Maternal & Child Nutrition

DOI: 10.1111/j.1740-8709.2011.00379.x

Original Article

Determinants of inappropriate complementary feeding practices in infant and young children in Bangladesh: secondary data analysis of Demographic Health Survey 2007

Iqbal Kabir*, Mansura Khanam*, Kingsley E. Agho†, Seema Mihrshahi‡, Michael J. Dibley§ and Swapan K. Roy*

*ICDDR,B, Clinical Sciences Division, Dhaka, Bangladesh, †School of Medicine, University of Western Sydney, Penrith, New South Wales, Australia, ‡School of Population and Health, University of Queensland, Brisbane, Queensland, Australia, and §Sydney School of Public Health, University of Sydney, New South Wales, Australia

Abstract

Suboptimal and inappropriate complementary feeding practices are one of the major causes of child undernutrition in the first 2 years of life in South Asian countries including Bangladesh. The aim of this study was to use the newly developed World Health Organization infant feeding indicators to identify the potential risk factors associated with inappropriate complementary feeding practices. We used data for 1728 children aged 6–23 months obtained from nationally representative data from the 2007 Bangladesh Demographic and Health Survey to assess the association between complementary feeding and other characteristics using multivariate models. Only 71% of infants were consuming soft, semi-solid and solid food by 6–8 months of age. In the multivariate analysis, mothers who had no education had a higher risk for not introducing timely complementary feeds [adjusted odds ratio (AOR) = 2.14; 95% confidence interval (CI): 1.08–4.23, $P = 0.03$], not meeting the minimum dietary diversity (AOR = 1.69; 95% CI: 1.14–2.54, $P = 0.01$), minimum acceptable diet (AOR = 1.70, 95% CI: 1.09–2.67, $P = 0.02$) and minimum meal frequency (AOR = 1.73; 95% CI: 1.20–2.49, $P = 0.003$) than the mothers who had secondary or higher education. Infants born in Sylhet, Chittagong and Barisal division had higher risks for not meeting minimum dietary diversity, meal frequency and acceptable diet ($P < 0.001$). The poorest two quintiles had poor levels of minimum meal frequency but dietary quality improved with age. In Bangladesh addressing the fourth Millennium Development Goal (MDG) target will require substantial improvement in complementary feeding practices. Appropriate Infant and Young Child feeding massages should to be development and delivered through existing health system.

Keywords: complementary feeding, South Asia, new indicators, infant feeding, dietary diversity, acceptable diet.

Correspondence: Dr Iqbal Kabir, ICDDR,B, GPO Box 128, Mohakhali, Dhaka 1212, Bangladesh. E-mail: ikabir@icddrb.org

Introduction

It is well recognized that the period from birth to 2 years of age is the 'critical window' for the promotion of optimal growth, health and development (Pan American Health Organization & World Health Organization 2003). Insufficient quantities and inadequate quality of complementary foods, poor child feeding practices and high rates of infections have a detrimental effect on health and growth in these important years. Even with optimum breastfeeding, children will become stunted if they do not receive sufficient quantities of quality complementary foods after 6 months of age (Black *et al*. 2008). An estimated 6% of under-five deaths can be prevented by ensuring optimal complementary feeding (Black *et al*. 2003).

In Bangladesh, only 62% of infants aged 6–9 months receive complementary foods while

continuing to be breastfed (BDHS 2004). These data, however, do not reflect the quality of the complementary foods received. Meeting minimum standards of dietary quality is a challenge in many developing country settings, especially in areas where household food security is poor, and it has often not been given enough emphasis. Children may not receive complementary foods at the right age (often either too early or too late), are not fed frequently enough during the day, or the quality of the food may be inadequate. Complementary feeding is one of the most effective interventions that can significantly reduce stunting during the first 2 years of life (Roy *et al*. 2007; Dewey & Adu-Afarwuah 2008). A comprehensive programme approach to improving complementary feeding includes counselling for caregivers on feeding and care practices, and on the optimal use of locally available foods, and the quality of complementary feeding.

The World Health Organization (WHO) guideline for complementary feeding for breastfed children describes other important aspects such as safe preparation, consistency, meal frequency and energy density ensuring required nutrient content of complementary food (Pan American Health Organization & World Health Organization 2003). In 2007, WHO introduced a set of new indicators to assess the infant and young children feeding (IYCF) practices (Daelmans *et al*. 2009). These indicators have been changed to reflect dietary quality and quantity and validated using existing data set (BDHS 2007).

We have previously published the prevalence and risk factors for inappropriate breastfeeding practices (Mihrshahi *et al*. 2010). This current analysis was conducted to determine the prevalence and risk factors associated with inappropriate complementary feeding practices such as delayed introduction of complementary feeding, low meal frequency, poor dietary diversity and inadequate minimum acceptable diet using a recently collected nationally representative data set for Bangladesh.

Materials and methods

Source of data

The data examined were the 2007 Bangladesh Demographic and Health Survey (BDHS 2007), which used a two-stage stratified sample of households. At the first stage of sampling, 361 primary sampling units (PSUs) were selected. The resulting lists of the households were used as the sampling frame for the selection of households in the second stage of sampling. On average, 30 households were selected from each PSU, using an equal probability systematic sampling technique.

