CURRENT PREVALENCE AND PREDICTORS OF PROTEIN-ENERGY MALNUTRITION AMONG SCHOOLCHILDREN IN RURAL PENINSULAR MALAYSIA

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Abstract. A cross-sectional study was carried out to determine the current prevalence of protein-energy malnutrition (PEM) among Orang Asli schoolchildren and to investigate the potential predictors of malnutrition. A total of 241 (120 males and 121 females) Orang Asli schoolchildren age 7-12 years living in remote areas of Pos Betau, Pahang participated voluntarily in this study. Anthropometric and socioeconomic data were collected and the children were screened for intestinal parasitic infections. The overall prevalences of mild and significant underweight conditions were 52.3% and 37.3%, respectively, and the prevalences of mild stunting and wasting were 43.6% and 43.1%, respectively, while the prevalences of significant stunting and wasting were 43.6% and 5.6%, respectively. There was a significant association between gender (male) and malnutrition (p=0.029). The results also showed a higher prevalence of stunting among children age ≤10 years than in older children (p=0.001). Other independent variables, including socioeconomic status and intestinal parasitic infections, had no significant associations with malnutrition indices. PEM is prevalent among schoolchildren in rural Malaysia and therefore of public health concern since PEM diminishes immune function and impairs cognitive function and educational performance. School-based programs of prevention through health education and interventions should be considered as an essential part of measures to improve the quality of life of schoolchildren in rural Malaysia.

INTRODUCTION

Although the World Health Organization has estimated that the overall prevalence of stunting has fallen from 47% in 1980 to 33% in 2000 in developing countries, protein-energy malnutrition (PEM) which impairs the growth and development of children is still a major public health problem in poor communities (WHO, 2000). Besides inhibiting child growth, PEM also increases morbidity, affects cognitive development, and reduces educational performance and future labor productivity (Gilgen *et al,* 2001).

PEM results from various factors, including inadequate intake of nutrients, abnormal gastrointestinal assimilation of the diet, and stress response to acute injury or chronic inflammation (Crompton and Tulley, 1987). Studies in developing countries investigating the possible determinants of child growth showed the nutritional status of children has a significant inverse relationship with the household income (Norhayati *et al,* 1997; Zamaliah *et al,* 1998; Li *et al,* 1999). Other factors, such as

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educational level of parents, distribution of food in the family (Rabiee and Geissler, 1990; Brugha and Kevany, 1994), immunization status and childhood illness (Berkman *et al,* 2002), intestinal parasitic infections (Nallam *et al,* 1998; Al-Mekhlafi *et al,* 2005a), and childhood nutrition (Maleta *et al,* 2003) also have been significantly associated with the nutritional status of children.

Despite significant improvement in socioeconomic status throughout 50 years of independence (since 1957), Malaysia is still plagued with malnutrition; especially in rural communities (Norhayati *et al,* 1997; Zamaliah *et al,* 1998; Zulkifli *et al,* 2000). To evaluate the current status of this problem, this study was undertaken to determine the prevalence of malnutrition among Orang Asli primary schoolchildren in Pos Betau, Pahang, Malaysia and to investigate the potential predictors of malnutrition in this population.

MATERIALS AND METHODS

Study area and subjects

This study was carried out in primary schoolchildren at the National Primary School of Betau (Sekolah Kebangsaan Betau), (200 km north of Kuala Lumpur, in Pahang, Malaysia. The schoolchildren come from 18 Orang Asli villages located around the school. Each village is comprised of a small population, the number of children in each village was estimated to be between 30 and 100.

The school had an enrolment of 405 pupils in the target age range of 7-12 years. A total of 292 (72.1%) schoolchildren who were present during the visits participated voluntarily in this study and delivered stool samples for examination (universal sampling). Of these children 241 came for an interview to fill in a questionnaire and undergo physical examination, including anthropometry; analysis of the association between malnutrition and the independent variables was based on these children. Throughout many visits to the villages to observe the activities of the schoolchildren during the daytime, most of the children played barefooted and swam or had their baths in the river. They also considered the river as the preferred site for defecation. Their personal hygienic practices were also poor.

