Prevention of malnutrition among young children in rural Bangladesh by a food-health-care educational intervention: A randomized, controlled trial

Swapan Kumar Roy, Saira Parveen Jolly, Sohana Shafique, George J. Fuchs, Zeba Mahmud, Barnali Chakraborty, and Suchismita Roy

Abstract

Background. *As a result of inappropriate feeding, poor health and hygiene, and poor caring practices, the nutritional status of many young infants deteriorates with advancing age.*

Objective. *To explore the effectiveness of a nutrition education package to prevent malnutrition among young children.*

Methods. *A community-based, randomized, controlled trial was conducted among 605 normal and mildly malnourished children aged 6 to 9 months in 121 Community Nutrition Centers (CNCs) of the Bangladesh Integrated Nutrition Project (BINP) in four regions of Bangladesh from 2000 to 2002. The intervention group received weekly nutrition education based on the nutrition triangle concept of UNICEF for 6 months, whereas the control group received regular BINP services. Both groups were observed for a further 6 months to assess the sustainability of the effects. Information on socioeconomic status, feeding patterns, morbidity, and anthropometric features was collected.*

Results. *A significant increase in the frequency of complementary feeding was observed in the intervention group as compared with the control group, and the increase was sustained throughout the observation period. The intervention group had a higher weight gain than the control group after the end of the intervention (0.86 vs. 0.77kg, $p = 0.053$) and after the end of the observation period (1.81 vs. 1.39 kg, $p < .001$). The proportion of normal and mildly malnourished children was greater in the intervention group than in the control group after the end of the observations (88.9% vs. 61.5%, $p < .001$). Nutrition education successfully prevented malnutrition in all the areas. Variation in the outcome of nutrition education among the regions was observed.*

Conclusions. *This culturally appropriate nutrition education package based on the nutrition triangle model effectively prevented growth faltering and malnutrition among young children.*

Key words: Bangladesh, child growth, complementary feeding, infants, malnutrition, nutrition education

Introduction

Malnutrition is a preventable and treatable cause of childhood morbidity and mortality. In Bangladesh, about 47.5% of children under 5 years of age are moderately to severely undernourished [1]. Although inadequate food intake as a result of household food insecurity is one of the important contributors to child malnutrition, the UNICEF conceptual framework also recognizes disease and poor caring practices as equally important causes of malnutrition [2]. Caregivers might not make the best use of available resources because of lack of knowledge of optimal feeding behaviors and inappropriate cultural beliefs and practices regarding feeding [3–5]. Growth faltering among children aged 6 to 12 months is a global phenomenon, and this period is the window of opportunity to reverse malnutrition among children [6]. Interventions that provide counseling to caregivers on the initiation and continuation of appropriate and adequate complementary feeding early in life, along with improved hygiene and caring practices, may effectively tackle malnutrition [7–9]. The present study aims to address an important public health question: whether and to what extent a nutrition

Swapan Kumar Roy, Sohana Shafique, Barnali Chakraborty, and Suchismita Roy are affiliated with the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), Mohakhali, Dhaka, Bangladesh; Saira Parveen Jolly is affiliated with the Institute of Food Science and Technology, Bangladesh Council of Scientific and Industrial Research, Dhanmondi, Dhaka, Bangladesh; George J. Fuchs is affiliated with the Department of Pediatrics, University of Arkansas for Medical Sciences, Little Rock, Arkansas, USA; Zeba Mahmud is affiliated with the Micronutrient Initiative, Gulshan, Dhaka, Bangladesh.

Please direct queries to the corresponding author: S. K. Roy, Senior Scientist, Clinical Sciences Division, ICDDR,B: Knowledge for Global Lifesaving Solutions, GPO Box 128, Dhaka 1000, Bangladesh; e-mail: skroy@icddrb.org.

education program, especially one designed for parents of infants aged 6 to 9 months, can prevent malnutrition in children from various community settings, and if so, whether the impact of the intervention is sustained after its discontinuation.

