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Nutritional Assessment of Pre-School Children in Rural Villages of the Family Dynamics, Lifestyles and Nutrition Study (1997-2001)

II. Prevalence of Undernutrition and Relationship to Household Socio-Economic Indicators

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ABSTRACT

This paper describes the nutritional status of pre-school children and analyzes its relationship to various household socio-economic indicators. Padi, rubber and fishing villages from the Functional Groups Study (1992-1996) were selected for having a high prevalence of child undernutrition, and all children between the ages of 12 and 72 months were measured for their weights and heights in April-May 1998. The NCHS reference values were used to calculate z-scores, which were categorised according to WHO (1983) recommendations. Children between minus 2SD and minus 1SD of reference median were classified as mildly malnourished. Prevalence of underweight was higher (30.5%) than stunting (22.3%), while wasting was only 9.7%. Padi villages had the highest prevalence of undernutrition, followed by fishing, and then rubber villages. Mean household incomes were found to be significantly lower for children with worse nutritional status, and undernutrition was higher in households below the poverty line income. The odds ratios for having stunted children were significantly higher for households whose heads were agricultural own-account workers (OR 3.66, 95% CI = 1.37-9.79), agricultural waged workers (OR 2.75, 95% CI = 1.06-7.10), and non-agricultural manual workers (OR 2.49, 95% CI = 1.04-6.00) compared to non-manual workers. Various household socio-economic indicators showed significantly higher odds ratios for underweight, stunting and wasting. After adjusting for confounding effects by logistic regression analysis, however, only mother's education was found to be a significant predictor for stunting, while poverty level and access to piped water supply were significant predictors for both underweight and stunting. Households without livestock were significant predictors for wasting. Thus, this study identified specific socio-economic factors that should be prioritized for policy and research towards the amelioration of childhood malnutrition in rural areas.

INTRODUCTION

In the UNICEF model that seeks to explain the etiology of child undernutrition (UNICEF, 1998), the three major contributing factors at the household level are the insufficient access to food, inadequate maternal and child caring practices, and poor water and sanitation and inadequate health services. Income, poverty, and other socio-economic indicators impinge and intertwine with these factors in straightforward as well as complex ways.

The link between poverty and household food insecurity is well elucidated, but whether or not poverty leads directly and inevitably to child undernutrition has been a matter of debate. DeRose, Messer & Millman (1998), in reviewing research in Kenya and the Philippines, point out that the relationships between child anthropometric indicators and household indicators such as income, food acquisition and calorie consumption, are found to be weak.

Nevertheless, it has been pointed out (Osmani, 1997) that nutrient and calorie availability could be more responsive to household incomes at the lower levels. Household incomes, particularly at lower levels, influence the accessibility to adequate sanitation and health care, which in turn, are co-determinants of child undernutrition. Furthermore, low income may not directly affect the availability of the relatively small amount of food necessary to feed a preschool child, but it could result in a household situation where the parents are unable to spare the time and attention necessary for a healthy and well fed child (Mason *et al.,* 2001).

In exploring the complex web of causes for child undernutrition, the observation that 'not all poor children are malnourished' have led to investigations for other factors, such as the behaviour and practices of mothers, fathers, siblings and child care providers, as well as the intra-family dynamics that might affect child feeding and food intake (Mason *et al.,* 2001). The Family Dynamics Study was motivated by such an observation made during an earlier study of the nutritional status among five major functional groups.[1]

In this paper, we report the anthropometric results from the Family Dynamics Study, and explore the relationship between child undernutrition and various socio-economic variables. Specifically, the objective is to identify the socio-economic variables, including household income, poverty status, occupation of household heads, ownership of household items, and availability of Piped water, that may predict child undernutrition in rural households.

MATERIALS & METHODS

The villages covered by the Family Dynamics Study were selected on the basis of having high prevalence of child undernutrition. Details of the selection procedure and the list of villages selected are in the preceding article of Chee *et al.* (2002). These villages have been categorised as padi, rubber and fishing villages, based on their original selection criteria to be villages representative of padi, rubber and fishing areas. In every village selected, all households with at

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[1] The preceding article, Chee et al. (2002), make some socio-economic comparisons between the two studies. Also refer to Chee et al. (1997) and Khor & Tee (197) for findings of the earlier study on functional groups.

least one child who is 12-72 months old were included in the study. The socio-economic and anthropometric data reported in this paper were collected in April-May 1998. Interviews were conducted by trained research assistants using a structured questionnaire.

The heights, weights, and birthdates of all children between the ages of 12 and 72 months were taken during home visits. Smaller children were weighed on a KUBOTA pediatric scale (maximum weight 12 kg) to the nearest 50g, while bigger children were weighed on a TANITA electronic balance to the nearest 100g. When it was not possible to weigh the child individually, the weight of the child was obtained by subtracting the weight of the mother from the combined weight of the mother and child. Heights were measured by using a microtoise tape (Stanley-Mabo Besancon) to the nearest 0.1 cm. Age was calculated from the birth date to the day the measurement was taken.

The National Centre for Health Statistics (NCHS) reference values were used to calculate the Z scores of the children. The children were categorised according to the recommendations of WHO (1983). Children with weight for age below minus 2SD from the NCHS median were categorised as underweight, height for age below minus 2SD were categorised as stunted, and weight for height below minus 2SD were categorised as wasted, while those with these indicators falling between minus 2SD to minus 1SD were considered to be mildly underweight, stunted and wasted respectively. Children whose weight for height were above 2SD were considered as overweight.

Analysis was carried out by the SPSS Version 10.0. Differences in household size and income among children in various categories of nutritional status were tested using the Kruskal-Wallis and Mann-Whitney U tests because the income distribution for most nutritional categories was found to be skewed (Levene's test yielded a statistically significant result). The Kruskal-Wallis test was first used to test the overall difference in mean ranks, following which the Mann-Whitney U test was used to test each pair of differences. The significance level was set at $p < 0.05$.