Data collection

The subjects' socioeconomic data, anthropometry and fecal samples were collected during five visits to the school in order to cover those who were absent and may have been missed during other visits. A list of the students' names and classes was collected from the headmaster's office. Each child was coded accordingly and particulars were entered in the data sheet. Information regarding bio-data and socioeconomic status were collected through a structured questionnaire.

All children underwent anthropometric measurements as follows: children were weighed wearing school uniforms, without belts or shoes and with empty pockets using a calibrated SECA scale (SECA 709 - USA) which has intervals of 0.1 kg; height was measured to the nearest 0.1 cm using the same device that has a scale and a sliding head piece. The precision of the scales was checked regularly to ensure scale calibration. To reduce intra-individual errors, weight and height were measured twice by different persons and the mean value was used for the analysis. The weight-for-age *Z*-score was used to denote underweight as an overall indicator for malnutrition. The height-for-age *Z*-score was used as an indicator for stunting (chronic malnutrition). The weight-for-height *Z*-score was used as an indicator for wasting (acute malnutrition). For this study, children who had a *Z*-score below -2 standard deviations (SD) of the NCHS Reference Population median values were considered to be significantly malnourished and *Z*-scores between -1 and -2 SD were considered to be mildly malnourished. The *Z*-scores were calculated based

on the median values of the National Center for Health Statistics (NCHS) Reference Population, United States, and were derived using EpiNut Anthropometery (Epi Info, Version 6, 2002).

Fecal samples were collected and examined by Kato-Katz technique as described by Martin and Beaver (1968) for the presence of soil-transmitted helminthes (STH), *Ascaris lumbricoides*, *Trichuris trichiura* and hookworm, eggs. Egg counts were also carried out using this technique and the results are expressed as eggs per gram of stool (epg). The intensity of infection was graded as heavy, moderate or light according to the criteria of the WHO (1987). In order to detect hookworm larva in light infections, the Harada Mori fecal cultivation technique using a test-tube, as descried by Jozefzoon and Oostburg (1994), was also used. Infection with two or three species of STH was considered as a mixed infection. Scores of the intensity of infection were given for each STH species (light=1, mild= 2 and heavy= 3), and infections with a worm score ≥5 were included in the analysis. *Giardia duodenalis* infections were evaluated for the presence of cysts and/or trophozoites on the fecal smears stained by the trichrome technique.

Data analysis

Statistical analysis of the data was performed using the Statistical Package for Social Sciences for Windows SPSS (version 11.5, March 2002). The chi-square test of proportions, the one-way ANOVA and the non-parametric test equivalent (Kruskal-Wallis 1-way ANOVA) were used for data analysis. The association between malnutrition and possible predictors was examined by univariate analysis and multiple logistic regression model; a p-value of 0.20 as elimination criterion was used as suggested by Bendel and Afifi (1977). These authors showed the use of the more traditional level of 0.05 often eliminated variables that later proved to be important.

Ethical consideration

This study was approved by the Medical Ethics Committee of the University of Malaya Medical Center, Malaysia. During the visits to the school and the villages, community meetings were held with the headmaster of the school, the heads of the villages, the parents and their school-age children before commencement of the study in order to give a clear explanation of the objectives of the study. Informed verbal consent was obtained from the participants.

RESULTS

General characteristics

Two hundred ninety-two primary schoolchildren (145 males and 147 females) age 7-12 years with a median age of 10 years (interquartile range 8-11) were studied. The general characteristics of the subjects are shown in Table 1. About one third (34.3%) of the fathers had formal education of at least 6 years, while 22.4% of mothers had a similar level of education. The villages had a homogenous nature in respect to socio-cultural and daily economic activities. Most residents worked as laborers, farmers, rubber tappers or performed odd jobs, such as selling forest products. The houses of the subjects are made up of wood or bamboo. Most of the villages had electricity during the night only, and piped water was the main source for drinking water. Water for domestic needs (bathing, washing clothes and utensils and feeding animals) was collected from rivers located adjacent to the villages. There was no proper sanitation in these communities.

