The Recovery of Guatemalan Children with Mild to Moderate Wasting: Factors Enhancing the Impact of Supplementary Feeding

Juan A. Rivera, PhD, MS, and Jean-Pierre Habicht, MD, PhD, MPH

ABSTRACT

Objectives. The purpose of this study was to identify factors that enhance the recovery due to supplementary feeding in wasted children.

Methods. Recovery rates were obtained in mild to moderately wasted 6- to 48-month-old rural Guatemalan children living in four villages. Children in two villages received a high protein-energy supplement (supplemented children), while children in the other villages received a low protein-energy supplement (nonsupplemented children). The difference in recovery rates between the groups was the attributable benefit. The net supplementation amounted to 11% of the recommended energy intake and its associated nutrients.

Results. Attributable supplement benefits were achieved in younger children (6 to 24 months old) and increased with decreasing weight for length, longer duration of supplementation, and duration of diarrhea, but not with chronicity of wasting.

Conclusions. Supplementation's effectiveness can be improved in similar populations by programs targeted according to these findings. (*Am J Public Health.* 1996;86:1430–1434)

Introduction

The prevalence of moderate to severe wasting (percentage of children who are two or more standard deviations below the National Center for Health Statistics weight-for-height median) has been estimated to range from 2.7% to 18.8% in different regions of developing countries, with important differences among regions. The highest prevalences occur in Asia (18.8%) and Africa (10.1%), while the lowest is found in Latin America (2.7%).[1] However, even in Latin America, prevalences in some countries or regions and in certain age groups are relatively high. A national survey in 1988 showed a prevalence of 6.3% in children under 5 years of age in Mexico.[2]

Mildly to severely wasted children are often referred to supplementary feeding programs. A large number of preschool children in developing countries participate in such programs, and the resources used are substantial. For example, in 1985, in Central America alone, at least 635 000 children were beneficiaries of supplementary feeding in maternal and child nutrition programs. This number of children amounted to about 16% of the population under 5 years of age in Central American countries that year. The cost of the food distributed in these programs was almost $12 million (Institute of Nutrition of Central America and Panama, unpublished data, 1986). In a review of 104 programs in 19 Latin American and Caribbean countries, Musgrove[3] found that more than $1.6 billion is spent annually to subsidize or provide food for the more than 80 million people supposedly at risk of malnutrition (21% of the population). However, food distribution programs have often failed to improve the nutritional status of their beneficiaries because they are not always targeted to the children who are most likely to benefit.[4]

We have shown that supplementary feeding can be effective in curing mild to moderate wasting in a free-living population with inadequate home dietary intakes.[5] This article identifies factors in the same population that increase or diminish the effects of supplementary feeding on recovery from wasting. The results can be used for planning and targeting supplementary feeding programs or other interventions aimed at improving the nutritional status of wasted children through dietary improvements.

Methods

The analysis was carried out on data collected during a controlled supplementation trial conducted in rural Guatemala between 1969 and 1977. Detailed descriptions of the design, the sample, and the methods and quality control of the data collection have been published elsewhere.[6] A brief description follows. Four rural Guatemalan villages that were similar in population (500 to 1000 inhabitants), ethnicity, development, and geographical area were selected for the study. Two of the villages were randomly allocated to receive a moderate-energy (378 kJ/100 mL), high-protein (6.3 g/100 mL) drink (Atole). The remaining two villages were assigned to receive a low-energy

Juan A. Rivera is with the Instituto Nacional de Salud Publica, Cuernavaca, Morelos, Mexico. Jean-Pierre Habicht is with the Division of Nutritional Sciences, Cornell University, Ithaca, NY.

Requests for reprints should be sent to Juan Rivera, PhD, MS, Instituto Nacional de Salud Publica, Av. Universidad No 655, Sta. Ma. Ahuacatitlan, CP 62508, Cuernavaca, Morelos, Mexico.

This paper was accepted April 12, 1996.