Bivariate analysis was carried out, using the odds ratio (OR) to test for associations between various socio-economic indicators and nutritional status. An OR with a 95% confidence interval that does not include the value of 1.00 in its range is considered statistically significant. For each indicator of undernutrition (underweight, stunting, wasting) at the cut-off points of minus 2SD and minus 1SD, logistic regression models were run for poverty (cut-off point of RM107 per capita monthly household income) and hard-core poverty (cut-off point of RM54 per capita monthly household income) to yield adjusted ORs. Only variables that were significantly related to undernutrition in the bivariate analysis were included as covariates in the logistic regression models.

RESULTS

Prevalence of malnutrition

Table 1 shows the mean weights, heights and z-scores for children by age and sex. Mean z-scores for weight for age and height for age largely fell within minus 2.00 and minus 1.00, while z-scores for weight for height were generally between 0 and minus 1.00. For weight for age, the categories having the lowest mean z-scores were boys aged 12 months to less than 24 months (-1.57±1.25) and girls aged 24 months to less than 36 months (-1.58±1.04), while for height for age, the lowest means were for boys aged 12 months to less than 24 months (-1.50±1.14) and 60 months to less than 72 months (-1.50±0.88).

Table 1. Height, weight and nutritional status of children according to sex and age (N=829)

Sex and age (months)	n	Mean ± SD				
		Weight (kg)	Height (cm)	Weight for age (z score)	Height for age (z score)	Weight for height (z score)
Boys (all ages)	431					
12 to <24	79	9.6±1.6	77.4±4.2	-1.57±1.25	-1.50±1.14	-0.97±1.33
24 to <36	91	11.4±1.5	86.5±4.1	-1.48±1.01	-0.99±0.95	-0.98±0.87
36 to <48	85	13.5±1.9	95.0±4.3	-1.26±0.95	-1.06±0.88	-0.79±0.96
48 to <60	78	14.7±2.0	100.7±4.4	-1.52±0.95	-1.32±0.94	-0.98±0.92
60 to 72	98	16.2±2.4	105.8±4.5	-1.53±1.02	-1.50±0.88	-0.82±1.09
Girls (all ages)	398					
12 to <24	80	9.1±1.2	76.9±4.7	-1.36±0.96	-1.17±1.15	-0.89±1.02
24 to <36	82	10.9±1.5	85.7±4.8	-1.58±1.04	-1.04±1.19	-1.02±1.00
36 to <48	74	12.9±2.2	91.9±10.2	-1.42±1.22	-1.27±1.23	-0.69±1.10
48 to <60	83	14.4±2.1	100.0±5.2	-1.37±1.09	-1.26±1.12	-0.77±0.98
60 to 72	79	16.1±2.7	105.9±5.1	-1.28±1.10	-1.31±1.01	-0.71±1.03
Combined (all ages)	829					
12 to <24	159	9.3±1.4	77.2±4.5	-1.47±1.11	-1.34±1.16	-0.93±1.18
24 to <36	173	11.2±1.5	86.1±4.5	-1.53±1.02	-1.02±1.07	-1.00±0.93
36 to <48	159	13.2±2.0	93.5±7.8	-1.33±1.08	-1.16±1.06	-0.75±1.03
48 to <60	161	14.5±2.1	100.3±4.9	-1.44±1.02	-1.29±1.03	-0.87±0.96
60 to 72	177	16.2±2.6	105.8±4.8	-1.42±1.06	-1.41±0.94	-0.77±1.05

Table 2 shows the distribution of the children in padi, rubber and fishing villages according to their nutritional status. In general, there were higher prevalences of underweight (30.9% for boys, 30.2% for girls, 30.5% for boys and girls combined, in all villages) compared to stunting (21.3% for boys, 23.4% for girls, 22.3**%** combined). The prevalences of wasting were the lowest (10.7% for boys, 8.5% for girls, 9.7% combined).

Overweight was not a problem in these communities, as the prevalence of high weight for height was less than the 2.5% level expected in normal healthy populations (2.1% for boys, 1.5% for girls, and 1.8% combined in all villages). Boys from fishing villages showed the highest proportion of overweight (2.8%), while girls from padi villages had the lowest proportion (0.6%).

On the other hand, large proportions of the children were mildly malnourished. Mild underweight was 42.5% for boys, 39.9% for girls, 41.3% combined; mild stunting was 39.0% for boys, 36.2% for girls, 37.6% combined; while mild wasting was 39.0% for boys, 38.4% for girls, and 38.7% combined.

For each of the two indicators, weight for age and height for age, the padi villages showed the highest prevalence of malnutrition, followed by fishing villages, and then rubber villages, which had the lowest prevalence. The gap appeared to be the widest for the prevalence of underweight, which was 35.0% in padi villages, 30.4% in fishing villages and 21.6% in rubber villages. The prevalence of stunting was likewise highest in padi villages (24.8%), followed by fishing villages (23.1%), and then rubber villages (16.2%). Rubber villages again showed the lowest prevalence for wasting (6.5%), but the fishing villages had a slightly higher level (11.4%) than padi villages (10.0%).

There was generally not much difference in the prevalence of malnutrition for boys and girls, with the exception of stunting in rubber villages, where the prevalence for boys (13.4%) was much lower than for girls (19.3%). In padi villages, the difference in prevalence for wasting is also quite large between boys (12.4%) and girls (7.3%).

Table 3 presents the distribution of children according to their nutritional status and household poverty status. For each of the three indicators, the prevalence of undernutrition was highest among children of the hard-core poor (45.2% underweight, 30.4% stunted, 13.0% wasted), followed by the poor (31.8% underweight, 24.7% stunted, 9.3% wasted), and then the non-poor (25.1% underweight, 17.9% stunted, 9.0% wasted).

For the prevalence of underweight, a similar order may be observed both for boys, that is, highest prevalence (42.6%) among the hard-core poor, followed by the poor (34.9%) and then the lowest among the non-poor (23.7%), as well as for girls (48.1% among the hard-core poor, 28.3% the poor, and 26.6% the non-poor).

Likewise, the prevalence of stunting among girls was highest among the hard-core poor (37.0%), followed by the poor (22.4%) and then the non-poor (20.3%), although the difference between the poor and the non-poor was small. However, for the boys, the prevalence of stunting was higher among the poor (26.7%) than the hard-core poor (24.6%), but markedly lower among the non-poor (15.7%).

