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Short-term nutrition education reduces low birthweight and improves pregnancy outcomes among urban poor women in Bangladesh

Khurshid Jahan, S. K. Roy, Seema Mihrshahi, Nigar Sultana, Soofia Khatoon, Hema Roy, Laboni Rani Datta, Anjana Roy, Sania Jahan, Wajiha Khatun, Naimun Nahar, and Jessica Steele

Abstract

Background. *Maternal malnutrition and poor gestational weight gain are the most important causes of low birthweight and infant mortality in Bangladesh.*

Objective. *To assess the effect of short-term nutrition education on weight gain in the third trimester of pregnancy, birth outcomes, and breastfeeding.*

Methods. *Three hundred pregnant women participated in this randomized, controlled trial during a 3-month intervention period. The study was conducted in two antenatal clinics in urban Dhaka. One group of women was given monthly education sessions during the third trimester of pregnancy to promote consumption of khichuri, while the control group received only routine services from the health facilities. Birthweight was recorded within 24 hours after delivery. Breastfeeding practices were observed for 1 month after delivery.*

Results. *In the intervention group, maternal weight gain in the third trimester was 60% higher (8.60 vs. 5.38 kg,* $p = .011$*), mean birthweight was 20% higher (2.98 vs. 2.49 kg,* $p < .001$*), the rate of low birthweight was 94% lower (2.7% vs. 44.7%,* $p < .001$*), and the rate of initiation of breastfeeding within 1 hour after birth was 52% higher (86.0% vs. 56.7%,* $p < .001$*), in comparison with the control group. Birthweight was associated with frequency of intake of khichuri (*$p < 0.001$*).*

Conclusions. *Nutrition education with a focus on promoting consumption of khichuri during the third trimester of pregnancy significantly reduced the rate of low birthweight and increased maternal weight gain.*

Key words: Antenatal, birthweight, breastfeeding, khichuri, nutrition education, pregnancy weight gain

Introduction

Bangladesh has one of the world's highest burdens of low birthweight, with 36% of infants born weighing less than 2,500 g. Maternal malnutrition is a significant contributor to low birthweight, with approximately 25% of women undernourished. When coupled with adolescent pregnancy, this causes preterm birth and intrauterine growth retardation (IUGR), leading to low birthweight. The cycle of malnutrition in childhood and adolescence continues throughout pregnancy, leading to low weight gain during pregnancy, and the birth of low-birthweight babies reflects the longer-term effect of malnutrition from one generation to another [1–4].

Low-birthweight infants have increased risks of morbidity and mortality, impaired immune function, and poor cognitive development [8–10]. They are much more likely to become sick, enter school late, and experience learning difficulties, and they are less productive as adults. They are more likely to suffer from diabetes, coronary heart disease, and hypertension as adults [8]. Ultimately, low birthweight will increase the burden on already overstretched health systems [8]. Low-birthweight infants are at four times the risk of developing acute diarrhea or of being hospitalized for diarrheal episodes, compared with their normal-birthweight counterparts [6, 8].The risk of neonatal death for low-birthweight infants weighing 2,000 to 2,499 g at birth is estimated to be four times higher than for infants weighing 2,500 to 2,999 g and 10 times higher than that for infants weighing 3,000 to 3,499 g [9]. In Bangladesh, the neonatal mortality rate for the period 2007 to 2011 was 32 per 1,000 live births for all infants

Khurshid Jahan, S.K. Roy, Soofia Khatoon, and Jessica Steele are affiliated with the Bangladesh Breastfeeding Foundation, Dhaka; Khurshid Jahan, Nigar Sultana, Hema Roy, Laboni Rani, Anjana Roy, and Sania Jahan are affiliated with the National College of Home Economics, Dhaka; Khurshid Jahan, Nigar Sultana, Hema Roy, Laboni Rani Datta, Anjana Roy, Sania Jahan, Wajiha Khatun, and Naimun Nahar are affiliated with the Nutrition Foundation of Bangladesh, Dhaka; Seema Mihrshahi is affiliated with the School of Public Health, University of Sydney, Australia; Wajiha Khatun is affiliated with the ICDDR,B: International Centre for Health and Population Research, Dhaka; Soofia Khatoon is affiliated with the Shaheed Suhrawardy Medical College, Dhaka.

Please direct queries to the corresponding author: S.K. Roy, Bangladesh Breastfeeding Foundation, Room 197-200, IPH Building, Mohakhali, Dhaka 1212, Bangladesh; e-mail: skroy1950@gmail.com.