(138.6 kJ/100 mL), nonprotein supplement (Fresco). The two supplements contained similar amounts of vitamins and minerals. Preventive and curative health services were offered in the four villages.[7] The supplements were distributed centrally in supplementary feeding centers and were available, on a voluntary basis, to all members of the community during two daily 3-hour sessions. Individual intakes of children 0 to 7 years old were measured and recorded at each session to the nearest 10 mL. As a result of the differences in the content of energy and nutrients between Atole and Fresco, the usual diet of children in the Atole villages was supplemented in significant amounts, while the diet of children in the Fresco villages was not supplemented significantly.[5]

The data used in this report were collected as follows. Weight was obtained at birth, and length was obtained at 2 weeks of age. Both measurements were made every 3 months thereafter for the first 2 years of life and, subsequently, every 6 months until 4 years of age. Home dietary intake, obtained by a 24-hour dietary recall method, was collected from 18 to 24 months of age every 3 months. Information on breast-feeding was obtained from biweekly home interviews with the mothers. In the same interviews, mothers were asked about the presence and duration of diarrhea, signs of respiratory disease, and fever during the previous 2 weeks.

The method used for analysis of the effect of supplementary feeding on recovery from wasting has been described in detail elsewhere.[5] Briefly, children were classified as belonging to a given weight-for-length category at the beginning of an age interval. The wasting category thresholds (usually 90% weight for length) were based on the National Center for Health Statistics–World Health Organization reference weight-for-length median as 100% of the expected value. A child was considered to have experienced recovery if, at the end of a specified time interval, he or she had gained enough weight to cross the initial weight-for-length category threshold. For example, for children in the less than 90% weight-for-length category, recovery was considered to be reached when the children had crossed the 89% threshold at the end of the study period. Recovery rates of wasted children whose diets were not improved (Fresco, or nonsupplemented, group) were subtracted from the rates of wasted children whose diets were improved (Atole, or supplemented, group). The difference in rates between supplemented and nonsupplemented groups (the difference attributable to supplementation) was considered the attributable benefit.

This method was applied for the assessment of effects of supplementation on recovery from wasting in subgroups of children according to categories of age, nutritional status, duration of supplementation, duration of wasting, and presence of diarrheal disease. It was suspected that all of these variables influence the effect of supplementary feeding on recovery from wasting; thus, they are referred to here as potential effect modifiers.

True dietary supplementation was considered to be achieved when a child's average supplement intake was above 10% of the recommended dietary intake for energy based on age. Depending on the particular age interval and category of potential effect modifier, between 37% and 54% of the children from the Atole villages achieved this level of supplementation. These groups are referred to here as supplemented groups. Supplements were available on demand, and mothers of children with high rates of participation were self-selected. Therefore, as a means of controlling for self-selection, the Fresco groups used for comparison with the supplemented groups (i.e., for estimating attributable benefits) were composed of children in a comparable upper distribution of intake of Fresco (upper 37% to 54% of the distribution of intake, depending on the particular group studied). These groups of children, referred to as the nonsupplemented groups, were considered to be comparable to the supplemented groups except for their supplemented dietary intakes. The difference in energy intake between the supplemented and the non-supplemented groups was 14.7% of the recommended intake. Home dietary intake did not differ between the two groups. No information was available about the quantities of breast milk consumed; however, children in the nonsupplemented group were breast-fed for a longer period. After the possible extra energy intake from breast milk in the nonsupplemented group had been taken into account,[5] the net increase in energy intake in the supplemented groups was about 11% of the recommended intake, with little differences between age categories. The differences in energy intake were accompanied by even larger differences in protein and smaller differences in other nutrients.[6]

Since some children experienced repeated episodes of wasting, contributing more than one observation in the sample, and a number of siblings were included in the group of wasted children, observations in the estimation of recovery rates from child intervals were not independent. As a result, the variances of the recovery rates were likely to be biased owing to cluster effects. As a means of avoiding potential biases in the estimation of variances, household intervals were used as units of analysis instead of child intervals. Within-household recovery rates were obtained, and the means of these rates and their variances were used for calculating attributable benefits. The mean household recovery rates of wasted children in the nonsupplemented groups were subtracted from the mean household recovery rates of wasted children in the supplemented groups to obtain the household attributable benefit (hereafter referred to simply as attributable benefit). Attributable benefit variances and 95% confidence intervals were computed and are presented here, along with the recovery rates.