The survey was designed to obtain 11 485 completed interviews with ever-married women aged 15–49 years. According to the sampling design, 4360 interviews were allocated to urban and 7125 to rural areas. All ever-married women age 15–49 years in the selected households were eligible respondents for the women's questionnaire and were interviewed, yielding a response rate of 98.4%. The present analysis was restricted to the youngest living children aged 6–23 months, living with the respondent (ever-married women age 15–49 years), alive, and the total weighted sample size was 1728.

The 2007 BDHS used five questionnaires: a household questionnaire, a women's questionnaire, a men's

Key messages

- Introduction of complementary food within 6–8 months of age was not satisfactory.
- Poor complementary feeding practices were associated with lower parental education, father's occupation, geographical region and age of the child.
- The minimum dietary diversity and minimum acceptable diet rate was associated with lower maternal education, poor socio-economic status and geographical variation, with the worst levels in Sylhet and Chittagong divisions.
- Parental education is a potential protective factor which might be linked to dietary knowledge, dietary diversity, quality of food and feeding frequency.

questionnaire, a community questionnaire and a facility questionnaire. Selected variables from all these questionnaires were used to determine complementary feeding indicators and the factors associated with poor complementary feeding indicators. Their contents were based on the measure Demographic and Health Survey (DHS) model questionnaires (BDHS 2007). These model questionnaires were adapted for use in Bangladesh during a series of technical meetings with representatives from National Institute for Population Research and Training, Mitra and Associates.

Complementary feeding indicators and explanatory factors

We applied the new and updated infant and young child feeding indicators of the WHO (Daelmans *et al*. 2009) which are based on the mother's recall of foods given to her child in the 24 h before the survey. The following four outcome measures were estimated:

- ***Introduction of solid, semi-solid or soft foods:*** Proportion of infants 6–8 months of age who received solid, semi-solid or soft foods.
- ***Minimum dietary diversity:*** Proportion of children 6–23 months of age who received foods from four or more food groups of the seven food groups. There were only six food groups in the BDHS data instead of the seven recommended in the WHO guidelines because eggs and flesh foods were combined as one group. The six foods groups used for tabulation of this indicator were: grains, roots and tubers; legumes; dairy products (milk, yogurt); flesh foods (meat, fish, poultry and liver/organ meats); vitamin A-rich fruits and vegetables; and other fruits and vegetables. Consumption of any amount of food from each food group was sufficient to 'count', i.e. there was no minimum quantity, except if an item was only used as a condiment.
- ***Minimum meal frequency:*** Proportion of breastfed and non-breastfed children 6–23 months of age who received solid, semi-solid or soft foods (but also including milk feeds for non-breastfed children) the minimum number of times or more. Minimum was defined as: twice for breastfed infants 6–8 months, three times for breastfed children 9–23 months and four times for non-breastfed children 6–23 months.
- ***Minimum acceptable diet:*** This composite indicator was calculated from the following two fractions: Breastfed children 6–23 months of age who had at least the minimum dietary diversity and the minimum meal frequency during the previous day; and non-breastfed children 6–23 months of age who received at least two milk feedings and had at least the minimum dietary diversity not including milk feeds, and the minimum meal frequency during the previous day. However, in the present analysis, this indicator was confined to only breastfed children because the minimum number of non-breast milk feeds was not available in the DHS survey data.

The explanatory variables were classified into four levels: attributes of child, parents, household, and health service and community. Child's age was categorized as 6–11, 12–17 and 18–23 months considering the practical importance to have narrower age intervals at younger rather than at older ages within the sample. Acute respiratory infection was defined as having symptoms of cough accompanied by short, rapid breathing which was chest related during 2 weeks preceding the survey. Any child with watery or blood and mucus stool in the last 2 weeks was considered as having diarrhoea, mother's literacy (reads newspaper, watches television and listens to radio). The household wealth index was calculated as a score of household assets such as ownership of transportation devices, ownership of durable goods and household facilities, which was weighted using the principal components analysis method (Filmer & Pritchett 1998). This index was divided into five categories (quintiles), and each household was assigned to one of these categories. Woman reads newspaper at least once a week or watches television daily or listens to radio daily. Standard definition for improved source of drinking water used in the Multiple Indicator Cluster Survey was applied (UNICEF 2010).

Statistical analysis

Complementary feeding practice indicators (introduction of solid, semi-solid or soft food, minimum

dietary diversity, minimum meal frequency and minimum acceptable diet rates) were examined against a set of independent variables to determine the prevalence and factors associated with inappropriate complementary feeding indicators. Analyses were performed using Stata version 10.0 (StataCorp, College Station, TX, USA). 'Svy' commands were used to allow for adjustments for the cluster sampling design, weights and the calculation of standard errors. The Taylor series linearization method was used in the surveys when estimating confidence intervals (CIs) around prevalence estimates. A chi-squared test was used to test the significance of associations. Survey logistic regression was used to adjust for the complex sampling design and weights, and the models were constructed using stepwise backwards regression in order to determine the factors significantly associated with inappropriate complementary feeding indicators. The models constructed by backward elimination used the following procedures: (1) only variables with P-value < 0.20 in the univariate analysis were entered into the models for backward elimination; (2) the screened variables (potential confounders) were included in the model and the non-significant variables ($P \geq 0.05$) were eliminated step by step; and (3) we also tested for collinearity. The odds ratios with 95% CIs were calculated in order to assess the adjusted risk of independent variables, and those with $P < 0.05$ were retained in the final model. Associations between all these variables/indicators were examined against individual, child, parental, health care and household characteristics using multiple logistic regression model.