Materials and methods

Study setting

This community-based, multistage, cluster-randomized, controlled trial was approved by the ethical review committee of the International Centre for Diarrhoeal Disease Research (ICDDR,B) and was conducted in areas where the largest nutrition program in the country, the Bangladesh Integrated Nutrition Project (BINP), was being carried out. The study was conducted among 605 children aged 6 to 9 months who were well nourished or mildly malnourished (weight-for-age above 75% of the median National Center for Health Statistics [NCHS] standard) from June 2001 to July 2002. The study took place in four *upazilas* (administrative units in each district) in four geographic regions of Bangladesh: northeastern Nikli in Dhaka Division, central Sherpur in Rajshahi Division, southeastern Chakaria in Chittagong Division, and southwestern Dacope in Khulna Division. Both qualitative and quantitative methods were used to assess the findings of this study.

Sample size calculation

We hypothesized that the nutrition education intervention would protect the normal and mildly malnourished children from growth faltering. Thus, the sample size calculations were based on the assumption that the proportion of normal and mildly malnourished children who developed malnutrition would be 20% higher in the control group than in the group whose parents received nutrition education, with a 5% probability and 90% power. At the end of the study, a power calculation was done to confirm that the remaining sample, after loss to follow-up, was sufficient to detect a significant difference between the groups with 90% power.

Enrollment and randomization

The study subjects were recruited from the growth-monitoring programs at 121 randomly selected Community Nutrition Centers where regular BINP activities were conducted. A detailed description of BINP activities is available elsewhere [9]. Trained staff selected the subjects using the Gomez classification (weight-for-age). There were 306 children in the intervention group and 305 in the control group. The Gomez classification was used because the BINP used this classification to determine which children to include in its program. The unit of randomization was the Community Nutrition Center, not the children within a Community Nutrition Center. To avoid contamination, adjacent Community Nutrition Centers were not included in the study. Parents were informed of the study protocol, and each child was included after written consent was presented verbally among illiterate mothers, caregivers and family members, and left thumb impression was taken from them. Children with severe illnesses or handicaps affecting development, feeding, or activity were excluded.

Intervention

At baseline, the mothers in the 48 groups participated in focus group discussions on child growth, feeding practices, disease control, and child care. Their perceptions, taboos, and behavioral norms were used to develop the nutrition education package. Behavioral change and communication materials, such as flip charts, were prepared with key messages in easily understandable language with color photographs based on this formative research information.

The intervention aimed to improve the dietary behavior, health-seeking behavior, and caring practices of the mothers. The messages were prioritized for food security, psychosocial stimulation, and care- and health-seeking behavior and were built on the preliminary exploration and focus group discussions mentioned earlier. The messages delivered were simple, standardized, and age-appropriate. That food, health, and care are equally important for the prevention of malnutrition was explained carefully to the mothers. However, emphasis was placed on demonstrations of the preparation of energy- and protein-rich local complementary foods rich in micronutrients, such as *khichuri* [9], and on the prevention, recognition, and control of diarrhea and acute respiratory tract infection. Both the quantitative and the qualitative aspects of complementary foods were explained to the caregivers, and separate feeding pots were identified in the household in order to provide estimates of the food intake of the infants. The caregivers were also counseled to interact with the children in an affable manner and to increase verbal communication.

Community health workers/counselors delivered these messages to small groups of mothers (six to eight in each group). The counseling sessions were conducted with the use of a teaching manual designed for specific topics. The sessions were interactive and were based on discussion of the common problems faced by the mothers. Afterwards, the community health workers discussed various options and ideal ways to overcome these problems. Moreover, community mobilization was carried out involving men and older members of the families on a monthly basis.

The intervention continued for 6 months, during which the intervention group received nutrition education once a week for the first 3 months and then once every 2 weeks for the next 3 months. The subjects were observed for the 6 months following the end of the intervention. The control group received regular BINP services. Structured instruments with defined formats were used for quality control.