The categories used for the assessment of each potential effect modifier were constructed as follows. The age category involved child intervals between 6 and 24 months of age and child-intervals between 24 and 48 months of age. The wasting categories were based on the percentage median weight for length of the National Center for Health Statistics–World Health Organization reference: (1) less than 90%, (2) 90.0% through 94.9%, and (3) 95.0% through 99.9%. Interval since the onset of wasting was defined as short term (less than 3 months since onset) or long term (3 or more months since onset). Duration of supplementation was categorized into 3-month, 6-month, and 12-month intervals. Time with diarrhea was expressed in the following categories (according to number of days with diarrhea during 3-month intervals): (1) without diarrhea, (2) between 1 and 25 days with diarrhea, and (3) more than 25 days with diarrhea.

The magnitudes of the attributable benefit among categories of potential effect modifiers were compared, and the differences were formally tested. For potential modifiers that involved two categories, a test of differences[8] was used; for those involving three categories, two distinct tests of differences were performed. The first test was used to compare the two extreme groups. This test for linear trend was followed by a test that

TABLE 1—Recovery Rates of Supplemented and Nonsupplemented Guatemalan Children with Wasting and Attributable Benefit for Different Categories of Effect Modifiers

	Treatment Group					
	Supplemented		Nonsupplemented			
Potential Effect Modifier	No.	Recovery Rate	No.	Recovery Rate	Attributable Benefit (95% Confidence Interval)	P for Attributable Benefit among Categories
Age, mo						
6–24	35	0.78	42	0.41	0.37 (0.18, 0.55)	<.05
24–48	32	0.73	72	0.65	0.08 (−0.09, 0.25)	
Degree of wasting, % weight for length						
<90	35	0.78	42	0.41	0.37 (0.18, 0.55)	
90–94	54	0.39	55	0.13	0.26 (0.11, 0.41)	<.05
95–99	70	0.18	74	0.08	0.10 (−0.00, 0.20)	
Duration of supplementation, mo						
3	72	0.59	97	0.41	0.18 (0.05, 0.30)	
6	64	0.62	78	0.37	0.25 (0.11, 0.39)	<.05
9	35	0.77	42	0.41	0.37 (0.18, 0.55)	
Chronicity of wasting						
Short term	51	0.58	73	0.38	0.20 (0.04, 0.37)	>.05
Long term	49	0.55	64	0.31	0.24 (0.08, 0.41)	
Time with diarrhea, d						
0	28	0.53	38	0.37	0.16 (−0.06, 0.39)	
1–25	48	0.63	67	0.38	0.25 (0.08, 0.41)	>.05
>25	20	0.51	16	0.18	0.33 (0.08, 0.56)	

evaluated departure from the linear trend by contrasting the values of the two extreme categories with the value at the center.[8] The tests of departure from linearity were never statistically significant and are not discussed further.

Logistic regression models, with child intervals as the units of analysis, were used to assess the effect of potentially confounding factors on attributable benefits. The dependent variable was a dichotomous variable indicating recovery from wasting (as defined earlier). The independent variables were an indicator variable for treatment groups (supplemented and nonsupplemented) and the following potentially confounding variables: duration of breast-feeding, birthweight, age, gender, initial weight, initial percentage weight for length, days with fever, days with diarrhea, days with respiratory disease, and mean dietary energy intake from 18 to 24 months of age. Adjusted recovery rates and attributable benefit values were obtained from the logistic regression models, and odds ratios for treatment were obtained and statistically tested. Since child intervals were used as units of analysis for the logistic regression models, a correction factor for the clustering effect was employed.[5]

Attributable benefit values lower than 0.10 were considered nonsignificant from a public health perspective, although in some cases effects of that size may be biologically important. Statistical significance was declared if the P value was less than .05 or the 95% confidence interval did not include zero. All results presented were statistically significant unless stated otherwise.

Results

Table 1 presents recovery rates for the supplemented and nonsupplemented groups, sample sizes, and attributable benefits for the different categories of effect modifiers. Results of the tests of differences in attributable benefits among categories of effect modifiers are also shown.