Results

Characteristics of the sample

Table 1 describes the distribution of the individual, household and community level characteristics of 1728 (weighted total) children aged between 6 and 23 months. About one-fifth of the mothers of these children were illiterate. About two-thirds of the surveyed mothers had a body mass index (BMI) within the normal range 18–25 kg/m^2 and slightly more than a quarter had a low BMI (<18 kg/m^2). Most of the mothers of these children were Muslim (92%). Male and female children were nearly equally represented in the sample. One in 10 deliveries was by Caesarean section. Of the total births, 81% was home deliveries, and 19% was deliveries at health facilities.

Types of food given to child by age

Table 2 shows the types of food given during the preceding 24 h among children aged 6–23 months. About 85% of children aged 6–23 months were given grains, whereas only 29% received legumes, 41% consumed dairy products and 48% consumed fish or meat or eggs. Among children 6–23 months, 54% had vitamin A-rich fruits and vegetables and 47% had other fruits and vegetables.

Complementary feeding indicators

More than two-thirds of the 1728 children aged between 6 and 8 months had been introduced to solid, semi-solid or soft foods (Table 3). Overall, less than half of the children 6–23 months (41.9%) meet the minimum dietary diversity criteria, but for infants aged 6–11 months the rate was lower (19.8%), although it almost tripled with children aged 18–23 months (59.7%). Two-thirds of the infants aged 6–11 months had the minimum meal frequency but this increased to more than nine out of 10 children in the 18–23 months age group. When these indicators were combined, less than half of the children aged 6–23 months (39.6%) had a minimum acceptable diet. Very small number for non-breastfed children among complementary feeding indicators.

Differentials of complementary feeding indicators

Table 4 shows that infants born to parents without education, in households with lower economic status, infants delivered by untrained birth attendants and to mothers having less antenatal check-ups had significantly lower minimum dietary diversity and minimum acceptable diet. Children of mothers with low BMI, a history of Caesarean section and who lived in rural areas had significantly lower minimum dietary

Table 1. Individual, paternal, household, health care and community level characteristics of children aged 6–23 months, Bangladesh 2007 ($n = 1728$)

Characteristic	*n*	Percentage	Characteristic	*n*	Percentage
Child characteristics			Father's occupation		
Gender of baby			Non-agricultural	1245	72.0
Male	861	49.8	Agricultural	442	25.6
Female	867	50.2	Other	41	2.4
Age of child (months)			Household wealth index		
6–11	616	35.6	Poorest	350	20.2
12–17	526	30.4	Poorer	368	21.3
18–23	586	33.9	Middle	342	19.8
Birth order			Richer	330	19.1
Firstborn	634	36.7	Richest	339	19.6
Second to fourth	917	53.1	Source of drinking water		
Five or more	177	10.2	Improved	1487	86.1
Preceding birth interval ($n = 1727$)			Not improved	241	14.0
No previous birth	634	36.7	Reads newspaper or magazine ($n = 1727$)		
<24 months	158	9.1	Not at all	1462	84.6
>24 months	935	54.2	Less than once a week	155	9.0
Diarrhoea			At least once a week	84	4.9
No	1486	86.0	Almost every day	27	1.5
Yes	242	14.0	Listens to radio ($n = 1727$)		
ARI			Not at all	1307	75.7
No	464	26.9	Less than once a week	92	5.3
Yes	292	16.9	At least once a week	169	9.8
Missing	972	56.2	Almost every day	160	9.3
Maternal characteristics			Watches television		
Mother's age (year)			Not at all	830	48.1
15–24	1030	59.6	Less than once a week	112	6.5
25–34	597	34.6	At least once a week	285	16.5
35–49	101	5.8	Almost every day	501	29.0
Mother's age at child's birth			*Health service characteristics*		
Less than 20	569	32.9	Antenatal clinic visits ($n = 1725$)		
20–29	916	53.0	None	642	37.2
30–39	228	13.2	1–3	679	39.4
More than 40	15	0.9	4+	404	23.4
Mother's education			Don't know		
No education	384	22.2	Timing of post-natal check-up		
Primary	520	30.1	Missing	1125	65.1
Secondary and above	824	47.7	0–2 days	411	23.8
Mother's working status ($n = 1727$)			3–6 days	59	3.4
Non-working	1355	78.5	Seventh day or later	133	7.7
Working (past 12 months)	372	21.6	Place of delivery		
Mother's literacy			Home	1401	81.1
Cannot read at all	560	32.4	Health facility	327	18.9
Able to read only part of sentence	125	7.2	Type of delivery assistance ($n = 1528$)		
Able to read whole sentence	1044	60.4	Health professional	342	22.4
Maternal BMI ($n = 1727$)			Traditional birth attendant.	43	2.8
Less than 18	454	26.3	Other untrained	1143	74.8
18–25	1147	66.4	Mode of delivery ($n = 1727$)		
More than 25	125	7.2	Non-Caesarean	1557	90.2
Mother's religion ($n = 1727$)			Caesarean	170	9.8
Muslim	1586	91.8	*Community level factors*		
Other	141	8.2	Residence		
Family/household characteristics			Urban	391	22.6
Marital status ($n = 1727$)			Rural	1337	77.4
Currently married	1697	98.2	Geographical region		
Formerly married (divorced/separated/ widow)	30	1.8	Barisal	98	5.7
			Chittagong	389	22.5
Father's education ($n = 1725$)			Dhaka	569	32.9
No education	544	31.5	Khulna	145	8.4
Primary	477	27.7	Rajshahi	395	22.9
Secondary and above	704	40.8	Sylhet	132	7.6

ARI, acute respiratory infection; BMI, body mass index. Weighted total was 1728 otherwise stated within brackets.