Parasitology

Most children (98.6%) were infected with one or more STH species. The overall prevalences of ascariasis, trichuriasis and hookworm infections were 67.8, 95.5 and 13.4%, respectively. Nearly one third (29.8%) of children had heavy trichuriasis, and 22.3%

Table 1
General characteristics of Orang Asli primary schoolchildren participating in the study (*N*=292).

Characteristics	Frequency (%)
Age groups	
≤ 10 years	69.2
> 10 years	30.8
Gender	
Males	49.7
Socioeconomic status	
Father's education level (at least 6 years)	34.3
Mother's education level (at least 6 years)	22.4
Low household income (<RM450)	81.2
Working fathers	51.4
Working mothers	58.1
Large family size (≥8 members)	35.0
Piped water supply	87.4
Intestinal parasitic infections	
Severe ascariasis (mean epg >50,000)	22.3
Severe trichuriasis (mean epg >10,000)	29.8
Hookworm infections	13.4
Mixed STH infections	62.8
Giardiasis	17.8

had heavy ascariasis. All hookworm infections in this population were light. The prevalence of giardiasis was 17.8% (52 children were positive for *G. duodenalis*).

Prevalence of PEM

The general anthropometric characteristics of schoolchildren who participated in this study are shown in Table 2. Generally, females (considered by age group) had better nutritional indices than males.

The prevalence of protein-energy malnutrition (PEM), based on the *Z*-scores of weight-for-age, height-for-age and weight-for-height, is presented in Table 3. The overall prevalences of mild and significant underweight were 52.3 and 37.3%, respectively. Mild stunting and wasting were found in 43.6 and 43.1%, respectively and significant stunting and wasting were found in 43.6 and 5.6%, respectively.

Potential predictors associated with malnutrition-univariate and multivariate analyses

Potential predictors associated with

Table 2
General anthropometric characteristics of Orang Asli primary schoolchildren in Pos Betau, Pahang (*N*=241).

	Age (years)			
	7-8 *N*=59	9-10 *N*=108	11-12 *N*=74	p-value
Males				
Weight (kg)	18.6 (3.2)	21.6 (2.7)	25.9 (6.5)	0.000 [ac]
Height (cm)	114.9 (5.6)	122.8 (5.7)	127.6 (5.6)	0.000 [ac]
Mean *Z*-score				
Weight-for-age	-2.0 (0.9))	-2.1 (0.6)	-1.9 (1.0)	0.659 [a]
Height-for-age	-1.9 (0.8)	-2.2 (0.8)	-2.4 (0.7)	0.046 [bc]
Weight-for-height	-1.1 (0.9)	-0.9 (0.7)	-0.3 (1.5)	0.030 [ac]
Females				
Weight (kg)	18.7 (2.5)	22.9 (3.9)	26.9 (4.6)	0.000 [ac]
Height (cm)	116.2 (6.6)	123.3 (6.7)	130.9 (5.8)	0.000 [ac]
Mean Z-score				
Weight-for-age	-1.7 (0.9)	-1.6 (0.7)	-1.9 (0.6)	0.261 [a]
Height-for-age	-1.5 (0.7)	-1.8 (0.9)	-2.5 (0.9)	0.000 [bc]
Weight-for-height	-1.0 (0.7)	-0.4 (0.9)	-1.1 (1.2)	0.06 [a]

[a]The distribution is normal (one-way ANOVA); [b]The distribution is not normal (Kruskal-Wallis 1-way ANOVA); [c]significant association (p<0.05)

Table 3
Prevalence of malnutrition among Orang Asli primary schoolchildren in Pos Betau, Pahang (*N*=241).

