Evaluation of the impact of weaning food messages on infant feeding practices and child growth in rural Bangladesh[1-3]

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ABSTRACT In rural Bangladesh, a community-based weaning intervention used volunteers to teach complementary feeding to families of 62 breast-fed infants aged 6–12 mo. Over 5 mo, treatment children gained on average 0.46 SD ($\approx$460 g) more in weight-for-age (WAZ) than the 55 control subjects, and were $\approx$0.5 kg heavier at the final measure. The differences were statistically significant ($P < 0.001$). The percent median weight-for-age (WAPM) of treatment children held steady at 76% of the National Center for Health Statistics' reference, whereas the WAPM of control subjects dropped from 78% to 72%. The increase in percentage points of severe malnutrition (below −3 WAZ) was only 5% in the treatment group compared with 26% in the control subjects. Treatment children consumed a significantly greater percent of their energy and protein requirements from complementary foods than did control subjects. The affordable complementary foods consisted mainly of cereal porridge with oil and brown sugar. These findings suggest that educational interventions teaching families to feed hygienic, simple, cheap, energy-enriched complementary foods to breast-fed infants after 5–6 mo can improve child growth, even under impoverished conditions. *Am J Clin Nutr* 1992;56:994–1003.

KEY WORDS Nutrition education, weaning, breast-feeding, dietary intake, malnutrition, children, Bangladesh

Introduction

In Bangladesh, numerous obstacles impede achieving good child health, including extreme poverty, frequent natural disasters, a poorly functioning health infrastructure, poor sanitation, and low literacy. Childhood malnutrition and mortality rates are among the highest in the world (1); an estimated nine million (56%) children aged < 5 y are chronically undernourished (2). As in other developing countries, Bangladeshi children gain weight well within the first few months after birth, but before 4–6 mo, weight gains falter relative to international standards (2–4). One study documents that 90% of rural girls and boys are below the 5th percentile of the National Center for Health Statistics (NCHS) reference standards by ages 8 and 15 mo, respectively (5).

Some of the growth deficit is likely due to poor diets and feeding practices. Nearly 100% of newborn infants in rural areas are breast-fed, and breast-feeding continues through the second and into the third years of life (6). However, undernourished mothers produce insufficient quantities of breast milk to meet the needs of children aged > 4–6 mo (7, 8), and complementary feeding fails to make up the nutrient deficit. Traditionally, Bangladeshi women do not persistently encourage their infants to eat other foods until $\approx$18–24 mo (9, 10; GS Guldan, unpublished observations, 1988).

Mothers restrict complementary feeding because they believe foods cause "stomach problems" (10, 11) and because their heavy domestic work schedules limit feeding time. Relatively, exclusive breast-feeding may have evolved as protection against severe cholera, which is endemic in Bangladesh (12). Infants themselves also limit food intake, possibly because of anorexia from infections (13) and satiety from frequent suckling (GS Guldan, unpublished observations, 1988).

Small amounts of liquid and solid foods (milk, cereal, and tastes of the family food) are offered in the first year of life, although these rarely include vegetables, fish, and lentils. Some evidence suggests that feeding practices favor males (2, 9, 14); however, girls may be fed more complementary foods in the 9–18-mo age range when cultural norms dictate that the baby not yet receive the family diet (15).

Exposure to education and information empowers a mother to maximize the resources around her for the health of her child (16, 17). But whether nutrition education alone can successfully improve children's diets under conditions of extreme poverty remains unclear.

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[2] Supported by the Social Sector Policy Analysis Project (SSPA), operated by the Academy for Educational Development (AED), contract no. PDC-0082-C-00-9080-00, for the Bureau for Program and Policy Coordination, Office of Policy Development and Program Review (PPC/PDPR) of the US Agency for International Development (AID); the PPC/PDPR of AID under contract no. PDC-0082-0-00-8118-00; and the Asia and Near East Bureau of AID (ANE/TR) through the US Office of International Health (OIH), Public Health Service Contract no. 282-86-0011.

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Received November 20, 1991.

Accepted for publication June 12, 1992.

 Am J Clin Nutr 1992;56:994–1003. Printed in USA.

In the present study, nutrition messages were designed for the Bangladesh Rural Advancement Committee's (BRAC) Child Survival Program to encourage complementary feeding of breast-fed infants after age 5–6 mo. Initial field observations suggested that infant-feeding practices of rural mothers could be modified through message dissemination by using modeling techniques. A follow-up survey in March 1988 confirmed these findings. However, we felt it essential to evaluate the impact of the complementary feeding messages on both the adequacy of the children's nutrient intakes from complementary foods and the nutritional status and growth of the children.

Methods

Intervention design

From May through November 1987, BRAC and Tufts University conducted a weaning intervention in a rural site in the Harirampur Upazilla of Bangladesh. The intent of the project was to develop feasible messages, through community-based behavioral trials, to encourage families to feed complementary foods to their breast-fed infants. The procedures followed were in accordance with the guidelines of the Tufts University Human Subjects Committee.

