CHILDHOOD MALNUTRITION: AN ANALYSIS OF THE EFFECTS OF NUTRITIONAL ADVICE

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Abstract. An analysis of malnutrition was done in 65 infants and preschool children (18 boys and 47 girls) who were under the third percentile of weight for age. Fifty-seven percent of cases had hematocrits of less than 36%, 7% had hematocrits of less than 30% and two had iron deficiency anemia which improved after iron supplement. Eosinophils of more than 400 cells/mm3 were found in 35% of cases. Eleven per cent had eosinophils of more than 1,000 cells/mm^3. Parasites were found on stool examination in 12.5% of cases. Bone development was retarded in 39% of 23 cases. In 7 cases with bone development delayed more than 6 months, thyroid function and trace elements were analysed and found to be within normal limits. In 5 cases with delayed bone development and height less than 5 cm/year, growth hormones showed normal levels.

Proper nutritional advice resulted in improvement in body weight and height in 57% of cases, tricept skin fold in 73%, bicept skin fold in 60%, arm muscle area in 50% and arm fat area in 29% of cases. Improvement was not associated with family income or education of the people who cared for the patients.

INTRODUCTION

Childhood malnutrition is one of the most important problems in developing countries. Most cases result from inappropriate food intake which may be due to poverty, illiteracy or infections. Malnutrition in infants affects growth, development and may decrease learning ability.

Healthy, well-nourished children are important to the country's development. The early diagnosis and management of malnutrition is important, but prevention is more important. Proper nutritional advice to pregnant mothers and people who look after the infants is essential. Understanding of the social background, nutritional intake, laboratory procedure and how to advise parents about childhood malnutrition is important.

Our previous study has analysed social background and nutritional uptake (Srimaruta *et al*, 1989). The aim of this study is to analyse laboratory data and the effects of nutritional advice on development of height, weight and anthropometry.

MATERIALS AND METHODS

The analysis was done in 65 infants and pre-school children less than 6 years of age who attended the Nutrition Clinic, Department of Pediatrics, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, from 1989 to 1992. The patients were all under the third percentile of weight for age by Thai standard (Chavalittamrong and Tantiwongse, 1987) and did not have any systemic diseases.

Full history and physical examination were carried out on the first visit. Body weight and height were classified as recommended by Gomez *et al*, 1955, 1956) with the cut-off level at 85%. Type of malnutrition and retardation was classified as recommended by Waterlow (1972). Anthropometric study was done on the first visit and the follow up period. Arm muscle circumference (AMC), arm muscle area (AMA) and arm fat area (AFA) were calculated using mid arm circumference (MAC) and triceps skin fold (TSF) by Gurney and Jellifee's method (Gurney and Jelliffe, 1973).

A three-day food record was obtained on the first visit and average calory, protein, fat and carbohydrate per day were estimated (Taylor and Anthomy, 1983; Penberton and Gastinean 1981). A comparison was made between the patient's intake and the normal values for the same age and weight (Holliday and Segar, 1957).

Complete blood count, urine and stool examination were done in all patients. Bone age was obtained in

23 patients who were under the third percentile of height for age. It was evaluated by radiologists who were unaware of the patients (Grenlich and Pyle, 1959). Thyroid function and trace elements were measured in patients who had a bone age more than 6 months delayed from the chronological age ± standard deviation. Growth hormone level was evaluated by the L-Dopa/propanolol test (Blackett *et al*, 1979; Collu *et al*, 1978) in the patients who had delayed bone age and delayed height increase (less than 5 cm of height gain per year).

Food advice was given on the first and every visit (1-2 months interval). There were only one doctor and one nutritionist involved in the study, both of whom advised the patients, the parents and the people who looked after the patients on every visit. The main purpose of the advice was to evaluate their problems and solve them. The advice was given regarding the proper kinds and volume of food, how to cook it, and when and how to give food to the child.

Weight, height and anthropometry were recorded on each visit by the nutritionist. The follow-up tests were performed after at least 6 months and comparison was made of the percentiles of weight, height and anthropometry between the first visit and the last one.