Table 2. Types of food groups given to the children aged 6–23 months by age group, Bangladesh, 2007

Child age category (months)	Grains	Legumes	Dairy products (cow's or goat's milk and yoghurt)	Fish/meat and egg	Vitamin A-rich fruits and vegetables	Others fruits and vegetables	*n*
6–8	55.6 (48.9, 62.1)	8.5 (5.9, 12.5)	41.3 (35.5, 47.4)	11.5 (8.3, 15.9)	28.8 (122.9, 35.6)	22.2 (17.1, 28.2)	340
9–11	86.5 (80.8, 90.8)	23.3 (17.6, 30.2)	44.9 (37.9, 52.2)	33.4 (26.5, 41.1)	47.9 (40.4, 55.6)	39.8 (32.4, 47.8)	276
12–17	91.7 (88.8, 93.9)	32.3 (27.8, 37.1)	41.6 (36.4, 47.0)	54.3 (49.2, 59.2)	58.3 (52.9, 63.5)	52.4 (47.5, 57.3)	526
18–23	91.3 (92.7, 96.9)	41.3 (36.7, 46.2)	38.7 (34.2, 43.4)	69.1 (64.8, 73.1)	68.8 (63.9, 73.4)	59.1 (53.9, 63.9)	586
6–23	84.9 (82.7, 86.9)	29.2 (26.8, 31.8)	41.1 (37.9, 44.3)	47.6 (44.6, 50.5)	54.4 (50.8, 57.9)	46.7 (43.7, 49.7)	1728

Table 3. Complementary feeding indicators among children aged 6–23 months by age group, Bangladesh 2007 (*N* = 1728)

Indicator	*N*⁺	*n***	Rate (%)	[95% CI]
Introduction of solid, semi-solid or soft foods rate (6–8 months)*	339	241	71.09	(64.51, 76.89)
Minimum dietary diversity rate				
Minimum dietary diversity rate, BF (6–11 months)†	606	119	19.59	(16.04, 23.71)
Minimum dietary diversity rate, non-BF (6–11 months)†	10	3	26.37	(7.19, 62.35)
Minimum dietary diversity rate, all (6–11 months)†	616	122	19.77	(16.25, 23.84)
Minimum dietary diversity rate, BF (12–17 months)‡	506	237	46.81	(41.88, 51.81)
Minimum dietary diversity rate, non-BF (12–17 months)‡	20	8	39.12	(16.91 66.98)
Minimum dietary diversity rate, all (12–17 months)‡	526	253	48.06	(43.15, 53.00)
Minimum dietary diversity rate, BF (18–23 months)§	543	319	58.72	(53.88, 63.30)
Minimum dietary diversity rate, non-BF (18–23 months)§	43	31	72.14	(58.50, 82.63)
Minimum dietary diversity rate, all (18–23 months)§	586	350	59.71	(54.99, 64.25)
Minimum dietary diversity rate, BF (6–23 months)¶	1655	674	40.75	(37.93, 43.63)
Minimum dietary diversity rate, non-BF (6–23 months)¶	73	50	68.91	(57.14, 78.86)
Minimum dietary diversity rate, all (6–23 months)¶	1728	724	41.93	(39.14, 44.76)
Minimum meal frequency rate				
Minimum meal frequency rate, BF (6–11 months)†	606	403	66.45	(61.73, 70.87)
Minimum meal frequency rate, non-BF (6–11 months)†	10	5	48.64	(18.72, 79.56)
Minimum meal frequency rate, all (6–11 months)†	615.8	407.5	66.17	(61.49, 70.56)
Minimum meal frequency rate, BF (12–17 months)‡	506	430	84.83	(80.55, 88.30)
Minimum meal frequency rate, non-BF (12–17 months)‡	19	15	77.78	(47.82, 93.04)
Minimum meal frequency rate, all (12–17 months)‡	526	445	84.57	(80.46, 87.94)
Minimum meal frequency rate, BF (18–23 months)§	543	513	94.55	(91.92, 96.35)
Minimum meal frequency rate, non-BF (18–23 months)§	43	35	81.13	(65.12, 90.83)
Minimum meal frequency rate, all (18–23 months)§	586	548	93.55	(90.89, 95.47)
Minimum meal frequency rate, BF (6–23 months)¶	1655	1345	81.28	(78.74, 83.59)
Minimum meal frequency rate, non-BF (6–23 months)¶	73	50	68.91	(57.14, 78.66)
Minimum meal frequency rate, all (6–23 months)¶	1728	1400	81.06	(78.61, 83.28)
Minimum acceptable diet rate				
Minimum acceptable diet rate (6–11 months)†	606	112	18.45	(14.96, 22.54)
Minimum acceptable diet rate (12–17 months)‡	506	230	45.57	(40.57, 50.46)
Minimum acceptable diet rate (18–23 months)§	543	313	57.72	(52.91, 62.39)
Minimum acceptable diet rate (6–23 months)¶	1655	655	39.59	(36.83, 42.42)

B, breastfed; CI, confidence interval. *N*⁺ = total number, *n*** = total positive. *Infants 6–8 months. †Infants 6–11 months. ‡Infants 12–17 months. §Infants 18–23 months. ¶Infants 6–23 months.