Field trials are described in detail elsewhere (18, 19). Briefly, eight village workers (VWs) were hired from the local community by BRAC. Additional staff included a supervisor, an anthropologist, and a nutritionist. The preliminary messages were developed by the VWs and technical staff and included in-home demonstrations of snack-type recipes and instructions for enriching meals with energy, protein, and other nutrients by adding oil, molasses, milk, fish, and lentil flour to foods or by offering vegetables or seasonal fruits. The messages also encouraged continued breast-feeding in addition to frequent and persistent feeding of new foods. A message on hygiene discussed proper food storage and the need to wash hands and utensils adequately before cooking and feeding.

The messages were then tested and revised. At the end of the project, messages were synthesized and modified on the basis of observations and outcomes during the intervention. The approach to teaching was family oriented, involving the child's mother, father, and grandmother.

Sampling

We identified families in three villages, through a BRAC census conducted in January 1987, with weaning-age children living near other families with children this age to whom they could disseminate the educational messages. Control mothers with children in the same age ranges as the treatment mothers' were recruited from five villages, located ≈1 h by foot away from the nearest intervention village, by using as a sampling frame a BRAC baseline nutritional-status survey conducted in January 1987. After initial screening, 117 children (62 treatment, 55 control subjects) were included in the sample. These children ranged in age from 4 to 14 mo at baseline to 9 to 18 mo at the final measurement.

Data collection and survey instruments

Baseline anthropometric, dietary, and socioeconomic (SES) data were collected on all sample households, and anthropometric, dietary, and child-morbidity data were collected monthly except during serious flooding in August and September. Weight was measured with a portable 25-kg dial scale, and arm circumference (AC) was measured with TALC (Teaching Aids at Low Cost; St Albans, UK) tape. The child's 24-h food recall was recorded on a pretested instrument containing common Bangladeshi foods (20, 21). Workers were trained in anthropometry by using methods developed by Zerfas (22) and in dietary-recall techniques by using a 24-h instrument developed by Zeitlin et al (20). Child-morbidity data consisted of mother's monthly recall of the type of illness and the approximate number of days during the month that the child was sick.

Data analysis and variable construction

The impact of each education program was evaluated based on changes in pre- and posteducation indicators for dietary adequacy and nutritional status, after baseline differences between treatment and control groups were adjusted for.

The children's weights, converted to Z scores (WAZ) according to the NCHS and World Health Organization (WHO) standards for age and sex (23), were used for statistical comparisons. Actual weights and percent of reference median weight-for-age (WAPM) according to the same standards were displayed for descriptive purposes. Because adequate standards were not available for AC of children aged < 1 y, raw values were used and the age and sex of the children were controlled for in the analyses. The baseline anthropometric variables were taken as the first measurement available during the May–July recruitment. For the final variables, the last measurement available during the months of October and November was used.

Infant intakes of energy, protein, fat, vitamin A, and iron from complementary foods were computed from 24-h dietary recalls by using Bangladesh food-composition tables (24) and US Department of Agriculture tables (25). Because all sample infants were breast-feeding throughout the study and test weighings for breast milk output were not feasible, the quantity of breast milk consumed at each age was estimated from research on a comparable Bangladeshi sample (7, 8).

Energy requirements per kilogram of body weight for infants aged 0–12 mo were derived from the FAO/WHO/UNU equation

$$\mathrm{kcal \cdot kg^{-1} \cdot d^{-1}} = [(123 - 8.9(\mathrm{age})) + 0.59(\mathrm{age})^2] \times 1.05$$

For children aged 12–24 mo, the estimated daily requirement was 440 kJ/kg (105 kcal/kg) (26). FAO/WHO/UNU protein requirements were also based on the child's age in months (26), with an extra 50% added to this requirement in graduated increments for children aged > 5 mo (27; NS Scrimshaw, MIT, UNU, personal communication, 1989) to compensate for high infection rates. The resulting safe protein requirement ranged from 2.3 g/kg for newborns to 1.7 g/kg for children 24 mo old. The protein content of nonanimal foods was adjusted for quality, assuming 85% digestibility and a 75% amino acid score (26).

Because most of the village children weighed far less than the international norm, estimates of daily maintenance requirements for energy and protein, as described above, probably would be insufficient for catch-up growth or to meet the additional requirements associated with frequent infections. Therefore, ideal requirements were also determined by using the NCHS median weight for the child's chronological age and sex (23) instead of actual weights (24).

The children's daily iron requirement ranged from 5 to 9 mg, depending on age. The vitamin A requirement was estimated at 300 μg RE for children aged < 12 mo and 250 μg for children aged > 12 mo (28).

Pre- and postintervention variables were created for all the above nutrient adequacies, both with and without estimates of breast milk intake. The baseline dietary variables were taken as the first 24-h recall available, and the final measures were created by averaging the final three 24-h recalls.

For analysis, the mother's monthly recall of the child's illness was grouped into *1*) gastrointestinal illness (diarrhea, dysentery, vomiting), *2*) respiratory and oral infections (cold, cough, throat or mouth infections), *3*) fever, *4*) measles, and *5*) other (skin or eye infections and other minor illness). When all the available observations for each child were combined, the mean percent of days per month the child was sick with the illness category was computed and used to control for the effects of morbidity on child growth.