Statistical analysis

The results were analyzed by Chi square and student's *t*-test. A p value < 0.05 were considered statistically significant.

RESULTS

The age range of the subjects at the start was 12 to 74 months and 68% were under 2 years of age. Average age at the onset of under-weight was 8.8 months. Sixty-two percent (40 cases) were under the third percentile of height for age. According to modified Gomez's classification, 83% of cases had first degree malnutrition and 17% had second degree.

Table 1 shows the percentage of malnutrition and retardation of the patients classified according to Waterlow's definition. Two percent of them classified as normal (normal weight for height and height for age), 29% had acute malnutrition (malnourished but not retarded), 40% had acute on chronic malnutrition (malnourished and retarded) and 29% were nutritional dwarfs (retarded but not malnourished).

Table 1

Percentage of malnutrition and retardation of the patients classified according to Waterlow's definition.

		Retardation		
		Grade	0	1-3
Malnutrition		%Expected hight for age	> 95	95- < 80
	Grade	%Expected Weight for hight		
	0	> 90	2%	29%
	1-3	90- < 70	29%	40%

The average calorie intake compare to expected values is shown in Table 2. The average calorie intake of the patients calculated from three-day food records was significantly less than the expected calorie intake calculated both from weight-for-age and present weight ($p < 0.001$). Protein : fat : carbohydrate from food intake was 15:30:55.

Table 3 demonstrates the percentage of the patients classified by percentiles of MAC, TSF, AMC, AMA and AFA compared to normal values. MAC in all cases was within the tenth percentile while 94, 75, 71 and 96 percent of cases were within the tenth percentile of TSF, AMC, AMA and AFA, respectively.

Table 4 demonstrates mean hematocrit, white count, neutrophils, lymphocytes and eosinophils of the patients. Fifty-seven percent of cases had hematocrit of less than 36%, seven percent less than

Table 2

Average calories per day received by the patients compare to expected calories.

Average kilocalories per day received by the patients	Average of expected kilocalories per day calculated from	
	weight for age	present weight
607 ± 107	1,160 ± 145 ($p < 0.001$)	982 ± 180 ($p < 0.001$)

Table 3

Percentage of the patients classified by percentiles of MAC, TSF, AMC, AMA and AFA.

	Percentiles				
	< 5	5-10	11- < 25	25-50	> 50
*MAC	94	6			
TSF	73	21	4	2	
AMC	44	31	21	2	2
AMA	40	31	19	8	2
AFA	90	6	2	2	

*MAC = Mid right arm circumference
TSF = Triceps skin fold
AMC = Arm muscle circumference
AMA = Arm muscle area
AFA = Arm fat area

Table 4

Mean hematocrit, white count, neutrophils, lymphocytes and eosinophils of the patients.

	Hematocrit	WC*	N	L	E
Mean	34	10,812	4,469	5,543	402
SE**	2	403	368	210	64
Maximum	41	18,100	10,390	9,280	1,870
Minimum	23.5	5,900	1,428	1,584	0

*WC = white count, N = neutrophils
L = lymphocytes, E = eosinophils
**SE = Standard error

30% and two of them had iron deficiency anemia which improved after iron supplement. Eosinophils of more than 400 cells/mm^3 were found in 35% of the patients while more than 1,000 cells/cm^3 were found in 11% of all patients.

Stool examinations were positive for parasite only 12.5% of the patients. These parasites were *Giardia lamblia, Entamoeba histolytica*, whipworm and pinworm. Only 33% of patients who had parasites in the stool had eosinophils of more than 400 cells/mm^3.

Bone age was determined in 23 cases and 39% of these (9 cases) had bone age less than chronological age ± standard deviation. Average months of bone age delay was 9.3 (range 3-16 months). Thyroid function and trace elements were checked in 7 cases with retarded bone development of more than 6 months and all of them were within normal limits. In 5 cases with retarded bone development and height, growth hormone was checked and showed normal levels.