The prevalence of wasting for the boys was also higher among the poor (14.0%) than the hard-core poor (13.1%), but considerably lower for the non-poor (7.1%). Among the girls, however, the prevalence of wasting was highest among the hard-core poor (13.0%), and was higher among the non-poor (10.9%) than the poor (3.9%).

Table 2. Nutritional status of children (aged 12-72 months) according to villages (N=829)

	Villages	n	% distribution of respondents			
			<-2.0 SD	-2.0 to 1.0 SD	>-1.0 to 2.0 SD	>2.0 SD
Weight for age						
Boys	Padi	193	36.8	40.9	21.8	0.5
	Rubber	97	21.6	41.2	36.1	1.0
	Fishing	141	29.1	45.4	24.8	0.7
	All	431	30.9	42.5	26.0	0.7
Girls	Padi	178	33.1	43.8	22.5	0.6
	Rubber	88	21.6	42.0	34.1	2.3
	Fishing	132	31.8	33.3	34.1	0.8
	All	398	30.2	39.9	28.9	1.0
Combined	Padi	371	35.0	42.3	22.1	0.5
	Rubber	185	21.6	41.6	35.1	1.6
	Fishing	273	30.4	39.6	29.3	0.7
	All	829	30.5	41.3	27.4	0.8
Height for age						
Boys	Padi	193	23.8	46.6	29.5	0.0
	Rubber	97	13.4	29.9	55.7	1.0
	Fishing	141	23.4	29.9	55.7	1.0
	All	431	21.3	39.0	39.4	0.2
Girls	Padi	178	25.8	37.1	36.0	1.1
	Rubber	88	19.3	27.3	52.3	1.1
	Fishing	132	22.7	40.9	35.6	0.8
	All	398	23.4	36.2	39.4	1.0
Combined	Padi	371	24.8	42.0	32.6	0.5
	Rubber	185	16.2	28.6	54.1	1.1
	Fishing	273	23.1	37.7	38.8	0.4
	All	829	22.3	37.6	39.4	0.6
Weight for height						
Boys	Padi	193	12.4	38.9	47.2	1.6
	Rubber	97	6.2	37.1	54.6	2.1
	Fishing	141	11.3	40.4	45.4	2.8
	All	431	10.7	39.0	48.3	2.1
Girls	Padi	178	7.3	44.4	47.8	0.6
	Rubber	88	6.8	30.7	60.2	2.3
	Fishing	132	11.4	35.6	50.8	2.8
	All	398	8.5	38.4	51.5	1.5
Combined	Padi	371	10.0	41.5	47.4	1.1
	Rubber	185	6.5	34.1	57.3	2.2
	Fishing	273	11.4	38.1	48.0	2.6
	All	829	9.7	38.7	49.8	1.8

Table 3. Nutritional status of children (aged 12-72 months) according to poverty status (N=829)

			% distribution of respondents			
	Poverty Status[1]	n	<-2.0 SD	-2.0 to -1.0 SD	>-1.0 to 2.0 SD	>2.0 SD
Weight for age						
Boys	Hard-core poor	61	42.6	47.5	9.8	0.0
	Poor	172	34.9	43.0	22.1	0.0
	Non-poor	198	23.7	40.4	34.3	1.5
	All	431	30.9	42.5	26.0	0.7
Girls	Hard-core poor	54	48.1	38.9	13.0	0.0
	Poor	152	28.3	44.7	27.0	0.0
	Non-poor	192	36.6	36.5	34.9	2.1
	All	398	30.2	39.9	28.9	1.0
Combined	Hard-core poor	115	45.2	43.5	11.3	0.0
	Poor	324	31.8	43.8	24.4	0.0
	Non-poor	390	25.1	38.5	34.6	1.8
	All	829	30.5	41.3	27.4	0.8
Height for age						
Boys	Hard-core poor	61	24.6	52.5	23.0	0.0
	Poor	172	26.7	41.3	32.0	0.0
	Non-poor	198	15.7	32.8	51.0	0.5
	All	431	21.3	39.0	39.4	0.2
Girls	Hard-core poor	54	37.0	42.6	18.5	1.9
	Poor	152	22.4	42.1	34.9	0.7
	Non-poor	192	20.3	29.7	49.0	1.0
	All	398	23.4	36.2	39.4	1.0
Combined	Hard-core poor	115	30.4	47.8	20.9	0.9
	Poor	324	24.7	41.7	33.3	0.3
	Non-poor	390	17.9	31.3	50.0	0.8
	All	829	22.3	37.6	39.4	0.6
Weight for height						
Boys	Hard-core poor	61	13.1	44.3	42.6	0.0
	Poor	172	14.0	42.4	43.0	0.6
	Non-poor	198	7.1	34.3	54.5	4.0
	All	431	10.7	39.0	48.3	2.1
Girls	Hard-core poor	54	13.0	38.9	48.1	0.0
	Poor	152	3.9	42.8	53.3	0.0
	Non-poor	192	10.9	34.9	51.0	3.1
	All	398	8.5	38.4	51.5	1.5
Combined	Hard-core poor	115	13.0	41.7	45.2	0.0
	Poor	324	9.3	42.6	47.8	0.3
	Non-poor	390	9.0	34.6	52.8	3.6
	All	829	9.7	38.7	49.8	18

[1] Hard-core poor: monthly household income per capita ≤ RM54
Poor: monthly household income per capita > RM54 - RM107
Non-poor: monthly household income per capita > RM107

Nutritional status by income and occupational groups

Table 4 compares the mean and median household size and income among the three groups of children whose nutritional status were undernourished (<-2SD), mildly undernourished (-2SD to -1SD), and normal/overweight (>-1SD weight for age, weight for height) or normal/tall (>-1SD height for age). Household size tends to be bigger for children with poorer weight for age and height for age scores, and the difference between stunted and mildly stunted children as compared to normal and tall children was significant.