Table 4. Introduction of complementary feeding, minimum dietary diversity, minimum meal frequency and minimum acceptable diet by individual, parental, health care and community level characteristics, Bangladesh 2007

Characteristic	Introduction of solid, semi-solid or soft foods rate			Minimum dietary diversity rate			Minimum meal frequency rate			Minimum acceptable diet rate		
	%	95% CI	*P*	%	95% CI	*P*	%	95% CI	*P*	%	95% CI	*P*
Child characteristics												
Gender of baby												
Male	76.7	(68.5, 83.3)		43.2	(39.3, 47.2)		81.9	(78.9, 84.5)		38.3	(34.5, 42.1)	
Female	66.2	(56.6, 74.6)	0.072	40.7	(36.8, 44.6)	0.781	80.3	(76.8, 83.4)	0.427	37.6	(33.8, 41.6)	0.821
Age of child (months)												
6–11				19.8	(16.3, 23.8)		66.2	(61.5, 70.6)		18.2	(14.7, 22.2)	
12–17				48.1	(43.1, 53.0)		84.6	(80.4, 88.0)		43.8	(39.0, 48.7)	
18–23				59.7	(55.0, 64.3)	<0.001	93.6	(90.9, 95.5)	<0.001	53.5	(48.8, 58.1)	<0.001
Birth order												
Firstborn	70.0	(59.3, 78.9)		46.9	(42.5, 51.3)		83.0	(79.3, 86.1)		41.5	(37.2, 45.9)	
Second to fourth	72.6	(63.8, 80.0)		40.6	(37.0, 44.3)		80.9	(77.7, 83.7)		36.8	(33.4, 40.4)	
Five or more	67.2	(50.0, 80.8)	0.798	31.0	(23.4, 39.6)	0.002	75.1	(67.2, 81.7)	0.097	31.0	(23.4, 39.6)	0.056
Preceding birth interval												
No previous birth	70.0	(59.3, 78.9)		46.9	(42.5, 51.3)		83.0	(79.3, 86.1)		41.5	(37.2, 45.9)	
<24 months	71.6	(52.1, 85.3)		37.7	(29.4, 46.9)		79.3	(69.8, 86.4)		34.9	(26.9, 44.0)	
>24 months	71.8	(63.5, 78.8)	0.948	39.2	(35.4, 43.2)	0.019	80.0	(76.8, 82.9)	0.499	36.0	(32.3, 39.9)	0.126
Diarrhoea												
No	70.9	(53.6, 86.1)		42.6	(39.6, 45.7)		81.2	(78.5, 83.6)		38.7	(35.8, 41.8)	
Yes	72.8	(64.0, 76.9)	0.829	37.8	(31.2, 44.9)	0.217	80.3	(74.6, 85.0)	0.769	33.1	(26.8, 40.1)	0.147
ARI												
No	70.0	(57.4, 80.1)		41.9	(40.5, 46.5)		80.4	(75.5, 84.5)		36.6	(31.7, 41.7)	
Yes	67.8	(55.7, 77.9)	0.707	34.3	(28.4, 40.6)	0.030	77.2	(71.5, 82.0)	0.166	31.9	(26.1, 38.4)	0.069
Missing	73.3	(64.1, 80.8)		44.3	(40.4, 48.2)		82.6	(79.6, 85.1)		40.4	(36.7, 44.2)	
Maternal characteristics												
Mother's age (year)												
15–24	74.1	(65.2, 81.3)		42.9	(39.6, 46.3)		82.8	(79.6, 85.6)		39.3	(36.0, 42.7)	
25–34	65.1	(55.4, 73.7)		41.4	(36.5, 46.6)		78.4	(74.0, 82.2)		36.5	(31.8, 41.4)	
35–49	81.5	(45.2, 95.9)	0.262	34.5	(25.2, 45.3)	0.346	78.7	(68.1, 86.4)	0.169	32.4	(23.1, 43.2)	0.358
Mother's age at child's birth												
Less than 20	72.8	(60.1, 82.7)		42.4	(37.8, 47.2)		85.1	(81.1, 88.3)		39.1	(34.5, 43.8)	
20–29	71.3	(63.3, 78.2)		42.3	(38.4, 46.2)		79.2	(76.1, 82.1)		37.7	(33.9, 41.6)	
30–39	64.0	(47.9, 77.5)		40.5	(33.0, 48.5)		78.2	(71.1, 84.0)		37.0	(30.1, 44.5)	
More than 40	100.0		0.490	25.6	(10.1, 51.3)	0.669	84.7	(59.8, 95.4)	0.050	25.6	(10.1, 51.3)	0.759