SES indicators collected at baseline included education and literacy of household members, occupation, housing type, amount of land, solvency, source of drinking water, latrine type, and possessions. Scales for household possessions or traditional wealth, agricultural possessions or agricultural wealth, and modernization and education were created for each household. Acceptable internal consistencies of the scales were confirmed by using *SPSSX's* Reliability Program with Cronbach's Alpha (SPSSX, Inc, Chicago). Characteristics of sample children and their families are presented in **Table 1**.

TABLE 1
Characteristics of sample children and their families

	Treatment (n = 62)	Control (n = 55)
Child's age (mo)		
Baseline	8.1 ± 1.8*	8.2 ± 2.5
Final	12.9 ± 1.8	13.0 ± 2.0
Mother's age (y)	27.5 ± 6.5	27.9 ± 6.5
Household members	7.4 ± 3.0	5.5 ± 2.1†
Mother's number of children	3.0 ± 1.8	2.8 ± 1.5
Mother's education (%)		
None	92	84
Some primary	3	2
Completed primary	3	9
Some secondary	2	5
Religion (%)		
Moslem	94	53‡
Hindu	6§	47‡§
Owns house and lot (%)	98	64‡
Landless (%)	47	91‡
Tubewell water source (%)	100	98
Bamboo, non pit latrine (%)	94	93
Major source of income (%)		
Farming	34	7‖
Agricultural/skilled labor	21	20
Government service	11	22‖
Business	16	20‖
Other	18	31‖

* $\bar{x}$ ± SD.
† Significantly different from treatment, $P < 0.001$ (t test).
‡‖ Significantly different from treatment, (chi-square test): ‡$P < 0.001$, ‖$P < 0.05$.
§ Significantly different from Moslems, $P < 0.001$ (chi-square test).

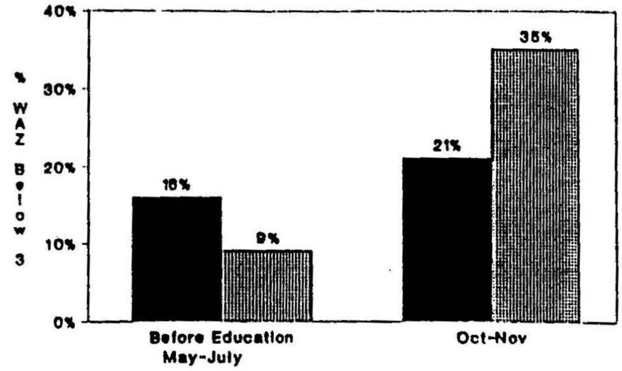

FIG 1. Percent of children severely malnourished [weight-for-age Z scores (WAZ) < −3] before and after weaning food education. For control subjects (□) the increase in percent of severely malnourished children is statistically significant, whereas the increase for treatment children (■) is not.

Statistical methods

The impact of the education intervention was determined by examining the differences in the baseline and endpoint variables with analysis of covariance (ANCOVA). Adjusted mean values for treatment and control groups were calculated for anthropometric and dietary variables, with wealth, mother's education, morbidity, child age and sex, mother's age, and baseline nutritional status or nutrient intake controlled for; t tests were used to determine group differences in morbidity. The McNemar nonparametric test for changes from pre- to postintervention was used to determine the significance of the change in the number of severely undernourished children in each group. Statistical significance was defined as $P < 0.05$.

Results

Changes in nutritional status

We defined severe malnutrition by using the United Nations Children's Fund (UNICEF) cutoff of 3 SD below the international reference for the child's weight-for-age and sex (29). **Figure 1** shows that the percent of severely malnourished children in the control group increased significantly ($P < 0.001$) over the study period, whereas the increase was not significant for treatment children (P = 0.508).

WAZs before and after treatment are presented in **Table 2**. The adjusted mean baseline WAZ was similar for control and treatment children (−1.94 vs −2.11); the average child was already moderately malnourished when recruited. The adjusted final mean WAZ of the treatment group was 0.46 SD greater than that of control subjects, indicating that treatment children were nearly 0.5 kg heavier than control children at the final measurement. The adjusted change in WAZ was also significantly different for the two groups ($P < 0.001$). Treatment children grew 0.46 SD more than the control group, which translates to an improvement of ≈460 g over 5 mo.

TABLE 2
Adjusted mean weight-for-age Z scores (WAZ) for weaning-age children before and after nutrition education*

	Baseline†	Final	Change
WAZ			
Treatment (n = 62)	−2.11	−2.22	−0.19
Control (n = 55)	−1.94	−2.68	−0.65
F for main effects	0.97	22.10‡	22.10‡
R^2	0.39	0.77	0.57
F for model	14.25‡	45.44‡	17.96‡
F for covariates	17.57‡	48.77‡	17.37‡
Baseline WAZ	—	239.33‡	18.81‡
Child's age	52.25‡	9.30§	9.30§
Child's sex	3.27	—	—
Modern/education	8.80§	—	—
Agricultural wealth	0.04	4.64‖	4.64‖
Diarrhea	—	20.30‡	20.30‡
Respiratory illness	—	8.22§	8.22§
Mother's education	—	3.02	3.02
Child's final food energy	—	0.18	0.18

* Means adjusted by analysis of covariance for significant covariates and potential confounding variables (as listed above).