Recovery rates of supplemented children were similar between age categories (differences were not statistically significant). In contrast, the attributable benefit value for the younger category was large, while the value for the older category was small and not statistically significant. The attributable benefit values were different across age categories. Children included in this analysis were in the less than 90% weight-for-length category and were exposed to supplementation for 12 months.

The results that follow refer only to children between 6 and 24 months of age because the attributable benefit values of older children were small and not statistically significant for all of the categories of wasting, length of supplementation, time since onset of wasting, and presence of diarrhea tested.

Recovery rates and attributable benefit values decreased as the percentage weight-for-length category increased. Attributable benefit values in the less than 90% and 90% through 94.9% categories were statistically significant, while the value for the 95% through 99.9% category was not. Results refer to children supplemented for 12 months.

Since attributable benefit values were larger in the less than 90% weight-for-length category, a threshold often used for selection of beneficiaries of supplementary feeding, the remaining results are presented only for this category of wasting.

Recovery rates of supplemented groups increased as duration increased. Also, attributable benefit values increased from 0.18 at 3 months to 0.25 at 6 months and then to 0.37 at 12 months. The 3-month duration of supplementation is used in the following results.

Recovery rates and attributable benefit values were not statistically different between short-term and long-term wasting. Therefore, the remaining results do not differentiate between categories of chronicity.

The attributable benefit was larger than 0.10 for all three categories of days with diarrhea (without diarrhea, 0.16; 1 to 25 days with diarrhea, 0.25; more than 25 days with diarrhea, 0.33) and statistically significant among those in the two upper categories but not among those in the without diarrhea category. A trend of increasing attributable benefit values as time with diarrhea increased was observed. This trend was not statistically significant ($P > .05$), probably as a result of small numbers of children in each category.

Results from logistic regression models that controlled for potentially confounding variables (data not presented) were consistent with the attributable benefit results described earlier. For example, the adjusted attributable benefit values obtained from the logistic models were 0.20 and 0.34, respectively, for 3 and 6 months of supplementation of 6- to 24-month-old children in the less than 90% weight-for-length category (as compared with values of 0.18 and 0.25 in Table 1). The odds ratios were 4.37 for the logistic regression and 2.36 with no control for confounding; both were statistically significant. In fact, controlling for confounding tended to increase the attributable benefit values more often than not.

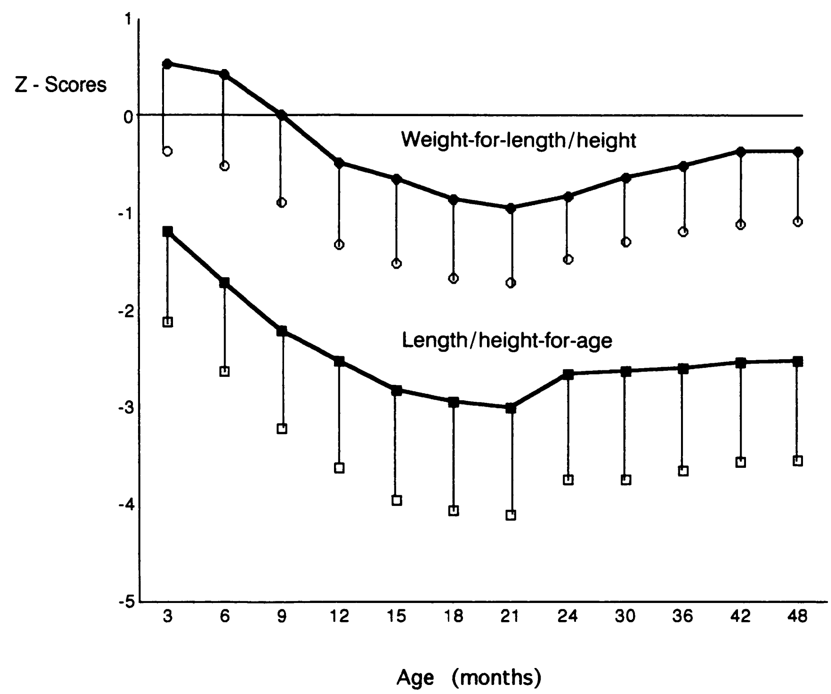

FIGURE 1—Mean (minus 1 SD) of weight-for-length/height and length/height-for-age z scores between 3 and 48 months in the nonsupplemented group of children (cross-sectional data).