[10] and 780 per 1,000 live births (range, 640 to 885) for infants whose birthweights were under 1,500 g [11]. The National Low Birth Weight Survey of Bangladesh 2003/04 found that preterm low-birthweight infants tend to be at a greater risk of dying in the neonatal period, whereas low-birthweight infants with IUGR tend to be at greater risk in the postneonatal period. It has been estimated that almost half of infant deaths in Bangladesh from diarrhea and pneumonia could be prevented if low birthweight was eliminated [4].

Weight gain in the second and third trimestersof pregnancy is of great importance for ensuring adequate fetal growth and preventing low birthweight [12]. The National Nutrition Program's Baseline Survey 2004 in Bangladesh showed that only one-third of women gained more than 4 kg during the third trimester, and the mean weight gain during the third trimester was 3.44 kg [13]. Previous studies have shown that long-term nutrition education during pregnancy can improve pregnancy weight gain and birth outcomes [12, 13]. A meta-analysis of dietary interventions that included food supplementation during pregnancy showed a reduction of about 30% in the rate of low birthweight in the intervention groups [14].

It is important to examine the efficacy of nutrition education in motivating family members during the third trimester and any associated significant effect on birthweight.These considerations are important, because supplementation is expensive and is difficult to sustain over a full term of pregnancy in a large population.Therefore, in this randomized trial, we tested the hypothesis that short-term nutrition education during the third trimester could improve pregnancy weight gain and reduce low birthweight in urban Dhaka.

Materials and methods

Study area and subjects

Women at a gestational age of 24 weeks attending the government Maternal and Child Health Training Institute, Azimpur, and the Marie Stopes Clinic, Bashbari, Dhaka, were invited to participate in the study. Women with complications and special requirements were excluded. Eligible women were randomly allocated to the intervention or control group according to a computer-generated randomized table. The participating women had similar socioeconomic characteristics to women in middle- and low-socioeconomic-status groups living in Dhaka City, where access to free maternity health services is available. They were comparable to the rural population in Bangladesh and those in the peripheral towns of Bangladesh, and their weight, height, and income levels were comparable to national demographic data. The women and their accompanying family members were provided with an explanation of the study before they were approached to give informed consent. Participating women agreed to attend monthly education sessions at the clinic for 3 months and to follow the advice provided. Each education session lasted for 1 hour, and the first session was preceded by a initial 2-hour interview to obtain baseline information. The nutrition education sessions were provided in a counseling format and focused on encouraging behavior change. The content of the sessions included the nutritional value of food, the importance of exclusive breastfeeding, establishing an adequate diet during pregnancy and lactation, cooking practices for optimum retention of nutrients, and creating awareness about food taboos relating to pregnancy and infant feeding. A demonstration was provided on cooking khichuri, a highly nutritious local dish that can be made with affordable, readily available ingredients. The women were informed of their right to withdraw from the study. The women agreed to comply with the study requirements and provided informed consent.A total of 300 women were finally selected for the study, which was conducted from November 2007 to August 2008. The intervention group received nutrition education and the control group received routine hospital services.

Nutrition education

The investigators received 3 weeks of detailed training from the senior author, S. K. Roy, on topics specific to nutritional dietary education, health and hygiene practices, disease control, food frequency, increased food intake, the importance of adequate diet during pregnancy, item-specific dietary education on appropriate foods for pregnant women, proper nutrition and dietary care during pregnancy, behavioural motivation of the pregnant women regarding food taboos during pregnancy, proper cooking practice for nutrient retention, early initiation of breastfeeding, and anthropometric measurements. The investigators developed a manual to provide nutrition education to the women containing principles of the UNICEF proposed nutrition triangle, including food security, caring practices, and disease control [15]. Nutrition education was provided in the outpatient areas of clinics to groups of six to eight women for 1 hour each month over a 3-month period. The pregnant women and any accompanying family members were educated on the significance of pregnancy weight gain, adequate food intake, and breastfeeding for the newborn. Nutrition education emphasized specific key messages, including increasing the frequency of food intake from the usual three to five times daily, as well as preparing and consuming a specific, nutrient-rich local food (khichuri). The women were given advice on food intake, personal hygiene, rest during the daytime, accessing antenatal care services, initiation of breastfeeding immediately