† Measurements taken between May and July with mean ages of 8.1 and 8.2 mo for treatment and control children, respectively; final measurements taken between October and November with mean ages of 12.9 and 12.0 mo for treatment and control children, respectively.

‡ $P < 0.001$.

§ $P < 0.01$.

‖ $P < 0.05$.

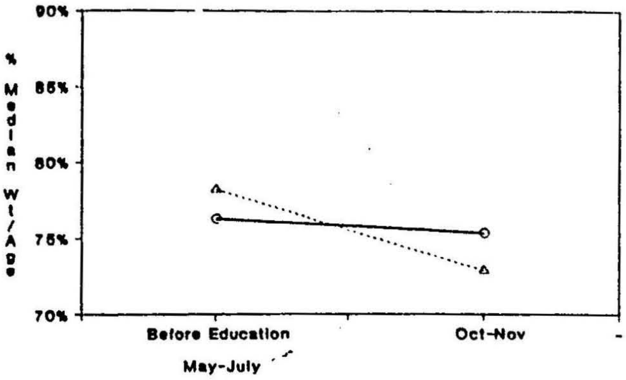

FIG 3. Weight adequacy [% of reference median weight-for-age (WAPM)] in children when family members receive weaning food education. Although the WAPM of treatment children (■) held steady, it dropped in control children (□).

AC data are presented in Table 3. There were no differences between the AC of treatment and control children at baseline. However, at the final measure, AC was significantly larger for treatment children than for control children, as was the change, showing an increase over the study period of 0.8 cm compared with only 0.3 cm in control children.

The average number of days per month that children were sick with each type of illness was similar for treatment and control groups, except that skin diseases were more common (P = 0.008)

Figure 2 illustrates the actual weight gain for treatment and control children relative to the cutoff for moderate malnutrition (2 SD below the reference). These gains represent 89% and 63%, respectively, of expected growth for children in this age range growing 2 SD below the median of international standards (26).

The unadjusted values for WAPM are presented in Figure 3. Adjusted figures were similar. Although the WAPM of treatment children held steady at 76%, that of the control subjects dropped from 78% to 72%.

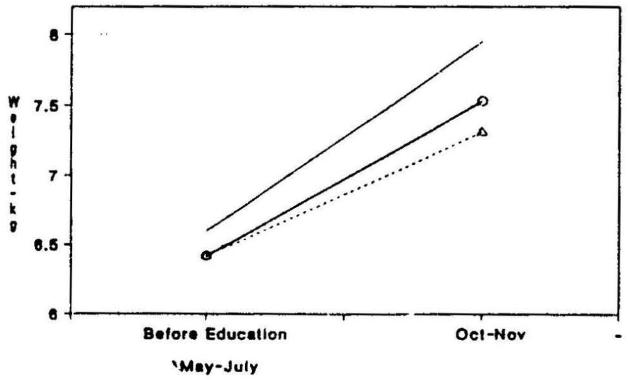

FIG 2. Weight gain in children when family members receive weaning food education relative to the −2 SD reference (—) for moderate malnutrition. Although neither treatment (O) nor control (Δ) children continue to track parallel to the −2 SD curve, control children gained significantly less weight than did treatment children.

TABLE 3
Adjusted mean arm circumference (AC) for weaning-age children before and after nutrition education*

	Baseline†	Final	Change
AC (cm)			
Treatment (n = 62)	13.1	13.8	0.7
Control (n = 39)	12.9	13.3	0.4
F for main effects	0.11	6.56‡	6.56‡
R^2	0.08	0.48	0.24
F for model	1.29	8.45§	2.°1‖
F for covariates	1.53	8.66§	2.50‡
Baseline AC	—	61.31§	18.06§
Child's age	3.97‡	0.15	0.15
Child's sex	2.31	0.23	0.23
Traditional wealth	0.84	0.30	0.00
Agricultural wealth	0.00	0.01	0.01
Diarrhea	—	0.71	0.71
Respiratory illness	—	0.01	0.01
Mother's education	0.09	0.92	0.92
Child's final food energy	—	0.87	0.87

* Means adjusted by analysis of covariance for significant covariates and potential confounding variables (as listed above).

† Measurements taken between May and July with mean ages of 8.1 and 9.9 mo for treatment and control children, respectively; final measurements taken between October and November with mean ages of 12.9 and 13.6 mo for treatment and control children, respectively.

‡ $P < 0.05$.

§ $P < 0.001$.

‖ $P < 0.01$.