Table 4. Continued

Characteristic	Introduction of solid, semi-solid or soft foods rate			Minimum dietary diversity rate			Minimum meal frequency rate			Minimum acceptable diet rate		
	%	95% CI	*P*	%	95% CI	*P*	%	95% CI	*P*	%	95% CI	*P*
Mother's education												
No education	63.1	(50.9, 73.9)		30.2	(25.0, 36.0)		76.8	(70.7, 81.9)		28.2	(23.1, 34.0)	
Primary	69.1	(55.0, 80.4)		37.2	(32.8, 41.9)		81.7	(77.2, 85.5)		35.0	(30.8, 39.5)	
Secondary and above	76.5	(67.7, 83.4)	0.193	50.4	(46.4, 54.3)	<0.001	82.7	(79.4, 85.5)	0.140	44.3	(40.4, 48.2)	<0.001
Mother's literacy												
Cannot read at all	66.6	(55.8, 76.0)		32.9	(28.7, 37.3)		79.1	(74.5, 83.1)		30.9	(26.8, 35.4)	
Able to read only part of sentence	61.9	(40.0, 79.8)		39.6	(29.7, 50.4)		80.3	(71.8, 86.8)		38.6	(28.8, 49.5)	
Able to read whole sentence	74.8	(67.2, 81.2)	0.234	47.1	(43.6, 50.6)	<0.001	82.2	(79.3, 84.7)	0.398	41.6	(38.3, 45.0)	0.001
Mother's working status												
Non-working	67.7	(60.2, 74.4)		41.0	(37.9, 44.2)		80.3	(77.6, 82.8)		36.7	(33.8, 39.8)	
Working (past 12 months)	83.3	(68.3, 92.0)	0.055	45.1	(39.6, 50.8)	0.211	83.7	(79.9, 87.6)	0.283	42.2	(36.8, 47.9)	0.078
Mother's BMI (kg/m^2)												
Less than 18	78.4	(64.0, 88.1)		32.3	(32.5, 42.3)		83.1	(78.5, 86.9		35.7	(30.9, 40.8)	
18–25	68.8	(61.0, 75.6)		42.0	(38.6, 45.3)		80.2	(77.1, 83.0)		38.1	(35.0, 41.4)	
More than 25	59.8	(33.8, 81.3)	0.267	59.2	(50.1, 67.7)	0.001	81.4	(73.3, 87.4)	0.479	44.6	(36.1, 53.4)	0.192
Mother's religion												
Muslim	71.5	(64.5, 77.6)		41.6	(38.6, 44.7)		81.3	(78.7, 83.6)		37.5	(34.6, 40.4)	
Other	66.9	(44.4, 83.7)	0.671	45.5	(36.7, 54.5)	0.433	78.5	(70.2, 85.0)	0.471	43.0	(34.2, 52.3)	0.264
Family/Household characteristics												
Father's education												
No education	67.4	(53.9, 78.6)		31.2	(26.8, 36.1)		80.8	(76.0, 84.9)		29.3	(24.8, 34.2)	
Primary	73.3	(60.6, 83.0)		39.9	(35.1, 44.9)		82.4	(77.7, 86.4)		37.5	(32.7, 42.6)	
Secondary and above	72.8	(63.1, 80.7)	0.710	51.5	(46.8, 56.2)	<0.001	80.2	(76.4, 83.6)	0.759	44.8	(40.4, 49.3)	0.001
Father's occupation												
Non-agricultural	66.4	(58.0, 74.0)		42.7	(39.4, 46.0)		79.5	(76.6, 82.2)		37.7	(34.6, 40.9)	
Agricultural	82.4	(71.5, 89.7)		40.6	(35.0, 46.4)		84.3	(79.7, 88.0)		39.1	(33.4, 45.1)	
Not working	80.5	(41.4, 96.0)	0.020	34.5	(21.3, 50.6)	0.545	92.7	(78.5, 97.8)	0.034	33.2	(20.2, 49.3)	0.763
Marital status												
Currently married	71.3	(65.1, 76.9)		42.1	(39.3, 45.0)		81.0	(78.6, 83.2)		38.0	(35.4, 40.8)	
Formerly married (divorced/ separated/widowed)	48.5	(5.5, 93.9)	0.465	31.9	(15.5, 54.6)	0.357	82.7	(61.1, 93.5)	0.845	31.9	(15.5, 54.6)	0.573