Baseline and follow-up data collection

A precoded, structured questionnaire was used to collect information on 7-day food frequency, hygiene, caring practices, and morbidity. Data on feeding and child-caring practices were obtained twice a month, and anthropometric data were obtained once a month. Anthropometric measurement techniques were standardized prior to data collection, and the data collectors were trained at regular intervals to reduce inter- and intraobserver variation in measurements [10]. Weight was measured by a Uniscale with a precision of 1 g, and recumbent length was measured with a locally made wooden stadiometer accurate to 0.1 cm. The project supervisors performed quality control on data from a randomly selected 25% of subjects. Feedback on the quality of collected data was provided to the field staff within a week by the field supervisor if it was different.

Outcome indicators

The major outcome measures were changes in weight, length, and infant-feeding practices during the 1-year study period.

Statistical analysis

SPSS for Windows software (version 10), Epi Info, and NCHS statistical packages were used for statistical analysis. Baseline characteristics were compared between the intervention and control groups with Student's *t*-test for normally distributed continuous variables, the Mann-Whitney U test for non-normally distributed variables, and the chi-square test for categorical variables. To evaluate the impact of the intervention, the groups were compared before the intervention, after the intervention, and at the end of the observation period by the chi-square test. Repeated-measures analysis of variance was used to evaluate the changes in weight gain and median weight-for-age over the study period. Statistical significance was accepted at a 5% probability level.

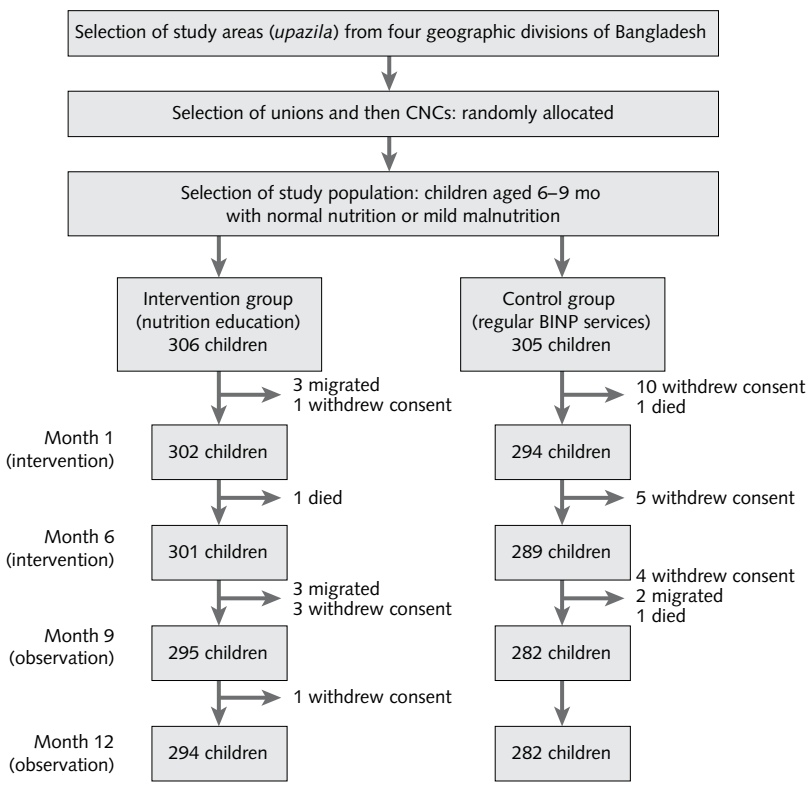

FIG. 1. Trial profile of the study. BINP, Bangladesh Integrated Nutrition Project; CNC, Community Nutrition Center

Qualitative data collection and analysis

Information on mothers' perceptions of child feeding, food taboos, caring practices, immunization, and health care-seeking behavior during illness was collected by focus group discussions at baseline, at the end of the intervention period, and at the end of the observation period. An anthropologist conducted the focus group discussion sessions as a mediator. A tape recorder was used to record the discussion, and one facilitator took notes. The information collected was ordered, reduced, analyzed manually by the qualitative data analysis method, and summarized.