Discussion

The choice of categories for the definition of wasting and recovery in this analysis stemmed from the use of categorical thresholds as criteria for admission to and discharge from supplementary feeding programs. Results of analyses using increments of percentage weight for length (data not presented) were consistent with the results presented.

Past studies have shown recovery rates of mildly to moderately wasted children ranging from 40% to 80%[9,10]; however, these studies did not use comparison groups. Therefore, the rates cited in these studies overestimate effects of supplementation.[5] Using appropriate comparison groups, we have shown[5] that the true effects of supplementation (i.e., the attributable benefits) are lower than those identified in previous reports, ranging in our population between 29% and 52%.

Participation in the supplementation programs in this study was the result of self-selection. The potential confounding effect of self-selection was accounted for in the analyses by comparing the recovery rates of children in Atole and Fresco villages with similar levels of participation in the supplementation programs.

In our previous report,[5] we showed a dose effect of supplementation between high and low participation in the Atole villages (a difference of 0.15 in attributable benefit value) and a lack of dose effect between high and low participation in the Fresco group, reinforcing the inference of unconfounded effects of supplementation on recovery from moderate wasting. In addition, in the present study, we controlled for a number of potential confounding factors in logistic regression analyses.

Moreover, the overall attributable benefit at the village level was 12%,[5] still statistically significant but lower than the attributable benefit value among high participants in the supplemented group because half of the children consumed small amounts of supplement (less than 10% of the recommended dietary intake). These overall effects were obtained with the village as the unit of analysis; hence, advantage was taken of the randomized study design. Thus, the probability of confounding was less than 5%.

The combination of the results of analyses that used the village as the unit of analysis and those of analyses that used children as units of analysis but controlled for confounding represents conclusive evidence that the attributable benefit effect was due to the supplementation and not to confounding.

In our previous paper,[5] we showed that significant attributable benefit values were restricted to children who received 10% or more of the recommended dietary intake from the supplement. The net effect of supplementation was about 11% of the recommended dietary intake, a significant contribution to the baseline dietary intake of about 75% of that recommended.

The effect of supplementation on recovery from wasting was restricted to children between 6 and 24 months of age. Older children had attributable benefit values that were no different from zero. This finding should be viewed in light of the weight-for-length/height pattern by age observed in the absence of supplementation. Figure 1 presents mean *z*-score weight-for-length/height values at different ages from birth to 42 months for children in the Fresco villages. Mean *z*-score values declined from 6 to 18 months, when the lowest value was reached. From 18 to 21 months, the values did not change, and, after 21 months, a trend of increasing values is observed at subsequent ages in the absence of supplementation. This can explain the lack of effect of supplementation after 24 months. The increase in mean z-score weight-for-length values after this age was not due to an increase in stunting in this period. As shown in Figure 1, after 24 months, the height-for-age z scores of the nonsupplemented group did not change, indicating that growth during this period was similar to that of the reference population.

Attributable benefit values were inversely related to the initial percentage weight-for-length values. The linear trend observed between the less than 90% and 95% through 99.9% weight-for-length categories indicates that, when resources are limited, programs should be targeted to those with the lower weight-for-length values.

Attributable benefit values did not differ according to the time since the onset of wasting. Thus, chronicity is not useful for the selection of beneficiaries.

Attributable benefit values were positively associated with duration of supplementation. Although effects of supplementation were statistically significant as early as 3 months after supplementation, longer durations of supplementation (6 and 12 months) delivered additional benefits. The results indicate that mildly to moderately wasted children benefit from long-term supplementation. However, while the attributable benefit value during the first 3 months of supplementation was 0.18, it dropped to 0.10 per trimester from 3 to 12 months of supplementation, indicating larger effects during the first trimester. Thus, in choosing the length of supplementation, availability of resources should be considered relative to the number of children in each weight-for-length category. The choice of 3 months of supplementation may be preferable when resources are scarce and a large number of children are below 90% weight for length. However, longer periods of supplementation may be preferable when a smaller proportion of children are below 90% weight for length.