Table 4. Mean and median household size and income by nutritional status of children (N=829)

	No. of children	Household size		Monthly household income (RM)		Monthly household income per capita (RM)	
		Mean	Median	Mean	Median	Mean	Median
Weight for age (z-scores) 6.0							
<-2SD	253	6.7±2.1	6.0	738±552	550[a]	121±96	86[a]
-2 to -1SD	342	6.6±2.0	6.0	812±608	600[a]	130±92	100[b]
>-1	234	6.4±2.2	6.0	1036±755	800[b]	172±123	133[c]
Height for age (z-scores)							
<-2SD	185	6.7±2.2	6.0[a]	742±515	600[a]	120±92	88[a]
-2to-1SD	312	6.8±2.2	7.0[a]	793±646	600[a]	125±98	90[a]
>-1	332	6.2±2.0	6.0[b]	971±697	800[b]	163±113	127[b]
Weight for height (z-scores)							
<-2SD	80	6.5±2.0	7.0	760±549	543[a]	123±81	97[a,b]
-2 to -1SD	321	6.5±2.0	6.0	798±632	600[a]	131±103	94[a]
	428	6.6±2.2	6.0	911±672	680[b]	148±110	110[b]
All	**829**	**6.6±2.1**	**6.0**	**853±648**	**633**	**139±105**	**100**

Superscripts of different alphabets located after median values indicate significant difference in mean ranks ($p<0.05$) as tested by the Mann-Whitney U Test

The mean household income and household income per capita both showed a consistent pattern with nutritional status of children. Generally, as nutritional status improves, mean incomes also rise. Thus, for example, children who were underweight were shown to come from households with the lowest mean incomes (RM1738 ± 552 household income, RM121 ± 96 per capita household income), followed by children who were mildly underweight from households with higher incomes (RM812 ± 608 household income, RM 130 ± 92 per capita household income), and then above minus 1SD weight for age children from households with the highest mean income (RM 1036 ± 755 household income, RM172 ± 123 per capita household income). Likewise, mean household incomes were lowest for the stunted children (RM742 ± 515 household income, RM120 ± 92 per capita household income), followed by the mildly stunted children (RM793 ± 646 household income, RM125±98 per capita household income), and were the highest for the above minus 1SD height for age children (RM971 ± 697 household income, RM163 ± 113 per capita household income).

Median incomes showed a similar pattern with weight for age and height for age. The differences in monthly household income between underweight children and above minus 1SD weight for age children, as well as between mildly underweight children and above minus 1SD weight for age children, were found to be significant. For monthly household per capita income, the differences among all three weight for age categories of children were found to be significant. Similarly, for height for age categories, the differences in monthly household income and household income per capita between stunted children and above minus 1SD height for age children, as well as between mildly stunted children and above minus 1SD height for age children, were found to be significant.

Mean household incomes and per capita household incomes were also higher for children with higher weights for height. The differences in monthly household income between wasted and mildly wasted children on the one hand and above minus 1SD weight for height children on the other were significant, while the difference in monthly household income per capita was significant only between the mildly wasted and the above minus 1SD weight for height children.
In exploring the relationship between undernutrition of children and occupation of head of household, the odds of having undernourished children was obtained for each type of occupation in relation to the group that had the lowest prevalence for undernutrition, which was non-manual workers for weight for age and height for age, and agricultural waged workers for weight for height (Table 5).[2] Although the odds of having underweight children were higher for each of the four types of occupation (OR 1.48 to 2.01) when compared to non-manual workers, none achieved a significant level. The odds of having stunted children, however, were significantly higher for agricultural own account workers (OR 3.66, 95% CI = 1.37-9.79), agricultural waged workers (OR 2.75, 95% CI = 1.06-7.10), and non-agricultural manual workers (OR 2.49, 95% CI = 1.04-6.00) when compared to non-manual workers. Wasting did not show any significant relationship with occupation.

Table 5. Odds ratios for undernutrition by occupation of head of household (N=778)

Occupation of household heads	Weight for age (<-2SD / ≥ -2SD)		Height for age (<-2SD / ≥ -2SD)		Weight for height (<-2SD / ≥ -2SD)	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Agricultural own account worker (N=71)	1.57	0.68-3.63	3.66	1.37-9.79	1.19	0.40-3.58
Agricultural waged worker (N=111)	1.48	0.68-3.24	2.75	1.06-7.10	1.00*	-
Non-agricultural, own account worker (N=140)	1.77	0.84-3.76	2.13	0.83-5.45	1.10	0.43-2.83
Non-agricultural, manual worker (N=401)	2.01	1.00-4.01	2.49	1.04-6.00	1.63	0.74-3.56
Non-manual worker	1.00*	-	1.00*	-	1.01	0.29-3.51

*Used as base value

Odds ratios for malnutrition by household socio-economic indicators

[2] Refer to Chee et al. (2002) for the list of occupations in each occupational category.

The relationship between undernutrition of children and various household-based socio-economic indicators were further explored (Tables 6-11). Table 6 shows the odds ratios for underweight (cut-off point minus 2SD from reference median weight for age) by these indicators. The odds for having underweight children were more than twice for hard-core poor households, that is, households with per capita monthly incomes of equal or less than RM54 (OR 2.11, 95% CI = 1.41-3.15), and 1.63 times higher for poor and hard-core poor households, that is, households with per capita monthly incomes of equal or less than RM107 (95% CI = 1.20-2.20).

The odds for having underweight children were also significantly elevated for households without motorised vehicles (OR 1.83, 95% CI = 1.15-2.89), refrigerator or washing machine (OR 1.43, 95% CI = 1.01-2.02), and telephone or mobile phone (OR 1.62, 95% CI = 1.19-2.20), as well as for households that had no access to piped water (OR 1.85, 95% CI=1.38-2.50).
After adjusting for confounding effects in the logistic regression model for underweight and poverty, it was found that the odds of having underweight children remained significantly higher for households that had no piped water (Adj OR l.61, 95% CI= 1.17-2.21), but poverty was no longer significantly associated with underweight children. In the logistic regression model for underweight and hard-core poverty, it was found that the odds of having underweight children were still higher for hard-core poor households (Adj OR 1.66, 95% CI = 1.08-2.56) and households that had no piped water (Adj OR 1.62, 95% CI = 1.18-2.23) even after adjustment.