Cost-effectiveness

The cost-effectiveness component of the study was carried out to assess the costs of the intervention activities. The method quantified all inputs used in the service delivery process irrespective of who provided the input. Data were collected on capital, recurrent, operation and maintenance, personnel, training, and travel costs. Time-motion study was carried out on time allocation of the personnel involved in the intervention.

Results

At baseline, 306 and 305 children were enrolled in the intervention and the control group, respectively (**fig. 1**). At the end, 294 subjects in the intervention group and 282 in the control group were included in the analysis.

At baseline, the mean weight-for-age as a percentage of the NCHS median was comparable in the intervention and control groups (83.9% vs. 83.6%, respectively; p = NS). In both groups, the mothers had a median of only 2 years of formal education, the family had a median of 0.1 acre of cultivable land, and the median monthly family income was 2,200 Tk (US$32.0) (**table 1**).

At baseline, 30.4% of mothers in the intervention group gave complementary foods to their children at least three times per day, as compared with 31.0%

TABLE 1. Comparison of baseline characteristics of infants randomly assigned to the intervention and control groups

Characteristic	Intervention (N = 294)	Control (N = 282)	p
Sex (%)			.129[a]
Male	49.8	57.1	
Female	50.2	42.9	
Nutritional status (mean ± SD)			
Birthweight (kg)	2.7 ± 0.4	2.8 ± 0.4	.462[b]
Weight-for-age median (% of NCHS standard)	83.9 ± 7.9	83.6 ± 8.1	.842[b]
Weight-for-length median (% of NCHS standard)	91.99 ± 9.00	92.64 ± 8.02	.853[b]
Length-for-age median (% of NCHS standard)	95.61 ± 3.68	95.00 ± 3.41	.993[b]
Mother's years of schooling			.54[c]
Median	2	2	
Range	0–14	0–14	
Family income (Tk/mo)[d]			.89[c]
Median	2,200	2,200	
Range	500–11,000	200–11,000	
Total land owned (acres)			.37[c]
Median	1.00	0.99	
Range	0.01–9.24	0.01–9.90	
Cultivable land owned (acres)			.46[c]
Median	0.1	0.1	
Range	0.01–9.90	0.01–9.90	
No. of under-5 children (% of families)			.886[a]
1	59.2	57.5	
2 or 3	40.8	35.5	

NCHS, National Center for Health Statistics
a. Chi-square test.
b. Student's *t*-test.
c. Mann-Whitney U test.
d. 1 US$=69.00 Tk

of mothers in the control group (p = NS) (**table 2**). After the intervention, the percentage increased to* 83.8% in the intervention group, as compared with only 19.4% in the control group ($p < .001$). After the intervention, a much larger proportion of children in the intervention group were fed *khichuri* as their main complementary food than children in the control group (44.3% vs. 2.2%, $p < .0001$). Even though this proportion decreased by the end of the observation period, it was still significantly higher in the intervention group than in the control group. The proportion of mothers using extra oil in the complementary food to enhance energy density more than doubled in the intervention group by the end of intervention (from 31.6% to 69.8%, $p < .01$), whereas in the control group, the proportion remained unchanged. A higher proportion of mothers in the intervention group than in the control group used separate feeding pots for their children (91.6% vs. 76.8%, $p < .001$).

Repeated-measures analysis of variance showed that at the end of the intervention, the net weight gain was 0.86 kg in the intervention group and 0.77 kg in the control group ($p = .053$). At the end of the observation period, the net weight gain was 1.81 kg in the intervention group and 1.39 kg in the control group ($p < .001$) (**fig. 2**). The nutritional status of the children declined during the first 3 months but improved thereafter in the intervention group, whereas the declining trend continued in the control group (**fig. 3**). There was a significant change in nutritional status within groups ($p < .001$) and between groups ($p < .001$) from baseline to end of observation.