Source of drinking water												
Improved	70.7	(63.7, 76.7)		41.7	(38.7, 44.8)		81.1	(78.4, 83.4)		37.9	(34.9, 40.9)	
Not improved	73.0	(58.3, 83.9)	0.739	43.2	(36.2, 50.4)	0.709	81.1	(74.7, 86.2)	0.979	38.5	(31.6, 45.8)	0.877
Household wealth index												
Poorest	72.2	(58.4, 82.8)		32.8	(26.8, 39.4)		83.8	(77.9, 88.3)		30.8	(24.9, 37.4)	
Poorer	65.8	(52.3, 77.1)		33.5	(28.1, 39.3)		78.4	(72.8, 83.1)		32.1	(26.8, 38.0)	
Middle	74.4	(60.3, 84.7)		44.6	(38.4, 51.0)		79.5	(72.8, 84.9)		41.6	(35.6, 47.8)	
Richer	74.9	(57.4, 86.8)		45.6	(39.3, 52.4)		83.5	(77.7, 88.0)		42.3	(36.1, 48.8)	
Richest	70.6	(55.1, 82.5)	0.831	54.1	(48.1, 60.0)	<0.001	80.3	(75.0, 84.7)	0.520	43.7	(37.7, 49.9)	0.004
Reads newspaper or magazine												
Not at all	70.9	(62.9, 76.9)		39.4	(36.6, 42.4)		80.9	(78.2, 83.3)		36.4	(33.6, 39.3)	
Less than once a week	84.4	(64.0, 94.3)		52.8	(43.4, 43.3)		86.8	(78.7, 92.2)		46.7	(37.4, 56.1)	
At least once a week	65.0	(38.9, 84.5)		57.6	(45.6, 68.8)		75.3	(64.3, 83.7)		45.0	(34.5, 55.9)	
Almost every day	40.9	(11.3, 79.0)	0.234	66.0	(48.3, 80.1)	<0.001	77.0	(59.6, 88.3)	0.194	49.2	(31.3, 67.4)	0.038
Listens to radio												
Not at all	69.0	(61.4, 75.7)		40.0	(36.8, 43.4)		81.2	(78.4, 83.8)		35.8	(32.7, 39.0)	
Less than once a week	88.2	(62.2, 97.2)		44.5	(32.5, 57.1)		75.6	(63.6, 84.6)		41.3	(29.7, 53.9)	
At least once a week	81.2	(58.5, 93.0)		46.0	(37.3, 55.0)		83.2	(75.1, 89.1)		42.5	(33.7, 51.8)	
Almost every day	66.2	(44.6, 82.6)	0.291	51.5	(42.7, 60.3)	0.088	80.7	(71.6, 87.4)	0.716	48.6	(39.8, 57.5)	0.038
Watches television												
Not at all	73.5	(65.0, 80.5)		33.9	(30.2, 37.8)		80.4	(76.7, 83.6)		32.1	(28.4, 36.1)	
Less than once a week	60.1	(36.9, 79.5)		37.6	(28.0, 48.2)		74.4	(63.6, 82.9)		35.5	(26.1, 46.1)	
At least once a week	77.8	(61.9, 88.4)		47.0	(40.3, 53.8)		84.4	(78.7, 88.8)		41.4	(34.6, 48.2)	
Almost every day	67.4	(55.1, 77.6)	0.409	53.3	(47.7, 58.8)	<0.001	81.8	(77.5, 85.4)	0.265	46.2	(40.9, 51.7)	<0.001
Health service characteristics												
Mode of delivery												
Non-Caesarean	56.7	(51.1, 62.2)		40.3	(37.4, 43.2)		81.6	(79.0, 83.9)		37.1	(34.4, 39.9)	
Caesarean	34.2	(20.3, 51.5)	0.012	57.5	(49.4, 65.2)	0.002	77.0	(68.7, 83.6)	0.058	46.0	(37.7, 54.6)	0.088
Place of delivery												
Home	73.0	(65.4, 79.4)		39.3	(36.3, 42.4)		81.8	(79.2, 84.1)		36.3	(33.4, 39.3)	
Health facility	60.9	(45.3, 74.5)	0.141	53.2	(47.6, 58.7)	<0.001	77.9	(71.8, 83.0)	0.174	44.9	(39.3, 50.6)	0.005
Type of delivery assistance												
Health professional	58.4	(43.5, 71.9)		56.0	(50.5, 61.4)		79.0	(73.6, 83.5)		47.5	(42.2, 52.8)	
Traditional birth attendant	57.8	(18.2, 89.4)		28.2	(16.1, 44.6)		83.1	(66.8, 92.3)		27.7	(15.6, 44.1)	
Other untrained	73.5	(65.4, 80.2)	0.230	40.1	(36.9, 43.5)	<0.001	81.4	(78.6, 83.9)	0.796	36.9	(33.7, 40.2)	0.007

Table 4. Continued

Characteristic	Introduction of solid, semi-solid or soft foods rate			Minimum dietary diversity rate			Minimum meal frequency rate			Minimum acceptable diet rate		
	%	95% CI	*P*	%	95% CI	*P*	%	95% CI	*P*	%	95% CI	*P*
Antenatal clinic visits												
None	71.7	(61.8, 79.9)		34.1	(29.3, 39.2)		79.4	(75.2, 83.0)		31.6	(27.0, 36.6)	
1–3	70.6	(60.7, 78.9)		41.1	(36.7, 45.6)		81.7	(78.0, 85.0)		38.1	(33.8, 42.5)	
4+	70.9	(56.8, 81.9)	0.983	55.7	(49.9, 61.4)	<0.001	82.5	(76.8, 87.0)	0.632	47.5	(41.4, 53.7)	0.001
Timing of post-natal check-up												
0–2 days	70.1	(56.2, 81.1)		50.4	(44.9, 55.8)		81.7	(77.0, 85.6)		44.5	(39.2, 49.9)	
3–6 days	76.2	(35.9, 94.8)		48.1	(34.7, 16.8)		70.9	(56.4, 82.1)		41.5	(28.7, 55.5)	
Seventh day or later	62.0	(39.0, 80.7)		57.3	(48.1, 66.0)		85.0	(77.2, 90.5)		49.9	(40.9, 58.9)	
No check-ups (including missing)	72.0	(63.2, 79.4)	0.855	36.7	(33.3.40.3)	0.001	80.9	(77.8, 83.7)	0.230	33.9	(30.7, 37.4)	0.003
Community level factors												
Residence												
Urban	73.4	(63.0, 81.7)		48.0	(43.1, 52.9)		84.3	(81.1, 87.1)		41.0	(36.2, 46.0)	
Rural	70.6	(62.7, 77.4)	0.651	40.2	(36.9, 43.6)	0.010	80.1	(77.1, 82.9)	0.056	37.0	(33.9, 40.3)	0.190
Geographical region												
Barisal	64.4	(48.7, 77.5)		36.9	(30.3, 44.2)		75.3	(67.5, 81.8)		33.4	(26.3, 41.2)	
Chittagong	54.0	(40.6, 66.8)		37.8	(32.0, 44.0)		69.4	(63.2, 75.0)		33.4	(28.7, 38.4)	
Dhaka	71.6	(56.8, 82.9)		41.5	(36.7, 46.4)		83.3	(79.4, 86.6)		35.6	(30.8, 40.7)	
Khulna	81.7	(63.2, 92.1)		47.7	(41.2, 54.2)		89.0	(82.7, 93.2)		45.0	(39.1, 51.1)	
Rajshahi	85.8	(69.6, 94.1)		51.3	(44.8, 57.8)		90.1	(85.5, 93.4)		49.1	(42.6, 55.6)	
Sylhet	61.7	(44.3, 76.6)	0.014	25.4	(18.3, 34.2)	<0.001	74.3	(66.1, 81.0)	<0.001	23.6	(17.0, 31.8)	<0.001