Table 6. Odds ratios for weight for age of children (<-2.0 SD / ≥ -2.0 SD) by household socio-economic indicators (N=829)

	Weight for age (< -2.0 SD / ≥ -2.0 SD)					
	Odds ratio	95% CI	Adjusted odds ratio[1]	95% CI	Adjusted odds ratio[2]	95% CI
Poverty (≤ RM107, > RM107)	1.63	1.20-2.20	1.29	0.92-1.80	-	-
Hard-core poverty (≤ RM54, > RM54)	2.11	1.41-3.15	-	-	1.66	1.08-2.56
Household size (≤4.6, >4.6)	0.80	0.53-1.22	-	-	-	-
Occupation of head of household (agriculture, non-agriculture)	0.91	0.63-131	-	-	-	-
Mothers education (<6yrs, ≥6yrs) (N=647)	1.27	0.90-1.79	-	-	-	-
Fathers education (<6yrs, ≥6yrs) (N=645)	1.03	0.73-1.49	-	-	-	-
Without/with:						
Livestock	1.24	0.92-1.67	-	-	-	-
Motorised vehicles	1.83	1.15-2.89	1.53	0.94-2.50	1.49	0.91-2.44
Car, van, lorry, tractor, motorboat	1.28	0.91-1.80	-	-	-	-
Refrigerator and/or washing machine	1.43	1.01-2.02	1.04	0.70-1.54	1.01	0.68-1.51

Telephone and/or mobile phone	1.62	1.19-2.20	1.22	0.86-1.73	1.22	0.86-1.72
Piped water (includes standpipe)	1.85	1.38-2.50	1.61	1.17-2.21	1.62	1.62
1.18-2.23Pour-flush and/or flush latrine	1.02	0.52-2.00	-	-	-	-

[1]Logistic regression model for poverty
[2]Logistic regression model for hard-core poverty

The analysis was repeated for a higher cut-off point for underweight (minus 1SD weight for age) to identify the socio-economic predictors for mildly to severely underweight children (Table 7). In this case, the odds were higher for poor households (OR 2.15, 95% CI = 1.58-2.93), and remained higher even after adjusting for the other socio-economic indicators (Adj OR 1.80, 95% CI = 1.28-2.53). For hard-core poor households, the odds were 3.56 times higher (95% CI = 1.96-6.48) and remained almost three times higher (Adj OR 2.85, 95% CI = 1.54-5.30) even after adjustment. Similarly, the odds were significantly higher for households that had no access to piped water (OR 1.78, 95% CI = 1.30-2.43) and remained so even after adjusting for the other socio-economic indicators, both in the logistic regression model for poverty (Adj OR 1.51, 95% CI = 1.08-2.11) as well as for hardcore poverty (Adj OR 1.57,95% CI = 1.13-2.19). Three other indicators showed elevated odds ratios, but these were not significant after adjusting for confounding effects.

The same analysis was carried out to identify predictors for households with stunted children (cut-off point minus 2SD from reference median height for age) (Table 8). Households in poverty and hardcore poverty, those with household heads in agricultural occupations, and those without piped water supply, and pour-flush or flush latrines, showed significantly increased odds of having stunted children. Odds ratios for stunted children were also significantly higher if either mother's or father's education was less than six years (OR 1.65, 95% CI = 1.13-2.40, and OR 1.79, 95% CI = 1.23-2.60).

Mother's education, but not father's education, was included in both the logistic regression models for poverty and hard-core poverty because it is more widely linked to children's malnutrition; and also because including father's education would have excluded children of single mothers who did not have fathers. After adjustment in both logistic regression models, only two indicators showed significantly higher odds ratios, that is access to piped water supply (Adj OR 1.95, 95% CI = 1.32-2.87 in the model for poverty, and Adj OR 1.96, 95% CI = 1.34-2.88 in the model for hard-core poverty), and mother's education (Adj OR 1.50, 95% CI = 1.01-2.25 in the model for poverty, and Adj OR 1.53, 95% CI = 1.03-2.27 in the model for hard-core poverty).

Table 7. Odds ratios for weight for age of children (<-1.0 SD/≥ -1.0 SD) by household socio-economic indicators (N=829)

	Weight for age (< -1.0 SD /≥ -1.0 SD)					
	Odds Ratio	95% CI	Adjusted odds ratio[1]	95% CI	Adjusted odds ratio[2]	95% CI
Poverty (≤ RM107, > RM107)	2.15	1.58-2.93	1.80	1.28-2.53	-	-
Hard-core poverty (≤ RM54, > RM54)	2.56	1.96-6.48	-	-	2.85	1.54-5.30
Household size (≤4.6, >4.6)	0.72	0.48-1.07	-	-	-	-
Occupation of head of household (agriculture, non-agriculture)	1.31	0.89-1.93	-	-	-	-
Mother's education (<6yrs, ≥6yrs) (N=647)	1.36	0.93-2.00	-	-	-	-
Father's education (<6yrs, ≥6yrs) (N=645)	1.27	0.88-1.83	-	-	-	-
Without/with:						
Livestock	1.04	0.77-1.42	-	-	-	-
Motorised vehicles	1.31	0.77-2.21	-	-	-	-
Car, van, lorry, tractor, motorboat	1.51	1.08-2.10	1.16	0.80-1.67	1.22	0.85-1.76
Refrigerator and/or washing machine	1.76	1.18-2.61	1.32	0.85-2.04	1.33	0.86-2.06
Telephone and/or mobile phone	1.47	1.08-1.99	0.94	0.65-1.36	0.96	0.67-1.38
Piped water (includes standpipe)	1.78	1.30-2.43	1.51	1.08-2.11	1.57	1.13-2.19
Pour-flush and/or flush latrine	1.00	0.50-1.98	-	-	-	-

[1]Logistic regression model for poverty
[2]Logistic regression model for hard-core poverty

Table 8. Odds ratios for weight for age of children (<-2.0 SD / ≥ -2.0 SD) by household socioeconomic indicators (N=829)