TABLE 4
Adjusted mean ideal energy adequacy of diets for weaning-age children before and after nutrition education*

	Baseline†		Final	
	Food only	Food and breast milk	Food only	Food and breast milk
Energy adequacy (% of ideal requirements)				
Treatment (n = 62)	16.3	63.9	20.2	55.5
Control (n = 56)	13.8	61.4	11.6	46.4
F for main effects	0.53	0.49	17.15‡	17.37‡
R^2	0.11	0.19	0.38	0.45
F for model	2.76§	5.06‡	8.20‡	10.98‡
F for covariates	3.32§	6.20‡	6.92‡	10.07‡
Child baseline food energy	—	—	15.68‡	—
Child baseline total energy	—	—	—	15.65‡
Child's age	1.93	10.41‖	1.39	7.80‖
Traditional wealth	0.35	0.17	0.10	0.07
Agricultural wealth	1.91	1.78	3.16	5.54§
Diarrhea	—	—	0.17	0.13
Respiratory illness	—	—	0.93	2.00
Mother's education	9.99‖	9.08‖	13.17‡	10.40‖

* Means adjusted by analysis of covariance for significant covariates and potential confounding variables (as listed above). Ideal energy requirement based on international reference median weight for child's age and sex; adjusted means are expressed as a percent of this requirement. Breast milk quantities at each age estimated from research on a comparable Bangladeshi sample (8, 9).

† Baseline measurements taken between May and July with mean ages of 8.1 and 8.2 mo for treatment and control children, respectively; final measurements taken between October and November with mean ages of 12.9 and 12.0 mo for treatment and control children, respectively.

‡ $P < 0.001$.

§ $P < 0.05$.

‖ $P < 0.01$.

in the treatment children. More than half the sample children had at least one episode of diarrhea, respiratory illness, or fever during the 5 mo observed; children were sick an average of 6–7% of the days per month (or 1.5–2 d/mo) with each illness. Illness rates exhibited seasonal trends. Reported diarrheal episodes were highest during the hot, dry months at the beginning of the study and through the rainy season, encompassing May through September. Severe floods, which prevented data collection during the middle of the study period, and the limited sensitivity of the monthly recall reduced our ability to determine whether diarrheal rates increased with complementary feedings.

Dietary adequacy

Table 4 summarizes the energy adequacies of the children's diets relative to ideal requirements. Percent energy adequacy was calculated by using intakes from complementary foods only and from both complementary foods and breast milk (estimates). All sample children were breast-feeding throughout the study. In addition, at baseline nearly three-fourths (68% treatment, 73% control subjects) were eating other foods, which provided ≈20% of total energy. At the final measurement, all treatment children and 86% of control children were consuming complementary foods.

Although the energy adequacy of food alone decreased from the initial measurement in control children, it increased in the treatment group. However, the extra food consumed by the treatment children did not compensate for the growing children's increased energy requirement and (estimated) decreased breast milk intake. Therefore, the energy adequacy of the diet, including breast milk, decreased for both groups over the study period. The decline was less for treatment than for control children, and the adjusted total ideal energy adequacy of the diet (including breast milk) was significantly greater ($P < 0.001$) after the intervention for treatment children than after that for control children (56% vs 47% of ideal). Findings were similar when maintenance requirements were used (data not shown). At the final measurement, treatment children were consuming ≈306 $kJ \cdot kg^{-1} \cdot d^{-1}$ (73 $kcal \cdot kg^{-1} \cdot d^{-1}$) and the control children only 272 $kJ \cdot kg^{-1} \cdot d^{-1}$ (65 $kcal \cdot kg \cdot d^{-1}$), including breast milk estimates.

As illustrated in Table 5, baseline protein intakes were similar for both treatment and control groups, whereas adjusted final protein adequacy from complementary food was significantly greater for the treatment group. Although the protein adequacy provided by complementary food increased in the treatment group from initial to final recall, it declined for the control group, reflecting the differences in weaning foods traditionally offered to younger rather than older children. Female children fared better than males in the protein adequacy of their diets.

TABLE 5
Adjusted mean ideal protein adequacy of diets for weaning-age children before and after nutrition education*

	Baseline†		Final	
	Food only	Food and breast milk	Food only	Food and breast milk
Protein adequacy (% of ideal requirements)				
Treatment (n = 62)	19.8	53.5	20.2	46.2
Control (n = 55)	15.4	50.6	11.2	38.2
F for main effects	0.72	0.31	22.54‡	20.08‡
R^2	0.21	0.27	0.40	0.40
F for model	4.73‡	6.75‡	7.82‡	8.00‡
F for covariates	5.54‡	8.04‡	5.98‡	6.49‡
Child baseline food protein	—	—	7.50§	—
Child baseline total protein	—	—	—	5.68‖
Child's age	0.09	7.24§	4.49‖	1.56
Child's sex	0.04	0.24	4.06‖	9.70§
Traditional wealth	0.01	0.00	1.06	1.83
Agricultural wealth	1.44	0.99	13.92‡	13.39‡
Diarrhea	—	—	3.64	3.06
Respiratory illness	—	—	0.00	0.16
Mother's education	25.38‡	26.74‡	7.61§	10.47§

* Means adjusted by analysis of covariance for significant covariates and potential confounding variables (as listed above). Ideal protein requirement based on international reference median weight for child's age and sex; adjusted means are expressed as a percent of this requirement. Breast milk quantities at each age estimated from research on a comparable Bangladeshi sample (8, 9).

† Measurements taken between May and July with mean ages of 8.1 and 8.2 mo for treatment and control children, respectively; final measurements taken between October and November with mean ages of 12.9 and 12.0 mo for treatment and control children, respectively.