after birth, and continuation of exclusive breastfeeding. The benefits of adequate energy, protein, and vitamins during pregnancy were explained. The benefit of regular iron intake was also emphasized. Manuals, leaflets, and flip charts with colored photographs were used to deliver key information. A practical demonstration was provided on the preparation of the nutrient-rich, nutritionally sound, and easy-to-prepare khichuri using inexpensive and locally available foods [16]. The dish is made with two fistfuls of rice (60 g), one fistful of lentils (25 g), one egg, 8 teaspoons of soybean oil (32 g), and one fistful of green, red, and yellow vegetables (35 g). This amount of khichuri provides 762 kcal of energy and 21 g of protein.The women were advised to eat khichuri three to four times per day in addition to their usual meals, and consumption of fruit and snacks was also encouraged. The low cost of khichuri (Tk 15.0 [US$0.22] per day, about 3% of the family income) made the intervention highly affordable.

Data collection

The investigators conducted a 2-hour interview with the women prior to the intervention using a structured questionnaire to collect data on education and income, body weight, dietary intake and knowledge, pregnancy history and care, and knowledge, attitudes and practice. The body weight of the participants was measured at enrolment and then each month until delivery, to the nearest 100 g, with an electronic digital scale (Seca model 725). Standing height was measured with a locally made height scale with a precision of 1 mm. To ensure accuracy in measurements of body weight and height, three measurements were obtained, with details of the type, quantity, and frequency of dietary intake, and the average of the three measurements was taken as the correct measurement. Newborns were weighed at the hospital within 1 hour after birth with a Salter scale with an accuracy of 100 g [17, 18].The mid-upper-arm circumference (MUAC) of the women was measured with a TALC (Teaching Aid at Low Cost) tape with a precision of 2mm at the midpoint between the tip of the shoulder and the elbow on the bare left arm.Anthropometric instruments were standardized daily.Three consecutive readings of weight, height, and MUAC were taken and the average value was calculated. The infants were weighed within 1 hour after birth by trained nurses using a Salter scale with an accuracy of 100 g at the Marie Stopes Clinic and a Seca 725 Infant Baby Scale at the Maternal and Child Health Training Institute. Low birthweight was defined as less than 2.5 kg. The investigators used a questionnaire to collect data on the frequency and types of food intake. The national Household Income Economic Expenditure Survey (HIES) was used to compare the participants' diet with the typical diet in Bangladesh.

Quality control measures

The data collection instruments were field-tested. Interviewing, anthropometric measurement, and record-keeping techniques were supervised at regular intervals. Random checks were performed by the senior author, S. K. Roy, who evaluated 10% of the subjects on topics of nutrition education and reinterviewed and rechecked 5% of the anthropometric measurements to randomly assess the validity of the data. These anthropometric and birthweight data were compared with study data and found acceptable (data not shown).

Statistical analysis

Statistical analysis was performed with standard statistical software (SPSS/Windows, version 15.0). Chi-squared tests were used to test the difference between proportions. Student's *t*-tests were used to test differences between two means. Repeated-measure analysis of variance (ANOVA) was used to compare group means of time series data on body weight and frequency of khichuri intake. Multiple regression analysis was performed to estimate the effects of nutrition education on birthweight, controlling for confounding factors such as education and income, initial body weight, khichuri intake, and pregnancy weight gain. Statistical significance was accepted at a 5% probability level.

Ethical approval

The study was approved by the Ethical Review Committee of the Bangladesh Medical Research Council, Mohakhali, Dhaka.

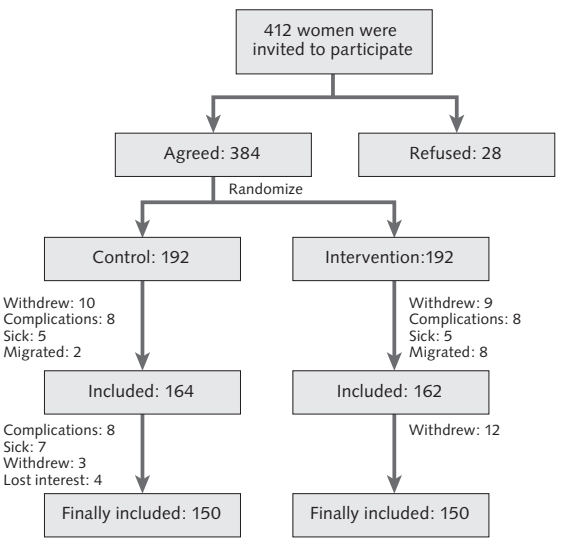

FIG. 1. Consort diagram for the randomized, controlled trial

Results

A total of 384 women agreed to participate in the study. Three hundred women completed the study up to 1 month after the birth of their babies **(fig. 1)**. **Table 1** shows the baseline anthropometric and demographic characteristics of the women in the intervention and control groups. Eighty-four women who dropped out during the study had comparable baseline data to those who stayed in the study with regard to age, years of education, body weight, MUAC, height, number of antenatal visits, income, and other variables **(table 2)**.