Age/Gender	Criteria					
	Underweight		Stunting		Wasting	
	Mild *N* (%)	Significant *N* (%)	Mild *N* (%)	Significant *N* (%)	Mild *N* (%)	Significant *N* (%)
Age (years)						
≤10 (*n*=167)	92 (73.0)	58 (64.4)	81 (77.1)	59 (56.2)	67 (97.1)	7 (77.8)
>10 (*n*=74)	34 (27.0)	32 (35.6)	24 (22.9)	46 (43.8)	2 (2.9)	2 (22.2)
Gender						
Male	56 (44.4)	53 (58.9)	49 (46.7)	60 (57.2)	46 (66.7)	8 (88.9)
Female	70 (55.6)	37 (41.1)	56 (53.3)	45 (42.8)	23 (33.3)	1 (11.1)
Total	126 (52.3)	90 (37.3)	105 (43.6)	105 (43.6)	69 (28.6)	9 (3.7)

N= represents the number of subjects

Table 4
Univariate analyses of potential predictors associated with underweight among Orang Asli primary schoolchildren in Pos Betau, Pahang (*N*=241).

Variables	Prevalence of underweight (%)		OR (95% CI)	p-value
	Normal + Mild %	Significant %		
Age ≤10 years	27.8	35.6	2.0 (0.2-0.9)	0.208
Male	44.4	58.9	2.0 (1.1-3.8)	0.029[a]
Severe ascariasis (mean epg >50000)	21.9	17.8	1.2 (0.7-2.1)	0.447
Severe trichuriasis (mean epg >10000)	31.8	27.8	1.1 (0.8-1.8)	0.512
Hookworm infection	11.9	14.4	0.8 (0.4-1.6)	0.571
Mixed infection with worm score ≥5	30.5	25.6	1.2 (0.8-1.8)	0.415
Giardiasis	17.2	21.1	1.0 (0.9-1.2)	0.453
Source of drinking water (river)	11.9	11.1	0.9 (0.7-1.1)	0.850
Low level of father's education (≥6 years)	70.2	66.7	1.1 (0.9-1.3)	0.567
Low level of mother's education (≥6 years)	76.7	82.1	1.1 (0.9-1.2)	0.305
Low household income (<RM450)	80.1	81.1	1.3 (0.6-1.8)	0.853
Family size ≥ 8 members	25.6	29.8	1.2 (0.8-1.8)	0.479
Working father	53.6	60.0	1.2 (0.8-1.6)	0.336
Working mother	57.0	57.8	1.0 (0.8-1.2)	0.900

OR: odds ratio; CI: confidence interval; epg: eggs per gram stool
[a]Significant (p<0.05) by univariate and logistic regression analyses

significant underweight and stunting were analyzed by univariate and multivariate analyses and the findings are presented in Tables 4 and 5, respectively. Only nine children (5.6%) were significantly wasted; this very low prevalence distorted the statistical associations with the independent variables, so significant wasting was excluded from this analysis.

Table 5
Univariate analyses of potential predictors associated with stunting among Orang Asli primary schoolchildren in Pos Betau, Pahang (*N*=241).

Variables	Prevalence of stunting (%)			
	Normal + Mild %	Significant %	OR (95% CI)	p-value
Age ≤10 years	20.6	56.2	3.4 (1.2-4.6)	0.001[a]
Male	44.1	57.1	2.2 (2.5-8.3)	0.045[a]
Severe ascariasis (mean epg >50000)	22.8	17.1	0.7 (0.4-1.3)	0.280
Severe trichuriasis (mean epg >10000)	32.4	27.6	0.8 (0.5-1.4)	0.428
Hookworm infection	11.8	14.3	0.8 (0.4-1.6)	0.562
Mixed infection with worm score ≥5	25.7	30.9	1.2 (0.8-1.8)	0.379
Giardiasis	15.4	22.9	0.7 (0.4-1.2)	0.143
Source of drinking water (river)	11.0	12.4	1.2 (0.5-2.9)	0.745
Low level of fathers' education (≥6 years)	69.1	68.6	1.0 (0.6-1.7)	0.928
Low level of mothers' education (≥6 years)	80.9	79.0	0.9 (0.5-1.7)	0.724
Low household income (<RM450)	78.2	82.4	0.8 (0.4-1.4)	0.408
Family size ≥ 8 members	24.3	33.3	1.6 (0.9-2.7)	0.121
Working father	56.6	55.2	0.9 (0.6-1.6)	0.831
Working mother	56.6	58.1	1.1 (0.6-1.8)	0.818