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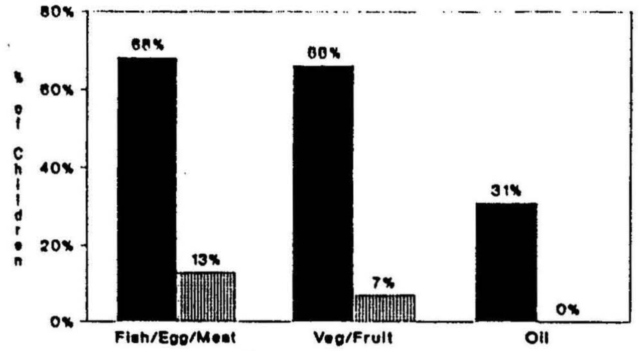

FIG 4. Consumption of selected foods by weaning-age children (13.0 ± 1.9 mo; $\bar{x}$ ± SD) after family members received weaning food education. Treatment children (O) consumed significantly more animal products, fruits and vegetables, and oils than did control children (Δ).

As with energy, the protein adequacy of the total diet (food and breast milk estimates) declined in both groups because of the decrease in (estimated) breast milk quantity as the child grew older. However, the adjusted protein adequacy of the diet, including breast milk and food, was significantly ($P < 0.001$) greater after the intervention for treatment children than after that for control children (46% vs 38%, respectively, of ideal requirements). Similar findings were obtained when maintenance protein requirements were used (data not shown).

Converted to grams per kilogram per day for descriptive purposes, the final protein intake was 1.39 g/kg for treatment children and 1.12 g/kg for control children. The trend is similar for treatment and control children with or without breast milk estimates, with treatment children increasing their daily total protein intake (from 9.9 to 10.4 g, including breastmilk), and control children actually decreasing their consumption (from 9.2 to 8.2 g).

The percent of good quality protein (ie, that from animal rather than plant sources) in the complementary food decreased from initial to final measurements, primarily because of reduced cow or goat milk consumption as growing children made a transition from a liquid diet to the grain-based family diet. The decrease was less for the treatment group, and the final contribution of good-quality protein was significantly higher ($P = 0.008$) for treated children than for control children (30% vs 22% of the total protein, respectively). The quality of the protein consumed was unaffected by the children's sex.

Although a greater percent of treatment children consumed foods from all food groups at the final measurement, the biggest differences compared with control children were in the percent eating fish, vegetables, and oil (Fig 4). The percent of complementary food energy provided by fat declined in both groups, although the decrease was more marked in the control group (from 20% to 9% of energy) than in treatment children (from 17% to 14%), who received infant foods with added oil. The percent of energy from protein remained the same in the treated group (11%) but declined from 11% to 9% in the control group. When breast milk estimates were added, the proportions of total energy derived from carbohydrate, protein, and fat for both groups changed very little from pre- to postmeasurements, averaging 57% carbohydrate, 7–8% protein, and 35–36% fat at the final measurement.

No significant differences were noted between the treatment and control groups for vitamin A and iron adequacy of the diets. Figure 5 compares the relative nutrient adequacies (on the basis of needs for maintenance growth) with food and breast milk for energy, protein, vitamin A, and iron, averaging both groups over all observations. Breast milk continues to contribute the greatest share of all nutrients for children aged < 2 y.

Discussion

The results of this study suggest that culturally appropriate nutrition messages can change infant-feeding practices, thereby improving child growth. Increased consumption of hygienically prepared, energy-enriched weaning foods after age 5–6 mo helped to prevent further deviation from reference growth standards, even if the supplement contained little or no animal protein.

Growth effects

Our findings suggest that in an impoverished setting such as Bangladesh, weaning food education, given without addressing economic, environmental, political, and social barriers, may soften the sharp deterioration in nutritional status seen from ages 4–6 mo to 2 y, but may not promote catch-up growth to international norms unless the socioeconomic conditions are improved.

The size and nature of the growth effects observed in this study (Table 2, Fig 2) are similar to findings from other countries, where nutrition education was conducted in isolation from other interventions (30–33). A follow-up evaluation in Indonesia 1 y after implementing a nutrition-education program found that program children grew better than nonprogram children after age 5 mo; at 24 mo, program children were 1 kg heavier, or 0.5 SD greater in weight and length than were nonprogram children (30). However, a positive association was not found for length-for-age in Indonesia (31) or in Upper Volta (33).

In the present study, comparison of the AC measurements between the groups led to the same conclusions as when WAZ was used as an indicator. AC is strongly related to weight-for-

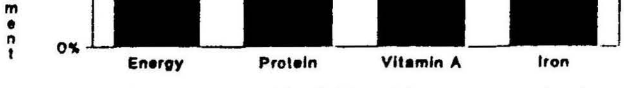

FIG 5. Nutrient adequacy of food (□) and breast milk (■) in diets of weaning age children in Bangladesh, based on maintenance growth; monthly averages from May to Nov of 132 children aged 7–20 mo (11.0 ± 2.09).

length, but its weak association with total body length suggests that it measures wasting (34). Nutrition interventions in stunted child populations with normal or high weight-for-length, for example INCAP's supplementation studies, have found no impact on wasting indicators (weight-for-length, AC) but have found a major impact on stunting (35). Weight-for-age, which was used as an indicator in this study, can reflect both stunting and wasting, and its use does not allow us to determine which indicator was most influenced. However, the consistency of the weight-for-age results with AC suggests an impact on wasting. Further study is warranted on the effect of weaning food supplementation on stunting.