Table 3 shows that women in the intervention group had significantly higher body weight in the 8th month than women in the control group (62.08 ± 4.65 vs. 59.98 ± 2.63 kg, $p = 0.001$), and body weight

TABLE 1. Baseline characteristics of women in the intervention and control groups (mean ± SD)

Characteristic	Intervention group ($n = 150$)	Control group ($n = 150$)	p^a
Age (yr)	23.45 ± 3.5	23.55 ± 3.54	.877
Age at marriage (yr)	19.88 ± 2.93	19.04 ± 3.08	.943
Educational level (yr)	7.50 ± 2.25	7.55 ± 3.21	.868
Monthly family income (US$)	176 ± 45	166 ± 68	.127
Weight (kg)	56.57 ± 4.86	56.81 ± 2.49	.590
Height (cm)	153.49 ± 3.54	152.99 ± 3.007	.184
Mid-upper-arm circumference (mm)	237.3 ± 14.3	235.10 ± 15.4	.196
No. of antenatal care visits	5.14 ± 1.43	4.95 ± 1.47	.250

a. Student's *t*-test.

TABLE 2. Comparison between women who continued in the study and those who dropped out (mean ± SD)

Characteristic	Continued ($n = 300$)	Dropped out ($n = 84$)	p^a
Age (yr)	23.5 ± 3.5	23.3 ± 3.4	.786
Age at marriage (yr)	19.46 ± 3.03	19.65 ± 2.93	.854
Educational level (yr)	7.8 ± 2.8	7.9 ± 2.5	.868
Monthly family income (TK)	11,642 ± 3,932	11,701 ± 2,633	.237
Weight (kg)	56.69 ± 3.86	56.16 ± 4.58	.845
Height (cm)	153.89 ± 3.64	154.01 ± 5.30	.237
Mid-upper-arm circumference (mm)	238 ± 16	242 ± 17	.546

a. Student's *t*-test.

TABLE 3. Impact of nutritional intervention on pregnant women during last trimester and on birth outcome[a]

Variable	Intervention group ($n = 150$)	Control group ($n = 150$)	p^b
Initial body weight in 6th mo	56.57 ± 4.86	56.81 ± 2.49	0.590
Body weight in 7th mo	59.18 ± 4.79	58.23 ± 2.45	0.300
Difference in body weight between 6th and 7th mo	2.37 ± 0.72	1.41 ± 0.60	0.006
Body weight in 8th mo	62.08 ± 4.65	59.98 ± 2.63	0.001
Difference in body weight between 7th and 8th mo	2.89 ± 0.83	1.74 ± 0.94	0.436
Body weight in 9th mo	65.41 ± 4.54	62.20 ± 3.28	0.001
Difference in body weight between 8th and 9th mo	3.33 ± 1.15	2.21 ± 1.39	0.003
Total body weight gain (7th to 9th mo)[c]	8.60 ± 2.32	5.38 ± 2.30	0.011
Birthweight of newborn	2.98 ± 0.33	2.49 ± 0.21	0.001
Low birthweight—no. (%)[d]	3 (2.7)	67 (44.7)	0.0001

a. Weights are in kilograms. Plus–minus values are means ± SD.
b. Student's *t*-test.
c. Repeated measure ANOVA.
d. Chi-squared test.

continued to increase more in the intervention group up to delivery (65.41 vs. 62.20 kg, $p = 0.001$). At the end of the third month of education, the mean pregnancy weight gain was 60% higher in the intervention group than in the control group (8.60 vs. 5.38 kg, $p = 0.011$). At baseline, the intake of khichuri was almost zero in both groups. After the nutritional intervention, the mean frequency of intake of khichuri in the intervention group was consistently higher than in the control group. The proportion of women who consumed khichuri at least six times per week was almost 10 times higher in the intervention group than in the control group (61.3% vs. 6.7%, $p = 0.001$) **(fig. 2)**. Mean birthweight was 20% higher in the intervention group than in the control group (2.98 vs. 2.49 kg, $p < 0.001$). There was a 94% reduction in low birthweight in the intervention group compared with the control group (2.7% vs. 44.7%, $p < 0.001$, odds ratio 0.04) **(fig. 3)**.