OR: odds ratio; CI: confidence interval; epg: eggs per gram stool
[a]Significant ($p<0.05$) by univariate and logistic regression analyses

The prevalences of underweight and stunting were significantly higher among children age ≤10 years than those age >10 years. Similarly, bivariate analysis indicates a higher prevalence of being significantly underweight or stunted in boys than girls ($\chi^2=4.75$, $p=0.029$; $\chi^2=4.02$, $p=0.045$). There was a significant difference in the mean *Z*-score for weight-for-age among children by gender; males had a lower mean *Z*-score than females ($t=0.401$, $p=0.002$). Other independent variables showed no significant association with malnutrition indices. Logistic regression (stepwise forward) showed that gender (male) was a predictor of being significantly underweight (OR=1.9; 95%CI=1.1, 3.3) and having significant stunting (OR=2.1; 95%CI=1.2, 3.6). Age ≤10 years was a predictor for significant stunting (OR=3.4; 95%CI=1.6, 5.7).

DISCUSSION

The WHO (2000) has estimated that 182 million children, representing 32.5% of all preschool children under 5 years of age in developing countries are malnourished and over two-thirds of them live in Asia, especially southern Asia. The first paper to highlight the prevalence of PEM in Malaysia was published by Williams in 1949. Subsequently, many studies have been carried out regarding the prevalence and determinant factors of PEM in Malaysia (Osman and Zaleha, 1995; Norhayati *et al,* 1997; Zulkifli *et al,* 2000; Al-Mekhlafi *et al,* 2005a).

The present study showed that the prevalences of being significantly underweight, having stunting and wasting were 37.3, 43.6 and 5.6%, respectively. This figure is consistent

with previous reports in other parts of Malaysia (Osman and Zaleha, 1995; Al-Mekhlafi *et al,* 2005a). However, the overall prevalences of being underweight, having stunting and wasting reported in this study are higher than previous studies conducted among rural children in Selangor (Norhayati *et al,* 1997) and Kelantan (Zulkifli *et al,* 2000). A study in Sarawak (East Malaysia) reported a higher prevalence among rural children (Kiyu *et al,* 1991). In comparison with global estimates, this prevalence of malnutrition is similar to the prevalences reported for Pakistan (Syed *et al,* 2003), Yemen (Raja'a *et al,* 2001) and Ethiopia (Silva, 2005). This prevalence was much higher than the prevalence reported for many regions in East Asia and Latin America (WHO, 2000).

Our study showed that significant stunting (chronic malnutrition) was the commonest form of PEM, more common than wasting (acute malnutrition). This indicates the nature of malnutrition in this population is chronic and probably of long duration. This observation is in accordance with previous reports in Malaysia (Norhayati *et al,* 1997; Al-Mekhlafi *et al,* 2005a). China and Pakistan also reported stunting as the most common form of malnutrition (Li *et al,* 1999; Syed *et al,* 2003).

Previous studies have revealed a wealth of data regarding the determinants of childhood malnutrition. Demographic, socioeconomic and genetic factors, breastfeeding practices (including duration), immunization status, birth weight and childhood illnesses, particularly with infectious diseases, have all been described as predictors of childhood malnutrition. Our findings show the prevalence of being significantly underweight or having stunting was more common among males, almost 16% higher, than females. The vulnerability of males to develop PEM has been reported among children in Malaysia (Zalilah *et al,* 2000), China (Li *et al,* 1999), and Lao PDR (Phimmasone *et al,* 1997). In contrast, studies in Yemen (Raja'a *et al,* 2001) and Tanzania (Mbago and Namfua, 1992) reported that males were nutritionally better than females. Previous local studies in rural Malaysia reported no significant differences in the prevalence of malnutrition by gender (Norhayati *et al,* 1997; Al-Mekhlafi *et al,* 2005a).