Attributable benefit values were biologically meaningful for all three categories of diarrhea, as was the trend of increasing attributable benefit with increased diarrhea. The lack of statistical significance for the attributable benefit of children with no diarrhea and for the trend was possibly due to small sample sizes in the higher and lower diarrhea categories. A possible reason for a larger effect of supplementation in children having more days with diarrhea is that after diarrhea has ceased, during the convalescence period, the appetite of children may increase and catch-up growth may occur. Children who have extra food available (supplemented children) may consume more food during this period than nonsupplemented children, and, as a result, they may gain more weight. Another explanation is that days with diarrhea might be a good proxy for an unhygienic environment characteristic of poor families. Since malnutrition is more prevalent in poorer children, a large proportion of children with low weight for length living in poor conditions are truly wasted, while among those in better conditions a large proportion with low weight for length are false positive. Whatever the reason, the findings show that children who have diarrhea during supplementation benefit somewhat more. Therefore, selecting children who are at risk of diarrhea may be advised when resources are scarce.

This paper has examined effect modifiers of supplementation on recovery from mild to moderate wasting (curative approach). Effect modifiers may be different for the effect of supplementation on the prevention of wasting (preventive approach) and for the effect of supplementation on stunting.

The results indicate that the greatest effects of supplementation on mildly to moderately wasted children in populations similar to the Guatemalan children studied here are likely to be achieved in young children (6 to 24 months of age) and with increasing duration of supplementary feeding. A high prevalence of diarrhea was also associated with larger effects. Duration of wasting before supplementation did not predict any increase in benefit from supplementation.

These findings are probably generalizable to other populations if the age pattern of weight loss in the population is taken into account and the quality of the supplement is similar to that of the Atole[6] supplement used in this study. The latter is usually the case.

This information can be useful for the design of supplementary feeding programs aimed at alleviating wasting in similar populations and for improving effectiveness by targeting such programs, according to our findings, toward children more likely to benefit. □

Acknowledgments

Data analyses were supported by National Institutes of Health grant R01 HDD22440-07A1 and Pew charitable trust grant 90-00210-00.

We are grateful to the many investigators, field-workers, and data managers from the Institute of Nutrition of Central America and Panama who conducted the longitudinal study that was the basis for this article.

References

1. Victora CG. The association between wasting and stunting: an international perspective. *J Nutr.* 1992;122:1105–1110.
2. Rivera-Dommarco J, González-Cossío T, Flores M, Hernández-Avila M, Lezana MA, Sepúlveda-Amor J. Déficit de talla y emaciación en menores de cinco años en distintas regiones y estratos en México. *Salud Publica Mex.* 1995;37:95–107.
3. Musgrove P. Feeding Latin America's children. *World Bank Observer.* 1993;8:23–45.
4. Beaton GH, Ghassemi H. Supplementary feeding programs for young children in developing countries. *Am J Clin Nutr.* 1982;35(suppl):864–916.
5. Rivera JA, Habicht JP, Robson DS. Effect of supplementary feeding on recovery from mild to moderate wasting in preschool children. *Am J Clin Nutr.* 1991;54:62–68.
6. Habicht J-P, Martorell R. Objectives, design and implementation of the INCAP Longitudinal Study (1969–77). *Food Nutr Bull.* 1992;14:176–190.
7. Habicht J-P, Working Group. *Rural Medical Care: Delivery of Primary Care by Medical Auxiliaries: Techniques of Use and Analysis of Benefits Achieved in Some Rural Village in Guatemala.* Washington, DC: Pan American Health Organization; 1973:24–37. PAHO/WHO scientific publication 278.
8. Snedecor GW, Cochran WG. *Statistical Methods.* 8th ed. Ames, Iowa: Iowa State University Press; 1989.
9. Beghin ID, Viteri FE. Nutrition rehabilitation centers: an evaluation of their performance. *J Trop Pediatr Environ Child Health.* 1973;19:403–416.
10. Beaudry-Darisme M, Latham M. Nutrition rehabilitation centers: an evaluation of their performance. *J Trop Pediatr Environ Child Health.* 1973;19:299–332.