	Height for age (< -2.0 SD / ≥ -2.0 SD)					
	Odds ratio	95% CI	Adjusted odds ratio[1] (N=647)	95% CI	Adjusted odds ratio[2] (N=647)	95% CI
Poverty (≤ RM107, > RM107)	1.62	1.16-2.27	1.00	0.67-1.50	-	-
Hard-core poverty (≤ RM54, > RM54)	1.65	1.06-2.54	-	-	0.89	0.51-1.58
Household size (≤4.6, >4.6)	0.66	0.41-1.08	-	-	-	-
Occupation of head of household (agriculture, non-agriculture)	1.51	1.03-2.21	1.18	0.72-1.93	1.20	0.73-1.96
Mother's education (<6yrs, ≥6yrs) (N=647)	1.65	1.13-2.40	1.50	1.01-2.25	1.53	1.03-2.27
Father's education (<6yrs, ≥6yrs) (N=645)	1.79	1.23-2.60	-	-	-	-
Without/with:						
Livestock	0.96	0.69-1.34	-	-	-	-
Motorised vehicles	1.55	0.94-2.55	-	-	-	-
Car, van, lorry, tractor, motorboat	1.11	0.77-1.62	-	-	-	-
Refrigerator and/or washing machine	1.42	0.98-2.07	-	-	-	-
Telephone and/or mobile phone	1.41	1.00-1.97	-	-	-	-
Piped water (includes standpipe)	2.17	1.56-3.03	1.95	1.32-2.87	1.96	1.34-2.88
Pour-flush and/or flush latrine	2.25	1.18-4.29	1.10	0.52-2.32	1.11	0.52-2.34

[1]Logistic regression model for poverty
[2]Logistic regression model for hard-core poverty

Note: Father's education was not included in the logistic regression models so as not to exclude children who do not have fathers but are living in single mother households

Table 9. Odds ratios for weight for age of children (<-1.0 SD / ≥ -1.0 SD) by household socio-economic indicators (N=829)

	Height for age (< -1.0 SD / ≥ -1.0 SD)					
	Odds ratio	95% CI	Adjusted odds ratio[1]	95% CI	Adjusted odds ratio[2]	95% CI
Poverty (≤ RM107, > RM107)	2.35	1.77-3.12	1.82	1.33-2.49	-	-
Hard-core poverty (≤ RM54, > RM54)	2.75	1.72-4.38	-	-	1.98	1.20-3.25
Household size (≤4.6, >4.6)	0.79	0.55-1.16	-	-	-	-
Occupation of head of household (agriculture, non-agriculture)	1.23	0.87-1.74	-	-	-	-
Mother's education (<6yrs, ≥6yrs) (N=647)	1.36	0.97-1.91				
Father's education (<6yrs, ≥6yrs) (N=645)	1.39	1.00-1.92	-	-	-	-
Without/with:						
Livestock	1.04	0.78-1.38	-	-	-	-
Motorised vehicles	2.03	1.22-3.37	1.52	0.88-2.61	1.51	0.88-2.60
Car, van, lorry, tractor, motorboat	1.45	1.06-1.97	-	-	-	-
Refrigerator and/or washing machine	1.77	1.24-2.52	1.19	0.79-1.78	1.27	0.85-1.90
Telephone and/or mobile phone	1.70	1.28-2.25	1.03	0.74-1.43	1.09	0.79-1.50
Piped water (includes standpipe)	2.54	1.90-3.40	2.15	1.58-2.93	2.26	1.66-3.07
Pour-flush and/or flush latrine	1.37	0.71-2.64	-	-	-	-

[1]Logistic regression model for poverty
[2]Logistic regression model for hard-core poverty

Table 10. Odds ratios for weight for height of children (<-2.0 SD / ≥ -2.0 SD) by household socio-economic indicators (N=829)

	Weight for height (<-2.0 SD /≥ -2.0 SD)	
	Odds Ratio	95% CI
Poverty (≤ RM107, > RM107)	1.16	0.73-1.84
Hard-core poverty (≤ RM54, > RM54)	1.50	0.82-2.73
Household size (≤4.6, >4.6)	1.38	0.77-2.50
Occupation of head of household (agriculture, non-agriculture)	0.86	0.48-1.55
Mother's education (<6yrs, ≥6yrs) (N=714)	1.10	0.64-1.87
Father's education (<6yrs, ≥6yrs) (N=711)	1.22	0.73-2.02
Without/with:		
Livestock	1.80	1.13-2.86
Motorised vehicles	1.30	0.64-2.64
Car, van, lorry, tractor, motorboat	1.21	0.71-2.08
Refrigerator and/or washing machine	1.11	0.65-1.91
Telephone and/or mobile phone	1.10	0.68-1.75
Piped water (includes standpipe)	0.94	0.59-1.50
Pour-flush and/or flush latrine	0.99	0.34-2.83

When the cut-off point for stunting was raised to include mildly stunted children (minus 1SD from reference median height for age), households in poverty (Adj OR 1.82, 95% CI = 1.33-2.49) and hardcore poverty (Adj OR 1.98, 95% CI = 1.20-3.25) showed significantly higher odds ratios even after adjusting for confounding factors in two separate logistic regression models (Table 9). In both these models, access to piped water was significantly related to undernutrition (Adj OR 2.15, 95% CI=1.58-2.93 in the model for poverty, and Adj OR 2.26, 95% CI = 1.66-3.07 in the model for hard-core poverty).

The odds ratios for wasting (cut-off point minus 2SD from reference median weight for height) was calculated for the same list of socio-economic indicators, but was found to be significantly higher for one indicator only, that is, households without livestock (OR 1.80, 95% CI = 1.13-2.86) (Table 10). Using a higher cut-off (minus 1SD from reference median weight for height), four indicators showed significantly higher odds ratios, but after adjusting, households without livestock was again the only indicator that had a significantly higher odds of having mildly to severely wasted children (OR 1.58, 95% CI = 1.19-2.09) (Table 11).

DISCUSSION

Prevalence of malnutrition

The mean z-scores for weight for age and height for age found in this study, in being between minus 2SD and minus 1SD, were generally similar to those for 1-6 year old children in the Functional Groups Study five years earlier (Khor & Tee, 1997). However, the overall prevalences of undernutrition in this study (31% underweight, 22% stunting, 10% wasting) were lower than the prevalences found in the earlier study (underweight 33% for boys and 36% for girls, stunting 28% for boys and 29% for girls, wasting 11% for boys and 10% for girls).