PEM usually manifests early, in children between 6 months and 2 years of age, and is associated with early weaning, delayed introduction of solid foods and frequent childhood infections (Berkman *et al,* 2002; Kwena *et al,* 2003). Our study also found that children age ≤10 years had a significantly higher prevalence of stunting than children age > 10 years. This finding is in agreement with earlier reports among rural Malaysian children (Norhayati *et al,* 1997; Zulkifli *et al,* 2000; Al-Mekhlafi *et al,* 2005a). A similar finding was reported in a study of rural Ethiopian children (Silva, 2005), and in Nigerian children (Odunayo and Oyewole, 2006). In contrast, a recent study among sub-Saharan African immigrant and refugee children in Australia found that age had no association with malnutrition indices (Renzaho *et al,* 2006).

Poverty is the root cause of malnutrition and poor socioeconomic factors propagate the occurrence of health problems in developing communities. In contrast to the findings of other studies, this current study found that socioeconomic factors, such as parental education, employment status and household income, did not correlate with PEM. Several studies have found that children of poor families are more prone to suffering malnutrition (Norhayati *et al,* 1997; Zamaliah *et al,* 1998; Li *et al,* 1999; Odunayo and Oyewole, 2006). In this population, almost 81% of children were from low household income families; thus this high proportion may hide the association. This present study also showed that parental employment status was not a significant predictor of malnutrition. Similar findings were reported in studies of rural children (Norhayati

et al, 1997; Al-Mekhlafi *et al,* 2005a) and also among Brazilian children (Huttly *et al,* 1991). It has been reported that the person who takes care of the child is much more important than the mother's employment status in determining the nutritional status of the child (Tuncbilek *et al,* 1996).

Parental education was identified as a significant determinant of nutritional status in a study in the Lao PDR where children whose mothers had completed primary education were less stunted and wasted than children whose mothers had never been to school (Phimmasone *et al,* 1997). However, this study showed there was no significant association between low levels of parental education and malnutrition indices. Our findings are consistent with previous studies of rural Malaysian children (Norhayati *et al,* 1997; Al-Mekhlafi *et al,* 2005a) and Ethiopian children (Silva, 2005).

Malnutrition and parasitic diseases have similar geographic distributions, with the same people experiencing both problems (Crompton and Tulley, 1987). Malnutrition makes children more susceptible to parasitic infections and diminishes the immune response to infections. Some parasitic infections influence nutritional status through a subtle reduction in digestion and absorption of nutrients, chronic inflammation and loss of nutrients (Northrop-Clewes *et al,* 2001). The findings of our study showed that STH and giardiasis are prevalent among these children. A 3-day course of albendazole tablets 400 mg daily was distributed to the children as part of the study. Previous studies of rural Malaysian children identified giardiasis and trichuriasis as significant predictors for wasting and stunting, respectively (Al-Mekhlafi *et al,* 2005a,b). However, our study found that STH and giardiasis were not significantly associated with the nutritional status of these children.

In Southeast Asia, including Malaysia, foods are usually based on rice with little protein or calories. Studies among aboriginal children in rural Malaysia showed that daily energy and protein intake among rural children were below the recommended daily intake (RDI), however this factor was not significantly associated with PEM (Khor, 1988; Norhayati *et al,* 1997). Dietary assessment was a part of our study and we reported similar dietary intakes.

In conclusion, PEM is prevalent in rural Malaysia and of public health concern since malnutrition may diminish immune functions and impairs cognitive function and the educational performance of schoolchildren. Hence school-based programs that promote prevention through health education and interventions should be considered as an essential part of measures to improve the nutritional status and quality of life of Orang Asli children in rural Malaysia. Periodic deworming programs should be included in public health strategies in order to significantly reduce the prevalence of intestinal parasitic infections in Orang Asli communities. Any efforts to improve the economical and educational statuses, particularly in improving the household income and health education of the mothers, are most likely to result in improvement of the nutritional status of the children in such rural communities.

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