The follow-up time was 6 months to more than 2 years. After nutritional advice, 57% of cases showed improvement in body weight and height (by more than 10 percentiles). The amount of improvement showed no correlation with family income ($p > 0.05$) or education of the people who cared for the patients ($p > 0.05$). The age of onset of malnutrition (below 2 years old or after) was not correlated with weight and height improvement ($p > 0.05$). Improvement (more than 10 percentile) in TSF, AMC, AMA and AFA occurred in 73, 60, 50 and 29% of cases respectively. This improvement in anthropometry did not correlate with weight gain ($p > 0.05$).

DISCUSSION

Most of the 65 cases started having malnutrition after weaning (mean age 8.8 months). All of them were under third percentile of weight for age for the Thai standard (Chavalittamrong and Tantiwongse, 1987). Sixty-two percent were under the third percentile of height for age which indicated chronic malnutrition. A modified Gomez's classification with 85% as cut-off level was used in this study instead of the 90% cut-off because use of 90% cut-off caused some of the normal cases to be misclassified as undernourished, leading to overestimation of malnutrition (Ramnath *et al*, 1993). The Nutritional status classification of Waterlow seems to be better in dividing types of malnutrition. According to our study, 2% had normal weight for height and height for age as classified by Waterlow but body weight was under the third percentile. Only 29% had acute malnutrition while 40% had acute on chronic malnutrition.

The caloric intake of the patients was only 50-60% of expected but the ratio of protein : fat : carbohydrate was acceptable. This means that the intake is very low for all three kinds of foods. It is important to supply enough volume of all three kinds of food. Milk and egg are good supplements because of their availability and food quality. Fat is also added when the volume is enough but the calories are too low. The previous study showed that high daily energy food supplement assisted rehabilitation of malnutrition in children but it should be continued until the subjects reachs acceptable height for age (Heikens *et al*, 1989).

It was shown that malnourished children fed with a high protein diet (15% of total energy) gain significantly more body weight than those receiving less protein (7.5%).

Anthropometry is used to evaluate nutritional status. It should include length (height), weight, skin fold thickness and circumference (Durnin, 1991). In this study, AFA was much lower than AMA which suggests that the patients had more chronic depletion of calories than protein (Bogin and McVean, 1981).

Our study showed that 57% of the children had hematocrit of less than 36% while two had iron deficiency anemia. The previous study showed that rapidly growing weanings became vulnerable to iron deficiency when neonatal iron stores had been consumed after the first few months of life (Dallaman, 1991). Infant may have a harmless condition of depleted iron stores or iron deficiency anemia depending on the foods selected during the period of weaning. Breast feeding, iron and ascorbic acid fortified cow's milk formula, ascorbic acid-rich food, meat, egg yolk and liver decrease the likelihood of iron deficiency (Dallaman, 1991). In our study, anemia may have been due to protein and or iron deficiency. Stool examination showed parasites in only 12.5% of the patients.

Bone development may be delayed in children with malnutrition. If bone growth is definitely delayed thyroid function should be checked. In the cases that have malnutrition and delayed height increase, growth hormone deficiency should be suspected. In our study thyroid function and growth hormone levels were normal. The previous study showed that growth hormone levels in children with delayed growth were significantly higher than in normaly growing children and definitely fell after nutritional rehabilitation (Lo *et al*, 1987).

Improvement of nutritional status of malnourished children required improvement of nutritional intake both in volume and in quality. More calories and protein should be given. Methods of cooking and feeding are also very important. In some cases, there was sufficient volume of good quality foods available but the children refused to eat. Feeding problems should be discussed on every visit (one to two months interval). We found that 57% of cases showed improvement in body weight and height which was not correlated with familial income or education. Other anthropometric indices also improved. Only 29% of the cases improved in AFA, probably because the improvement required more time than our follow-up period. The nutritional program is reported to be more effective at curing than preventing malnutrition (Musgrove, 1990), although prevention of malnutrition is more important.

In conclusion, we have shown that nutritional advice can improve body weight and height in most infants and preschool children who are under the third percentile of weight for age. Nutritional advice is recommended in every case of childhood malnutrition.

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