Significant sex differences in growth or female discrimination in complementary feeding were not observed in this study. Others (2, 9, 14) have reported sex biases in feeding and higher malnutrition rates in female Bangladeshi children. Some have suggested that sex differentials may be more predominant after age 18 mo, and the younger age of our study children may account for the discrepancy in findings. Observations from the previous year suggest that mothers introduced food significantly earlier to girls, reflecting a less strict following of taboos to earlier feeding (15) that may positively affect female infants' growth, counterbalancing other negative practices (such as less medical attention).

Energy and protein adequacy

These findings suggest that the intervention successfully encouraged families to feed more (volume and variety) complementary foods to their infants. A study of rural Bangladeshi children aged 5–30 mo, which measured complementary-food intakes and used test weighings to determine breast milk intakes, found that total energy and protein intakes averaged 264–297 kJ/kg (63–71 kcal/kg) and 1.2–1.5 $g \cdot kg^{-1} \cdot d^{-1}$, respectively (7). Our results are consistent with these findings, with the treatment-group means exceeding the values on the higher end and those of the control group on the lower end of the range.

Another study in Bangladesh reported that intakes of 362.2 kJ/kg (86.5 kcal/kg) and 1.48 g protein $\cdot kg^{-1} \cdot d^{-1}$ in infants aged < 9 mo were associated with weight gain comparable to the reference population, but did not permit recovery from existing relative weight deficits (3). Our study sample was somewhat older, thus the requirement per kilogram might be slightly less. Still, these data support our finding that intakes of ≈ 306 $kJ \cdot kg^{-1} \cdot d^{-1}$ (73 $kcal \cdot kg^{-1} \cdot d^{-1}$) and 1.39 g protein $\cdot kg^{-1} \cdot d^{-1}$ for treatment children were not quite sufficient to maintain normal growth rates, resulting in a slight decline in weight-for-age relative to standards (−0.19 in WAZ over 5 mo). Although treatment children consumed significantly more energy and protein from complementary food than did control children, and had better weight gains, the energy intake of the children, as measured, was not statistically significant in predicting their change in weight in individual-level analyses. This may be because energy and protein intakes had high variability and breast milk intakes were unknown and likely varied considerably in individual children.

Did increased consumption of complementary food decrease breast milk intake? Because measuring breast milk outputs would have interfered with the purpose of our project, we used the best available estimates. Other studies suggest that children who consume the most complementary food are likely to decrease their breast milk intake somewhat (36–39). However, because growth rates were better overall for treated children, it is unlikely the complementary food substituted detrimentally for breast milk. Studies of breast milk outputs in developing countries, where infants suckle frequently, support this hypothesis (38, 40, 41). Observational data in Bangladesh suggest that older infants and young children who consume more complementary food in addition to breast milk grow better, despite an increase in diarrhea than do those solely breast fed (K Brown, personal communi cation, 1989). Moreover, research in India suggests that althoug the case rate of diarrhea increases with the introduction of com plementary foods in exclusively breast-fed infants (42), the deat rate is lower (43).

Breast milk intakes estimated by test weighing from othe studies in Bangladesh where children consumed complementar food suggest that intake declines from 632 g/d in the first ye of life to 563 g/d in children aged 12–17 mo (7), amounting ≈ 168 kJ (40 kcal) and 0.69 g protein/d. In our sample, treatme children increased their intake of complementary food fro baseline (mean age 8 mo) to final (mean age 13 mo) measur ments by 272 kJ/d (65 kcal/d) which exceeds the (estimate decrease from breast milk. Control children only consumed kJ/d (9 kcal/d) more at final measurement than at baseline, fa ing to compensate for the (estimated) decline in breast m energy. The daily protein intake increased in treatment childr by 1 g, which offsets the (estimated) loss from breast milk, e after protein quality was adjusted for. Control children, howe consumed less protein from complementary food at the fi measure than at baseline (decrease of 0.55 g).

We found that although mothers were willing to give t children starch-based weaning foods, they were reluctant to g them foods that incorporated animal products, reportedly cause of cost. If breast milk still constituted 75% of the die energy content at the final measure, the ratio of good qualit poor quality protein was still high, although the total amc of all nutrients was inadequate. Although encouraging the of "energy-rich, protein-poor" complementary foods in bre fed infants is not ideal, it is potentially more beneficial tha recommending foods that families cannot afford to provide d. These findings should not be extrapolated to weaning food m from cassava, which provides < 1% of energy from protein (

Weaning-food contamination

Bacterial contamination of weaning foods is a concern tropical environment with poor sanitation and hygiene an refrigeration (45, 46; GS Guldan, unpublished observat 1988). However, we found no differences in diarrheal preval rates between treatment and control children. Findings fron previous year suggest that diarrhea is more strongly assoc with the child's contact with ground contaminants than the quantity of food ingested. Unfortunately, limitations i monthly morbidity data prevent our determining whethe creased intake of complementary food led to increased diar Other studies suggest that mild diarrhea is more comm children eating more complementary food (47). Howeve cause diarrhea is negatively related to growth outcomes treatment children, on average, had greater weight gain changes in AC than did control children, it is unlikely tha rheal losses were greater for treatment children.