This general impression is true even when we compare more specifically by functional groups. For example, the fishing villages had lower prevalences in the present study (30% underweight, 23% stunting and 11% wasting) compared to the earlier one (underweight 40% for boys and 37% for girls, stunting 35% for boys and 27% for girls, wasting 14% for boys and 13% for girls). Padi villages showed improvement only for stunting (25% in the present study, 32% boys and 37% girls in the previous study), with similar levels of underweight (35% in the present study, 34% boys and 39% girls in the previous study) and wasting (10% in the present study, 10% boys and 7% girls in the previous study).

Table 11. Odds ratios for weight for height of children (<-1.0 SD / ≥ -1.0 SD) by household socio-economic indicators (N=829)

	Weight for height (< -1.0 SD / ≥ -1.0 SD)			
	Odds ratio	95% CI	Adjusted odds ratio	95% CI
Poverty (≤ RM107, > RM107)	1.43	1.09-1.88	1.31	0.98-1.77
Hard-core poverty (≤ RM54, > RM54)	1.36	0.92-2.02	-	-
Household size (≤4.6, >4.6)	0.84	0.57-1.22	-	-
Occupation of head of household (agriculture, non-agriculture)	0.87	0.62-1.22	-	-
Mother's education (<6yrs, ≥6yrs) (N=714)	1.13	0.81-1.56	-	-
Father's education (<6yrs, ≥6yrs) (N=711)	0.82	0.60-1.13	-	-
Without/with:				
Livestock	1.52	1.15-2.00	1.58	1.19-2.09
Motorised vehicles	1.47	0.94-2.32	-	-
Car, van, lorry, tractor, motorboat	1.38	1.01-1.88	1.20	0.85-1.69
Refrigerator and/or washing machine	1.38	1.00-1.92	-	-
Telephone and/or mobile phone	1.45	1.10-1.91	1.25	0.92-1.72
Piped water (includes standpipe)	1.20	0.91-1.57	-	-
Pour-flush and/or flush latrine	0.67	0.36-1.27	-	-

Following the trend shown by the socioeconomic indicators (refer to previous article, Chee *et al.*, 2002), rubber villages showed the largest improvement, registering 22% underweight, 16% stunting, and 7% wasting in the present study compared to 32% (boys) and 37% (girls) underweight, 35% (boys) and 32% (girls) stunting, and 8% (boys) and 7% (girls) wasting in the earlier Functional Groups Study. From this earlier study, Zamaliah *et al.* (1998) had analyzed the ruhher villages in Kuala Kangsar and found that among 93 children 0-5 years of age, 31.5% were underweight, 26% were stunted, and 3.8% wasted, thereby confirming the observation that child malnutrition has decreased substantially in the rubber villages over the last five years.

In comparison, Norhayati *et al.* (1997) had reported much higher prevalences of underweight (46%) and wasting (30%) among 221 children 1-7 years old in rural Malay villages selected for being agricultural and low income. These levels are more comparable with the prevalences found in the poverty villages of 1984 (Chong *et al.)* where a prevalence rate of 37% was reported for underweight, and 5% for wasting among 726 children aged 1-6 years. Nevertheless, the high level of wasting reported by Norhayati *et al.* (1997) is unusual and should be further investigated. Wasting is an indicator of acute malnutrition, and its high prevalence is usually indicative of an emergency situation or a high rate of infections.

In general, it may be noted that large proportions of the children in this study were mildly malnourished, that is, having indicators between minus 1SD to minus 2SD of reference median for weight for age and height for age. The majority of the children (between 60 to 70%) therefore had weights and heights that were below minus 1SD of reference median. The level of acute malnutrition, as indicated by wasting, was lower, and only about 50% of the children were below minus 1SD of reference median weight for height.

It should be noted that children who have poor weight for age as well as height for age may have a weight for height that is within normal range. For this reason, if weight for height was the sole indicator used for malnutrition, then there could be under-estimation. Overweight among these children was non-existent as a community nutrition problem, as proportions whose weight for height exceeded 2SD were generally lower than the statistically expected 2.5%.

In general, padi villages were found to have the highest prevalence of malnutrition, and rubber villages the lowest, which is to be expected from the socio-economic profile presented in the previous paper (Chee *et al.,* 2002). Comparing by poverty levels, the highest prevalence of undernutrition was also expectedly found among the hard-core poor, followed by the poor, and then the non-poor.

However, among girls, the difference in prevalences of current and chronic undernutrition between poor and non-poor was very little. Furthermore, prevalence of acute undernutrition (as indicated by wasting) was higher among the non-poor compared to the poor. This could be due to poor household children with low height for age also having low weight for age, with their weight for height showing up as normal, resulting in an underestimate of acute malnutrition. Sudden spurts in growth in height, or growth faltering due to episodes of infection may also cause weights for heights to register a sudden decline.

Factors related to malnutrition

Previous studies of rural villages in Peninsular Malaysia have demonstrated the relationship between socio-economic indicators and malnutrition among preschool children. Norhayati *et al.* (1997), had examined the relationship of malnutrition with parents' education, whether mother was working outside, family income, and family size and had found that most of these variables were not significantly related, except for household income (equal or less than RM750) which was a significant risk factor for stunting and wasting. On the other hand, Soon & Khor (1995) had studied 105 children aged 1-6 years in a rural land scheme, and had found significant correlations between height for age and weight for age and mother's education and number of children; but these indicators of malnutrition were not significantly correlated to the number of household members nor household income.

Zamaliah *et al.* (1998) had found higher prevalences of stunting, underweight and wasting among children 0-5 years from households below the poverty line income compared to those above it. Likewise, significant differences between households above and below the poverty line were also shown for both the indicators weight for age and weight for height. In addition to income, significant correlation was also found between height for age and household size, weight for age and acreage of land cultivated, and weight for height and land cultivated.

In the current study, a clear relationship was seen between malnutrition and household income. Mean household income per capita is preferable to mean monthly household income as an indicator because it takes into consideration the variable household size, and it was found to be generally lower for malnourished children.