Both the mean weight-for-age z-score (WAZ) and the mean length-for-age z-score (LAZ) of the children of the intervention group increased significantly compared with those of the control group after intervention (WAZ, –1.30 vs. –1.96, p < .001; LAZ, –1.73 vs. –1.96, p < .002) and by the end of observation period (WAZ, –1.90 vs. –2.15, p < .001; LAZ, –1.90 vs. -2.15, p < .002). (**table 3**). The weight-for-length z-scores (WLZ) were already significantly different at baseline, and no statistically significant differences were found in the mean mid-upper-arm circumference (MUAC) of the children. After end of intervention, 83% of chil-

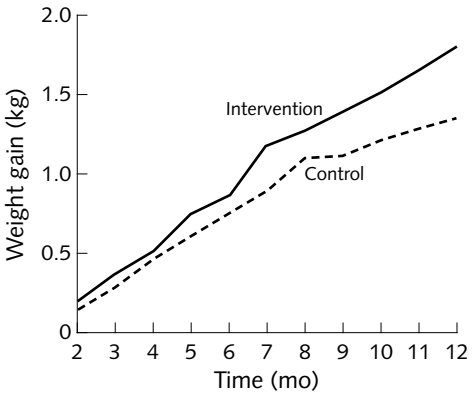

FIG. 2. Cumulative weight gain over the study period. Both the within-subject effects and the between-subject effects showed significant intervention × time interactions ($p < .001$) by general linear model (GLM) repeated-measures analysis of variance (ANOVA)

TABLE 2. Changes in feeding practices of the children in the intervention and control groups at baseline, after intervention, and at end of observations

	Baseline		After intervention		End of observations	
	Intervention (N = 294)	Control (N = 282)	Intervention (N = 294)	Control (N = 282)	Intervention (N = 294)	Control (N = 282)
Practice	% of families					
Currently breastfeeding	97.3	97.4	89.8	91.9	79.4	79.0
Frequency of feeding complementary food						
< 3/day	69.6	69.0	16.2**	80.6	11.5**	75.5
≥ 3/day	30.4	31.0	83.8**	19.4	88.5**	24.5
Khichuri is main complementary food	6.6	8.8	44.3**	2.2	15.4*	4.4
Family food is main complementary food	47.2*	46.6	67.7**	95.6	96.5	96.2
No. of eggs fed per week						
0	60.6	60.7	8.4**	33.9	23.8*	43.3
< 3	28.7	29.3	43.1*	49.8	46.5*	44.8
≥ 3	11.3	10.0	38.5	16.2	29.8*	11.9
Extra oil in the food	31.6	22.8	69.8**	20.9	61.3**	21.5
Separate pot for child	52.5	52.3	91.6**	76.8	91.8**	76.8

*$p < 0.01$, **$p < .0001$, intervention vs. control, chi-square test.

TABLE 3. Changes in nutritional status of the children in the intervention and control groups at baseline, after intervention, and at end of observations[a]

Indicator	Baseline			After intervention			End of observations		
	Intervention (*N* = 290)	Control (*N* = 282)	*p*	Intervention (*N* = 290)	Control (*N* = 282)	*p*	Intervention (*N* = 290)	Control (*N* = 282)	*p*
WAZ	−1.58 ± 0.72	−1.56 ± 0.76	.05[a]	−1.35 ± 0.77	−1.59 ± 0.89	.001[a]	− 1.43 ± 0.73	− 1.90 ± 0.79	.001[a]
LAZ	−1.24 ± 0.98	−1.39 ± 1.10	.077[a]	−1.73 ± 0.82	−1.96 ± 0.99	.002[a]	− 1.90 ± 0.93	− 2.15 ± 0.99	.002[a]
WLZ	−0.66 ± 0.80	−0.89 ± 0.86	.001[a]	−0.69 ± 0.90	−0.85 ± 1.08	.05[a]	− 0.64 ± 0.87	− 1.14 ± 0.93	.001[a]
MUAC	13.79 ± 0.90	13.83 ± 0.93	.65[a]	14.02 ± 0.88	14.04 ± 0.90	.88[a]	14.17 ± 1.25	14.0. ± 0.90	.065[a]
Proportion (%)of children remained better nourished (WAM ≥ 75%)	100	100	ns[b]	83.00	73.70	.001[b]	88.90	61.50	.001[b]

WAZ, weight-for-age *z*-score; LAZ, length-for-age *z*-score; WLZ, weight-for-length *z*-score; MUAC, mid-upper arm circumference; WAM, weight-for-age median (%of NCHS standard)
a. Values are means ± SD. *P* values were calculated by Student's *t*-test.
b. Values are percentages. *P* values were calculated by chi-square test.