Table 4 shows that after controlling for confounding variables in the multiple regression, birthweight was positively and independently associated with body weight of pregnant women at the entry of trial, weight gain during the last trimester, nutritional intervention, and the frequency of khichuri intake ($p < 0.001$).However, family income and education of the women had no significant relationship with birthweight.

Table 5 shows that in the intervention group, 86.0% of babies were breastfed within 1 hour after birth, compared with 56.7% in the control group ($p = 0.001$). Colostrum feeding was also significantly more frequent

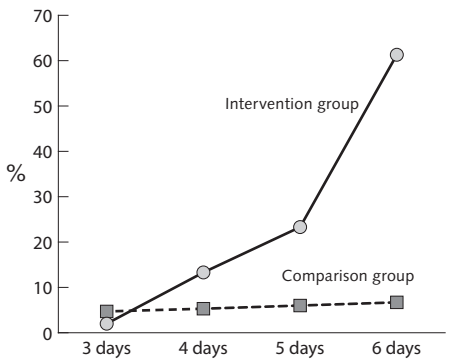

FIG. 2. Frequency of weekly intake of khichuri during pregnancy

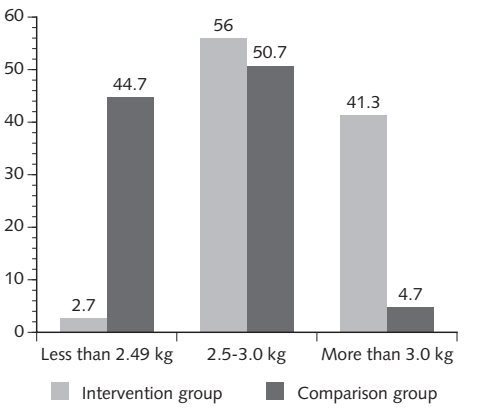

Figure 3: Effect of nutrition education on birth weight of the new born

TABLE 4. Multiple regression for maternal determinants of birthweight. Confounding factors: income, education, initial weight, khichuri intake[a]

Predictor variable	Slope	SE β	B	*p*
Intervention	0.585	0.059	0.788	0.000
Initial weight of mother	0.047	0.003	0.491	0.000
Weight gain after 3mo intervention	0.164	0.031	0.178	0.000
Khichuri intake ≥ 3×/wk	0.116	0.060	0.156	0.052
Monthly family income (TK)	2.570E–06	0.000	0.027	0.458
Education	0.001	0.005	0.005	0.894

a. Multiple $R = 0.855$, adjusted R square = 0.725 ($F = 105.4$, $p < 0.001$).

TABLE 5. Effect of nutrition education on breastfeeding practices of pregnant women in last trimester—no. (%)

Indicator	Intervention group ($n = 150$)	Control group ($n = 150$)	p^a
Early initiation of breastfeeding	129 (86.0)	85 (56.7)	.001
Feeds colostrum	129 (86.0)	98 (65.3)	.001
Exclusive breastfeeding after 1 mo	126 (84.0)	104 (69.3)	.003

a. Chi-squared test.

in the intervention group (86.0% vs. 65.3%, $p = 0.001$) [18]. The rate of exclusive breastfeeding 1 month after delivery was 33% higher in the intervention group than in the control group (84.0% vs. 69.3%, $p = 0.003$).

Discussion

This study demonstrated the capacity of short-term nutrition education to change dietary behavior and the associated impact on weight gain during pregnancy and subsequent birthweight. In urban Dhaka, the intervention was composed of simple messages regarding diet, care during pregnancy, disease control, and breastfeeding and met the knowledge gap of participating women, which facilitated behavior change and the translation of knowledge into practice.

In Bangladesh, low birthweight is related to maternal malnutrition, teenage pregnancy, poverty, reduced food intake during pregnancy, and a lack of education [19, 20]. Pregnancy weight gain has been identified as an important factor associated with an increase in birthweight [21, 22]. This is not confined to developing countries; studies in the United States on pregnant women and adolescents have also demonstrated the positive effects of nutrition education or supplements on birthweight [23, 24]. In Bangladesh, a large-scale national survey showed a smaller magnitude of weight gain during the third trimester [13]. In our study, significant weight gain during the last 3 months of pregnancy was achieved through specific nutrition education, such as explanation of the benefits of increased frequency of food intake, providing a dietary guideline with easy-to-prepare, energy-dense formulas, and advice on healthcare [25, 26]. Our study also found that daily khichuri intake was significantly higher in the intervention group than in the control group. The khichuri contained simple ingredients with adequate dietary diversity from five food groups, such as protein from lentils and eggs, energy from oil and rice, and micronutrients from green, red and yellow-colored vegetables.