Cholera is endemic in Bangladesh, and research has shown that exclusive breast-feeding completely protects against severe cholera (12). Therefore, food beliefs prohibiting mothers from feeding significant quantities of complementary foods to young infants could have protected them, historically, from cholera. A protective effect is still evident in children up to 30 mo of age (12). During cholera epidemics, complementary feeding may increase the child's risk of contracting cholera and messages that encourage complementary feeding should be evaluated carefully.

Messages

Field observations suggested, and our analysis confirmed, that many mothers heeded the feeding messages, although the extent and frequency varied. A follow-up survey conducted by a separate research staff in March 1988 revealed that the messages were still persuasive and memorable (48). Mothers in the treatment group offered more traditionally fed foods, feeding their infants more energetically and frequently. They were also willing to add small amounts of oil, fish, and vegetables or fruit to the child's diet, although cultural beliefs restrict these foods (except fruit) for children this age (10, 18). Because mothers perceived these feedings as snacks (ie, foods that "didn't count"), weaning messages did not challenge mealtime taboos. In addition, if a mother had evidence that adding a food improved her child's health, she was often willing to overcome her stated feeding belief.

The most popular and most frequently implemented messages were those requiring little time and money, whereas those meeting the most resistance were more expensive and required more preparation. For example, after education, > 30% of the treatment mothers added a small spoon of oil to the child's food, although a dish made up of rice, vegetables, oil, and fish, egg, and milk, which took 30–45 min to cook, was much less popular.

Most mothers were unwilling or unable to cook separately for the baby on a daily basis. One transitional food encouraged in the messages, chop chop, was frequently offered because it required little preparation time and used ingredients that were often readily available—wheat flour, brown sugar, and oil. Still, mothers were reluctant to prepare this food more than once a day. Storage of the mixture for any period of time could breed potentially harmful microorganisms, contributing to diarrhea (45, 46). To reduce the potential dangers of food contamination, guidance on sanitary food preparation, feeding, and storage was provided with the other messages.

Food refusal and morbidity

One of the most common reasons reported for not giving more complementary food was because "the child refused." The reality of child development, unfortunately, is that no matter how nutritious, tasty, and appropriate a food, one can never guarantee a child will eat it.

Although normal interactive feeding behaviors have been observed between Bangladeshi infants and mothers (49; in addition to informal field observations during this study), the reasons why the children do not demand and consume sufficient food to sustain normal growth, as healthy children are expected to do, remains unclear. Caretaker inattentiveness to feeding, as well as frequent acute infections, chronic illnesses, and malnutrition in the child, may account for a portion of the energy deficit (50).

Several reports indicate that on sick days, children in developing countries consume ≥ 20–30% less energy from complementary food (13, 50, 51), although intakes of breast milk may not change (51). The decrease in complementary feeding is not overcome by intensive educational efforts to encourage feeding (13). In Bangladesh, cultural beliefs about withholding food during illness exacerbate the energy deficit, widening the gap between expected and actual growth. In Columbia, Lutter et al (52) found that the negative effects of diarrhea on attained stature at age 36 mo were not observed in children given a nutritional supplement from birth.

High morbidity, with its increased metabolic costs and anorexia, limits the potential success of nutrition-education messages in improving child growth (53). Programs to prevent and control infections in young children are likely to create a more positive feeding environment, resulting in better food intakes, improved growth, and more effective compliance with nutrition education.

Conclusions

This project was designed to develop and test nutrition messages with the potential for behavior change and for a positive impact on child health, given the many existing constraints in rural Bangladesh. The trials occurred during the seasons of poor growth and high morbidity (7), with extreme flooding superimposed on already difficult conditions. Given these limitations, it is remarkable that any differences were detected between the treated and control groups.

We conclude that nutrition education can play an important role in the health of the weaning-age child. The results suggest that if appropriate messages are marketed through appropriate channels, changes in infant-feeding practices resulting in improved infant growth are possible, despite impoverished conditions. Families should be encouraged to feed hygienic, cheap, energy-enriched complementary foods to breast-fed infants after ages 5–6 mo. Complicated, time-consuming, or expensive practices are not likely to achieve sustained compliance. In Bangladesh, the messages designed in village homes by this project have demonstrated the potential to produce positive changes. Incorporating the nutrition messages into other development programs (eg, infection prevention and control, or income-generating programs) may enhance the potential impact of the education.

We thank Fazle Abed, Azmat Ahmad, Suaib Ahmed, Sobita Datta, Halida Khondaker, the village workers and volunteers, and other BRAC staff without whom this project would not have been possible. The many persons who provided technical, editorial, and administrative assistance and advocacy included Alayne Ronnenberg, Judy Brace, Melanie Marlett, Nancy Pielemeier, Helen Armstrong, Linda Vogel, Collette Chabbott, Mary Lee McIntrye, and Karen Nurick.

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