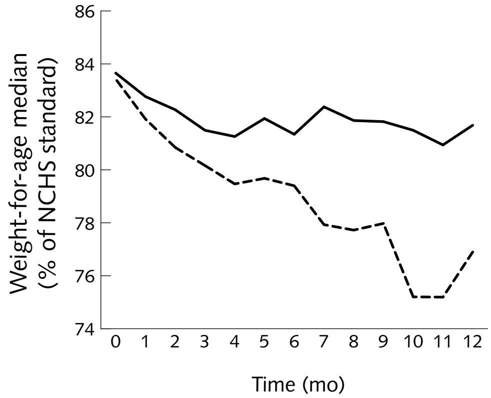

FIG. 3. Mean weight-for-age median (percentage of NCHS standard) over the study period. Both the within-subject effects and the between-subject effects showed significant intervention × time interactions ($p < .001$) by general linear model (GLM) repeated-measures analysis of variance (ANOVA)

dren in the intervention group remained well (WAM ≥ 75%), compared to 73.7% of the children in the control group ($p = .01$). This proportion increased to 88.9% in the intervention group at the end observation which decreased to 61.5% in the control group ($p = .01$).

Figure 4 shows the proportion of children with various degrees of malnutrition after intervention and after the end of the observation period in the four geographic areas of the study. In Nikli, at the end of 6 months of intervention, severe malnutrition was prevented in the intervention group but not in the control group (2.6%). The rate of prevention of malnutrition at the end of the study in the intervention group was higher than in other areas (89%). In Sherpur, more children developed malnutrition in the control group, and the rate of prevention of malnutrition in Sherpur was lower (20%). In Chakaria, about 20% of the children developed malnutrition in the intervention group, as compared with 60% in the control group, during the period of intervention. The rate of prevention of malnutrition in this area was 61% in the intervention group. In Dacope, 8% of children in the intervention group and 50% of those in the control group developed malnutrition by the end of the observation period. The rate of prevention of malnutrition in this area was 81% in the intervention group.

Findings from qualitative research revealed that before the intervention period, mothers neither had sound knowledge of appropriate infant and young child feeding nor recognized the need for giving adequate food during rapid growth of their children. They had taboos on foods and little knowledge about the nutritional status of their children and the nutrient density of foods. They had faith in traditional or spiritual healers rather than in medical treatment by a health-care provider. After the intervention, the mothers gave *khichuri* to children as the main transitional

