

*editor: Robert B. Bradfield, Ph.D.***international nutrition****Effect of calorie supplementation on growth of undernourished children¹**

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It has been generally believed that the major reason for the widespread malnutrition and growth retardation in early childhood in many countries in the world is the existence of a "protein gap" in the diets of children in these countries. There has been overwhelming emphasis on protein deficiency as the major factor concerned in childhood malnutrition. Though the term "protein-calorie malnutrition" is often used, the general acceptance of this term does not appear to have had much effect upon general thinking or planning. Most people use the term "protein-calorie" and then proceed to discuss "protein" (1).

The synergistic role of infection in childhood and malnutrition is well recognized. This recognition should have normally led to an emphasis on the need for control of infections as an integral part of nutritional rehabilitation programs in poor communities. Instead, unfortunately, it has been again interpreted as indicating the need for an increased allowance of protein as a blanket coverage for infections, actual and potential, in underdeveloped areas. The failure to take a total view of all the ingredients leading to the "deprivation syndrome" commonly referred to as PCM and the deliberate undue emphasis on "protein deficiency" alone has resulted in unfortunate distortions in nutritional rehabilitation programs in several developing countries.

Probably a major reason for this is that precise data on the actual dietaries of preschool children in poor communities are

scanty. Most of the data on nutrient intake of preschool children in these areas have been generally derived from family diet surveys with the application of arbitrary "consumption coefficients." Because the distribution of food within a family does not always parallel physiological requirements of various age groups, the data thus obtained, using coefficients based on physiological consideration, often fail to reflect the actual dietary intakes of children. Under these circumstances, the relative importance of calorie gap and protein gap in the dietaries of the children has not been appreciated.

Direct assessment of the dietary intakes of a large number of preschool children carried out by experienced and trained investigators in a coordinated, countrywide study in India showed that in the current dietaries of preschool children, the major bottleneck was calories and not protein (2). This study showed that if children were to get quantities of even their present home diets in amounts that would meet their calorie requirements, their protein needs would have been met.

The effect of bridging the calorie gap on the growth and development of undernourished children in a poor Indian community has been investigated in the present study.

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Materials and methods

The investigation was carried out in nine villages in the environs of Hyderabad and were similar to those studied earlier (2) for assessing dietary intakes. A total of 415 children between the ages of 1 and 5 years, drawn from 343 families and belonging to the low income groups, served as subjects.

A diet survey was carried out on a subsample of 72 children, the results of which confirmed that their diets were essentially similar to those reported previously (3). The diet provided, on an average, approximately 700 kcal and 18 g of protein per day. The NDP Cal% of these diets (protein calories percent \times net protein utilization (operative) (4)) was found to be 5.8. On the basis of height- and weight-for-age, the children were divided into a control group ($n = 109$) and a group that received supplements ($n = 306$). The two groups were matched initially with respect to sex, height, and weight and the prevalence of nutritional deficiency signs were therefore comparable.

The food supplement consisted of wheat flour (23 g), sugar (35 g), and edible oil (10 g) and provided 310 kcal and 3 g protein.

The ingredients were cooked and prepared as sweet cakes. All children in the experimental group were assembled daily at a central place in the village and were fed the supplement 6 days a week. It was ensured that all children consumed the entire supplement. The time of the feeding was so arranged that the supplementary food did not result in less of the usual home diet being consumed. That the supplement was a real supplement and not a partial replacement of the home diets was confirmed by results of diet surveys done on these children before and during the period when the supplements were being given. The home diets were surveyed in 40 children before supplementation was initiated, and the survey was repeated 1 year later. No significant differences in the intakes of home diets between the two periods were noticed.

The feeding was carried out over a period of 14 months covering 276 feeding days. A daily record of attendance of the children receiving the supplement revealed an 85% attendance. Base-line data on the heights and weights of children along with a clinical assessment of their nutritional status was obtained before the start of the supplementary feeding and thereafter at intervals of 3 months.

During the course of the study, there was an outbreak of measles, with 114 of the 415 children being affected. Of these, 32 belonged to the control group and 82 to the experimental group.

Results

The results of the study are presented in Table 1.

There were no differences in the mean heights and weights as well as the prevalence

TABLE 1

Gain in height and weight of children whose diets were supplemented and unsupplemented over a period of 14 months

Age, years	Increment in height, cm			Increment in weight, kg		
	Supple-mented	Unsupple-mented	P	Supple-mented	Unsupple-mented	P
1-2	9.3 (25)	6.5 (9)	<0.001	2.35	1.74	<0.03
2-3	9.5 (50)	7.8 (26)	<0.001	2.34	1.71	<0.001
3-4	9.1 (65)	7.4 (33)	<0.001	2.04	1.58	<0.01
4-5	8.4 (71)	7.3 (15)	<0.014	1.86	1.38	<0.02

Figures in parentheses give number of subjects in each group.

of nutritional deficiency signs between the control and experimental groups of children at the start of the study. As increments in heights and weights were found to be not significantly different between sexes and between age groups, data have been pooled and presented.

