002; 359: 564-571.
30. Tuncbilek E, Unalan T, Coskun T. Indicators of nutritional status in Turkish preschool children: results of Turkish demographic and health survey 1993. J Trop Pediatr 1996; 42: 78-84.
31. Jumaan AC, Serdula MK, Williamson DF, Dibley MJ, Binkin NJ, Boring JJ. Feeding practices and growth in Yemeni children. J Trop Pediatr 1989; 35: 189-191.
32. Asha BP, Leela M, Subramaniam VR. Adequacy of breast milk for optimal growth of infants. Trop Georgr Med 1980; 32: 158-161.

33. Taren L, Chen J. A positive association between extended breastfeeding and nutritional status in rural Hubei Province, People's Republic of China. Am J Clin Nutr 1993; 58: 862-867.
34. Mqlbak K, Gottschau A, Aaby P, Hqjlyng N, Ingholt L, Silva AP. Prolonged breastfeeding, diarrhoeal disease and survival of children in Guinea-Bissau. Br Med J 1994; 308: 1403-1406.
35. Caulfield LE, Bentley M, Ahmed S. Is prolonged breast-feeding associated with malnutrition? Evidence from nineteen demographic and health survey. Intern J Epidemiol 1996; 25: 693-703.
36. Huttly SRA, Victoria CG, Barros FC, Teixeira AMB, Vaughan P. The timing of nutritional status determination: Implication for interventions and growth monitoring. Eur J Clin Nutr 1991; 45: 82-86.
37. Rabiee F, Geissler C. Causes of malnutrition in young children: Gilan, Iran. J Trop Pediatr 1990; 36: 165-170.
38. Robertson LJ, Crompton DWT, Sanjur D, Neshiem MC. *Trichuris trichiura* and the growth of primary school-children in Panama. Trans R Soc Trop Med Hyg 1992; 86: 656-657.
39. Ramdath DD, Simeon DT, Wong MS, Grantham-McGregor SM. Iron status of school children with varying intensities of *Trichuris trichiura* infection. Parasitol 1995; 110: 347-351.
40. Gilman RH, Chong YH, Davis C, Greenberg B, Virik HK, Dixon HB. The adverse consequences of heavy *Trichuris* infection. Trans R Soc Trop Med Hyg 1983; 77 (4): 423-438.
41. Cooper ES, Bundy DAP, Macdonald TT, Golden MHN. Growth suppression in the *Trichuris* dysentery syndrome. Eur J Clin Nutr 1990; 44: 285-291.
42. Saldiva SR, Silveira AS, Philippi ST, Torres DM, Mangini AC, Dias RMD, de Silva RM, Buratini MN, Massad E. *Ascaris*-*Trichuris* association and malnutrition in Brazilian children. Paediatr Perinat Epidemiol 1999; 13: 89-98.
43. Abbas Bhuiya MA, Susan Zimicki MK, D'Souza S. Socioeconomic differentials in child nutrition and morbidity in rural areas of Bangladesh. J Trop Pediatr 1986; 32: 17-23.
44. Jodjana H, Eblen JE. Malnutrition, malaria and intestinal worms in young children (Indonesia). Br Med J 1997; 315: 96-97.
45. Gupta MC. Effect of ascariasis upon nutritional status of children. J Trop Pediatr 1990; 36: 189-191.