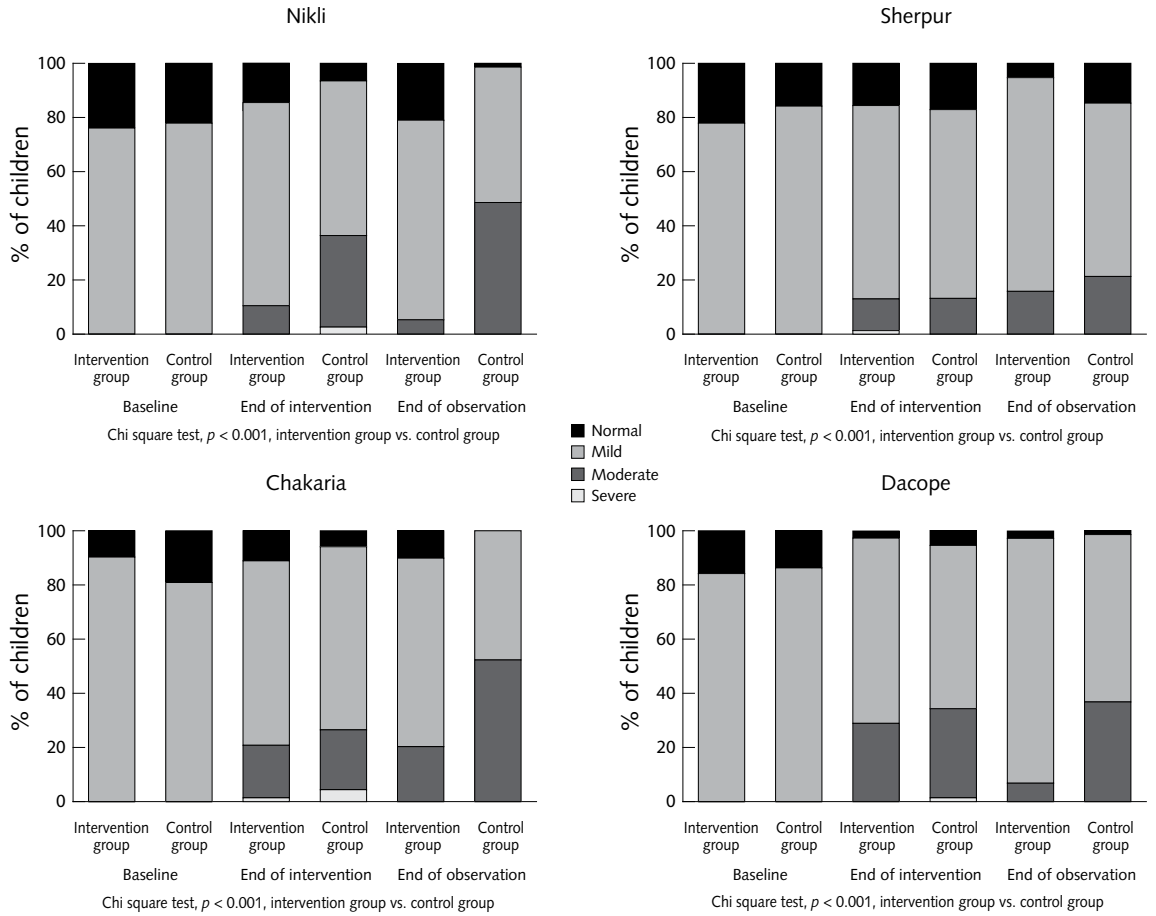

FIG. 4. Proportion of children with various degrees of malnutrition (weight-for-age, percentage of NCHS standard) in the intervention and control groups at baseline, after intervention, and after the end of the observation period in four geographic areas

complementary food or added oil and eggs to the available family food. Superstitions and food taboos were reported to have been removed from the mothers in the intervention groups as they changed their practices. The mothers' ability to identify malnutrition improved extensively. They realized that disease could be prevented with proper care, and they wanted to seek care from local government health-service providers instead of going to *hekim* or traditional healers.

Findings from the cost-effectiveness study showed that the total cost of preventing malnutrition in one child was Taka 2,561.80 (US$37.00), 1,850.00 (US$26.81), 1,305.68 (US$18.92), and 1,473.66 (US$21.34) for Nikli, Sherpur, Chakaria, and Dacope, respectively.

Discussion

We intended to evaluate a carefully designed nutrition education package to explore whether malnutrition can be prevented among young children by improving their parents' feeding, caring, and health-seeking practices. We used UNICEF's suggested "food-health-care" (nutrition triangle) model [11] to test whether malnutrition could be prevented. The results of our study showed that improved knowledge of preventive health-care behaviors and infant-feeding practices by the caregivers could successfully prevent growth faltering of the children in community-based settings using their available resources. These results also add to the body of evidence that education intervention without provision of food supplements in an impoverished society can improve the dietary intake of young children and lead to better growth. This is in line with the results of our earlier study that showed that nutrition education alone was as effective as providing food supplementation [9].