The gains in both weights and heights at the end of the 14th month were significantly higher in children of all age groups who had received the supplement than in those who had not received the supplement. In fact, the mean increment in heights and weights corresponded to the 50th percentile increments observed in American children (5). Results of clinical assessment at the end of 14 months showed that there was a considerable reduction in the prevalence of signs of protein-calorie malnutrition in the supplemented group. During the course of the study, one child who was irregular in the supplemented group developed kwashiorkor (0.47%), whereas in the unsupplemented group, five children (4.59%; three kwashiorkor, two marasmus) developed severe protein-calorie malnutrition, one of whom expired. On the other hand, there was no significant difference in the prevalence of ocular signs of vitamin A deficiency and oral signs of vitamin B complex deficiency between the supplemented and unsupplemented groups. We wish to point out that the supplement did not provide these nutrients in adequate amounts.

As mentioned previously, an outbreak of measles in the community occurred during the course of this investigation, and this provided an opportunity to examine the effect of food supplements on the response to the disease. Eighty-two of 306 supplemented children and 32 of 109 unsupplemented children developed the disease. The percentage incidence in the two groups was thus similar. A comparison of the gains in weights and heights made 6 to 8 weeks after the infective episode of children with and without measles between the supplemented and unsupplemented group is given in Table 2. In the unsupplemented group, gains in heights and weights of the children who had developed measles were considerably lower than those in children who were not affected. In fact, in those who had developed measles, there was an actual loss in body weight (mean -0.3 kg) as against an increase in children who had not incurred the disease (mean 0.1 kg). In marked contrast, in children who had received the supplement, gain in heights and weights were similar, whether or not they had developed measles, and these increases were similar to those of the 50th percentile of American children (5). No measurements of heights and weights were taken during the attack of measles itself, and it is not possible therefore to comment on any difference there might have been present in the immediate response to infection between the two groups. The total protein intake of the children in the present study was 21 g/day (approximately 1.1 g reference protein/kg body wt), which is only marginally higher than the

recommended allowance of 1.0 g/kg body wt.

Discussion

Food supplements given here provided approximately 300 kcal and 3 g protein and may thus be considered to have bridged the calorie gap present in the habitual diets. The NDP Cal% of the food supplement was actually lower than that of the home diets. The observation that growth of undernourished children could be so strikingly improved by a food supplement, which provided adequate calories but increased the total protein intake only marginally, and which did not alter the protein quality of the diet, must be considered significant and as having practical implications. These data strongly support conclusions drawn from the results of the diet surveys that the primary bottleneck in the dietaries of preschool children living in poor communities in India is calories and not protein. What the children are really suffering from is in effect a "food gap." In such a situation, the use of protein concentrates that fail to meet the calorie requirements is obviously likely to be ineffective.

It is not suggested that "empty calories" should be provided to these children to make up the calorie deficit; this is neither desirable nor practicable. Even if the food supplements are predominantly cereal-based and conform to the type that the children regularly consume at home, not only will the calorie deficit be made up, but additional proteins will automatically be supplied.

Interaction between infection and nutrition

TABLE 2

Mean increments in height and weight over a period of 3 months of the children affected and not affected with measles

Age, years	Height, cm				Weight, kg			
	Supplemented		Unsupplemented		Supplemented		Unsupplemented	
	Measles	Nonmeasles	Measles	Nonmeasles	Measles	Nonmeasles	Measles	Nonmeasles
1-2	2.4	2.7	2.0	2.2	0.42	0.67	0.13	0.19
2-3	2.5	2.5	1.1	1.9	0.64	0.44	-0.19	0.05
3-4	2.4	2.4	1.3	1.6	0.48	0.37	-0.63	0.36
4-5	2.5	2.5	1.5	1.8	0.30	0.52	-0.12	-0.03

is well-known. Infections not only interfere with the absorption of protein, but also promote greater loss of nitrogen in urine, thus increasing protein requirements. On the basis of these considerations, it has been suggested that recommended allowances for protein for children in communities exposed to risk of recurrent infection be fixed at a level higher than for normal children.

The observation in the present study would show that a diet that provided no more than the recommended level of calories and protein for normal children was, in fact, adequate to meet the additional needs of an infective episode like measles.

Summary

The results reported here may be generally applicable to poor communities in several Asian countries where dietaries are based largely on cereals and to a smaller extent on legumes and pulses. They may perhaps not be applicable to situations in some African countries where the staples are tapioca and plantain.

The present observations should not be interpreted to mean that the current home diets in the concerned poor communities are satisfactory and do not need improvement. On the contrary, these diets are deficient in a number of nutrients, particularly vitamin A, riboflavin, iron, and possibly calcium. It should, however, be possible to overcome some of these deficiencies by improving the existing dietaries through the inclusion of relatively inexpensive foods that are locally available and well within the reach of the poor.

A question often raised is whether, in view of the bulk arising from low fat content and low calorie concentration, young children would be able to consume predominantly cereal-based diets in quantities adequate to meet their calorie needs. The present study shows that the bulk should not present an insuperable problem provided the total daily diet is divided into several appropriate meals in the course of the day.

The immediate practical approach towards combating malnutrition in children living in poor rural Asian communities would seem to lie in educating these communities in bridging the calorie gap with the present dietaries after such improvement, rather than in distributing elaborately processed "protein-rich formulations," which are unnecessary and expensive. ☞

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