A previous study by the Bangladesh National Nutrition Program indicated that early supplementation during pregnancy with 650 kcal/day continued for 120 to 150 days up to delivery resulted in improved birthweight [10]. Another study found that intensive nutrition education using a khichuri formula similar to that in our study significantly improved the status of moderately malnourished children within 3 months of the intervention period [18]. There is supportive evidence that encouraging the consumption of khichuri with a composition similar to that in our study increases weight gain among women performing highly strenuous physical work [15]. Generally, a change in behavior is considered difficult, but in our study, significant changes were clearly evident in the intervention group after receiving nutrition education [25].

Our study results reaffirmed the importance of pre-pregnancy weight gain as well as weight gain throughout pregnancy. An important implication is that women should be in better nutritional status before entering pregnancy and that nutritional support during the whole pregnancy is important.

The ingredients of khichuri had suitable nutrients to promote weight gain of pregnant women during the last trimester if the frequency of intake is increased [27]. Eggs provided high-quality protein and the limiting amino acid methionine, and lentils provided a high proportion of protein and another limiting amino acid, lysine, helping the synthesis of protein and supporting intrauterine growth of the fetus. Adequate oil added to khichuri enriched energy density and helped with weight gain of the women and the birthweight of the babies. Birthweight was positively associated with frequency of khichuri intake, the intervention, baseline body weight of the pregnant women, and weight gain during the study period. The benefits of such dietary intake were shown in our previous smaller-scale study [27].

The primary limitation of our study was a dropout rate of approximately 20%. However, this was not seen as detrimental to the study, since the participants who dropped out were not significantly different in demographic and anthropometric characteristics from the women who remained in the study. Future interventions may consider using the opportunity to provide one-to-one counseling to women in the waiting room of the antenatal clinic. The waiting room was seen as an opportunistic setting to speak with women individually, allowing them to ask questions in a comfortable environment.

The strengths of our intervention include its adaptability to clinic environments in Bangladesh and other countries, its low cost, and its applicability to community and home-based intervention programs. Because antenatal care is delivered in health facilities, this intervention is feasible to be scaled up in urban or rural settings. This intervention can be implemented in rural settings in Bangladesh, since the free antenatal care at the upazila (sub-district) and community clinic (rural) levels is similar to that provided in urban areas. The most important feature was that a home-based, readily available, low-cost, and sustainable diet was used to improve nutritional status during pregnancy. The study showed that the intervention was effective, independently of women's income and educational status.The socioeconomic status of the participating women was low; however, the ingredients of khichuri are affordable and readily available, allowing accessibility without difficulty.

The study also found that significantly more mothers in the intervention group breastfed their babies

within 1 hour after birth. This is an important strategy to reduce neonatal mortality [28]. Mothers in the intervention group had a higher rate of exclusive breastfeeding, which helps to reduce morbidity and mortality of low-birthweight babies [29–31]. Early initiation of breastfeeding reduces neonatal deaths by 31%, and exclusive breastfeeding reduces child mortality by 13% [29, 30].

In conclusion, we have shown that a short-term nutrition education intervention resulted in increased pregnancy weight gain, a strong reduction in the rate of low birthweight, and improved breastfeeding practices. We recommend that antenatal nutrition education be provided to pregnant women during the third trimester in countries facing high levels of maternal malnutrition and low birthweight.The intervention is relatively easy to implement in all maternity facilities, including community clinics, in Bangladesh and should be adopted without delay in order to achieve Millennium Development Goals 4 (reduce child mortality) and 5 (improve maternal health).

Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions

K. Jahan, the principal investigator, was involved in designing the study concept and conducted the study. S. K. Roy contributed to study design, supervision, and quality control and provided substantial advice on data analysis and interpretation of results. S. Mihrshahi was involved in editing and interpreting the manuscript and provided significant advice. N. Sultana, H. Roy, R. Datta, A. Roy, and S. Jahan assisted with data collection and data entry. S. S. Khatoon reviewed the manuscript and provided critical input. J. Steele assisted in interpretation of the results as well as the final editing of the manuscript.

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