Compared to household income, occupation of household heads appeared to be a less sensitive indicator. The odds of having children with current and acute malnutrition were not significantly different by occupation of head of household, but the odds of chronic undernutrition were significantly higher for children from households where the heads were in the agricultural sector, whether as own account workers, or as waged workers, and where the household heads were non-agricultural manual workers. Chronic undernutrition, as indicated by stunting, is a reflection of long-term food availability and health status, where the effects are cumulative. The lower prevalence of chronic undernutrition among the children of non-manual worker households therefore reflects the longer-term nutritional effects of the higher socio-economic status of these households.

Predictors for malnutrition

Among the household indicators tested by logistic regression analysis, only three were found to have significant predictive value for malnutrition of pre-school children as measured by underweight and stunting, these being poverty level, mother's education and availability of piped water supply in the household. Mother's education was found to have predictive value as an indicator for households with stunted children only. Poverty and hard-core poverty were better predictors as they were found to be related to underweight and stunting, using either the cut-off point of minus 2SD or minus 1SD. The availability of piped water supply was, however, found to be the most consistent predictor of child malnutrition. The odds of having malnourished children was elevated in households without access to piped water supply for both indicators of underweight and stunting, and whether at minus 2SD or minus 1SD cut-off.

Poverty is a social state involving a complex web that includes income occupation, education, opportunities, and deprivation, and it affects the nutritional status of children through many mechanisms, such as household food availability and security, and child feeding practices. Mother's education may affect a child's nutrition indirectly, as an indicator of socio-economic status, or directly, for example, through the mother's ability to provide good nutrition and prevent infections. Safe water supply, on the other hand, is almost always a direct factor in the prevention of infections among children.

In a situational analysis of child malnutrition in eight Asian countries, it is reiterated that poverty remains an important determinant (Mason *et al.* 2001:18-19). Other important socio-economic determinants are household food insecurity, employment, and real income. Secondary school enrollment and literacy among women were also identified as important factors contributing to child malnutrition. In the same study, it is pointed out that poor water supply and bad sanitation is usually associated with growth failure in children, and water supply in particular is singled out as being of the highest priority in efforts to reduce child malnutrition.

In the analysis of acutely malnourished children, the only indicator found to have predictive value was households without livestock. This may reflect more stable food availability in households that rear livestock; but it could also mean that households with acutely malnourished children are ones that lack the resources needed for rearing livestock. In any case, weight for height, used to denote acute malnutrition, is not a good indicator for the detection of child malnutrition in surveys, which are conducted at one point in time, as it is sensitive to short term fluctuations and hence easily affected by temporal factors such as acute food shortages and infectious disease epidemics.

CONCLUSION

In this current study, a high level of malnutrition was found among pre-school children in rural villages. The prevalence was highest in padi villages, followed by fishing villages, and lowest in rubber villages; and also highest in hard-core poor households, followed by poor households, and lowest in non-poor households.

Household income had a more consistent relationship with malnutrition compared with occupation of head of household. Among all the household indicators tested, mother’s education, poverty level, and availability of piped water showed significant relationship with malnutrition even after adjusting for confounding factors. The twin factors, poverty level and household income, are important overall determinants of nutritional and health status, and continue to be so in these rural villages.

Piped water supply proved to be the most consistent predictor for malnutrition of children. The lack of piped water supply appears to be an anomaly in these villages where ownership of other household items, such as the refrigerator and washing machine as well as motorised vehicles, is generally high. Considering the importance of piped water supply in child health and nutrition, its redress needs to be prioritized.

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REFERENCES

Chee HL, Khor GL & Tee ES (1997). Nutritional assessment of rural villages and estates in Peninsular Malaysia: I Socio-economic profile of households. *Malaysian J of Nutr* 3(1): 1-19.

Chee HL, Khor GL, Fatimah A, Wan Abdul Manan WM, Ahmad Affendi S, Asnalrulkhadi AS, Rohani A, Siti Jamilah B, Zahid E & Zamaliah MM (2002). Nutritional assessment of preschool children in rural villages of the family dynamics, lifestyles and nutrition study (1997-2001): I. Socio-economic status of households. *Malaysian J of Nutr* 8(1): 13-31

Chong YH, Tee ES, Ng TKW, Kandiah M, Hanis H, Teo PH & Siti Mizura S (1984). Status of community nutrition in poverty kampungs. Institute for Medical Research (IMR) Bulletin No. 22.Kuala Lumpur: IMR.

DeRose L, Messer E & Millman S (1998). Who's Hungry? And How Do We Know? Food Shortage, Poverty and Deprivation. Tokyo: United Nations University Press.

Khor GL & Tee ES (1997). Nutritional assessment of rural villages and estates in Peninsular Malaysia: II Nutritional status of children aged 18 years and below. *Malaysian J of Nutr* 3(1): 21-47.

Mason JB, Hunt J, Parker D, & Jonsson U (2001). Improving child nutrition in Asia. *Food and Nutrition Bulletin* 22 (3): 1-85 (supplement).

Norhayati M, Noorhayati MI, Mohammod CG *et al.* (1997). Malnutrition and its risk factors among children 1-7 years old in rural Malaysian communities. *Asia Pacific J Clin Nutr* 6(4): 260-264.

Osmani SR (1997). Poverty and nutrition in South Asia. In Nutrition & Poverty: Papers from the ACC/SCN 24th Session Symposium, Kathmandu, March 1997. ACC/SCN Symposium Report, Nutrition Policy Paper No. 16, November 1997.

Soon SD & Khor GL (1995). Taraf pemakanan kanak-kanak berumur satu hingga enam tahun di FELDA Sg. Koyan, Pahang. *Malaysian J of Nutr* 1(2): 115-128.

UNICEF (1998). The State of the World's Children 1998. Oxford: Oxford University Press.

World Health Organization (WHO) (1983). Measuring change in nutritional status: Guidelines for assessing the nutritional impact of supplementary feeding programmes for vulnerable group. Geneva: WHO.

Zamaliah Mohd Marjan, Mohd Nasir MT, Khor GL & Tee ES (1998). Socio-economic determinants of nutritional status of children in rural Peninsular Malaysia. *Asia Pacific J Clin Nutr* 7(3/4): 307-310.s