We believe that the main reason this approach was effective was that the package was prepared in a culturally appropriate manner. Moreover, this intervention was based on demonstrations of feeding of identified affordable and seasonal foods along with feasible

caring and health-seeking behaviors. In addition, appointments made for intervention sessions were flexible and according to the mothers' convenience. The authors also considered the sociocultural context of Bangladesh, where empowerment of women is minimal and women do not have much share in household decision-making. Therefore, since the main decision makers were fathers or other male or older members of the family (e.g., grandmothers), a monthly community mobilization meeting was carried out for these groups, involving the local leaders during the intervention. Probably for these reasons, our results confirm the sustainability of the changes, even after 6 months of intervention.

The mothers from extremely poor families in our study reported having financial and time constraints on child care and the preparation of complementary food. Demonstration of complementary food was a key component in this study and was well followed by the mothers. *Khichuri* is a home-based transitional complementary food made with locally available inexpensive items in which rice and lentils complement each other to provide limiting amino acids (lysine and methionine, respectively), and the addition of an egg further increased the protein quality. Moreover, egg yolk and vegetables increased the vitamin A, β-carotene, and other micronutrient contents of *khichuri*. Although animal-origin foods are a rich source of iron, they were not affordable to a large proportion of the families in our study population. During the intervention, there was a sharp increase in the use of *khichuri* as the main complementary food, but subsequently the practice decreased to some extent, largely due to the increase in age of the study children, when they were already habituated to the family foods.

It is important to note that at baseline, only a small proportion of mothers fed diverse foods such as pulses, vegetables, fish oil, and eggs to their children, but the proportion increased significantly after the intervention. On the other hand, a few mothers in the control group added such foods to the diet of their children. The results are consistent with those of our earlier interventional study that improved the nutritional status of moderately malnourished children in a similar community [9].

Studies in the Philippines and Nepal revealed that weight and height gains of the children were positively associated with caregivers' time spent in caring for the children [12–14]. Increased caring time also improved the cognitive development of children in a variety of cultural and ethnic groups [15]. Studies in South Africa and Michigan, USA, showed that education helped improve the weight of children after intervention [16, 17]. However some studies argue that nutrition education alone cannot improve nutritional status [18]. Nutrition education in our study prompted mothers to feed their children appropriately and practice proper hygiene, which was reflected in weight gain; these results are in agreement with those of other studies in China [19]. The rate of prevention of malnutrition was higher in Dacope and Nikli than in the two other study areas. Although the monthly family income was higher in Chakaria than in the other areas, the number of years of maternal schooling was less. It is important to address the barriers to better nutrition in Sherpur and Chakaria. In Sherpur there was a conflict between mothers' use of time for generating income and for child care, whereas the main barrier to better child care in Chakaria was the conservativeness of the culture. Prevention of malnutrition did not depend on financial status, but other factors, such as mothers' time for child care, availability of food, access to health facilities, and personal hygiene, were inadequate.

Future research could be carried out to explore the impact of an intervention similar to ours on body composition, as determined by measures such as skinfold thickness and muscle mass, for a better understanding of the growth pattern of rural Bangladeshi children.

In conclusion, the results of our study suggest that with 6 months of nutrition education, it is possible to prevent malnutrition and growth faltering among high-risk young infants using the family's own resources. Such education should be incorporated into primary health care and nutrition services in Bangladesh and in other settings with high rates of childhood malnutrition.

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Contributors

S. K. Roy was the principal investigator of the study, took part in design and analysis of the study, and will act as guarantor for the paper. G. J. Fuchs and Z. Mahmud were coinvestigators of the study and provided comments on the manuscript. S. Shafique took lead responsibility in this project phase, including questionnaire design and data collection, and was also involved in data interpretation and writing the manuscript. S. P. Jolly undertook statistical analyses and interpretation and wrote the main drafts of the manuscript. B. Chakraborty and S. Roy took part in reanalysis and writeup after reviews.

Conflict of interest

The authors declare that they have no conflicts of interest relevant to this study.

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