ARI, acute respiratory infection; BMI, body mass index; CI, confidence interval. *P*-values based on chi-squared test.

Table 5. Determinants of not introducing solid, semi-solid or soft food to infants 6–8 months, Bangladesh 2007: unadjusted and adjusted ORs

Outcome variable	Characteristic	Unadjusted			Adjusted		
		OR	[95% CI]	*P*	OR	[95% CI]	*P*
Not complementary fed	Mother's education						
	Secondary and above	1.00			1.00		
	Primary	1.50	(0.71, 3.20)	0.287	2.31	(1.07, 4.96)	0.033
	No education	2.04	(1.05, 3.96)	0.036	2.14	(1.08, 4.23)	0.029
	Father's occupation						
	Agricultural	1.00			1.00		
	Non-agricultural/Others/Don't know	2.34	(1.04, 5.27)	0.040	3.05	(1.33, 7.00)	0.009
	Age of child (in months)	0.68	(0.47, 0.99)	0.045	0.62	(0.41, 0.92)	0.018

CI, confidence interval; OR, odds ratio. Notes: Independent variables adjusted for are: gender, age, birth order, preceding birth interval, diarrhoea, acute respiratory infection, mother's age, mother's literacy, mother's working status, mother's body mass index, father's education, marital status, household wealth index, reads newspaper, listens to radio, watches television, mode of delivery, place of delivery, type of deliver, delivery assistance, antenatal check-up, post-natal check-up, residence and geographical region. *P*-values for odds ratios are based on multiple logistic regression model that includes all predictor variables and takes account of clustering.

diversity rate. All complementary feeding indicators were significantly lower in Sylhet, Chittagong and Barisal divisions.

Determinants of inappropriate complementary feeding practices

Factors associated with not introducing complementary food

Table 5 shows the risk factors for not introducing complementary food in a timely manner. After controlling for other potential confounders, our result indicated that mothers who had no education had higher risk of not introducing timely complementary feeds than the mothers who had formal education. In the final model, we also found that mother's literacy was significant if it replaced mother's education [adjusted odds ratio (AOR) = 2.31; 95% CI: 1.07–4.96 for primary education], and similarly for father's education (AOR for no education = 1.40; 95% CI: 0.6–3.17). Infants whose fathers had non-agricultural occupations, such as rickshaw puller or small enterprises, had a higher risk of not introducing complementary feeding compared to fathers who had agricultural occupations (AOR = 3.05; 95% CI: 1.33–7.00).

Factors associated with not meeting the minimum dietary diversity

Children of mothers with no formal education were twice as likely not to meet the minimum dietary diversity criteria (AOR for primary education = 1.41; 95% CI: 1.03–1.94) than mothers with secondary or higher level of education (AOR = 1.69; 95% CI: 1.14–2.54). Infants born in the divisions of Sylhet (AOR = 4.00; 95% CI: 2.01–7.99), Chittagong (AOR = 2.25; 95% CI: 1.48–3.43) or Barisal (AOR = 1.98; 95% CI: 1.19–3.26) all had higher risks of not meeting the minimum dietary diversity criteria compared to infants born in Rajshahi division. Infants from the poorer and poorest households had higher risks of not meeting dietary diversity (AOR = 2.16; 95% CI: 1.23–3.77 and AOR = 2.63; 95% CI: 1.39–4.94, respectively) compared to the infants from the wealthiest households (Table 6). When we replaced mother's education by father's education in the final model, fathers with primary education and no education had higher risks of not meeting dietary diversity (AOR = 1.81; 95% CI: 1.28–2.55 and AOR = 2.54; 95% CI: 1.84–3.51, respectively).

Factors associated with not meeting the minimum meal frequency

Table 7 shows that infants of mothers with no education had significantly higher risks for not meeting minimum meal frequency (AOR = 1.70; 95% CI: 1.09–2.67, $P = 0.01$) compared to children of mothers with secondary education. Similarly, infants born in Sylhet (AOR = 3.40; 95% CI: 1.67–6.94, $P = 0.001$), Chittagong (AOR = 4.52; 95% CI: 2.57–7.94,

Table 6. Determinants of not meeting the minimum dietary diversity among children aged 6–23 months: unadjusted and adjusted ORs, Bangladesh 2007

Outcome variable	Characteristic	Unadjusted			Adjusted		
		OR	[95% CI]	*P*	OR	[95% CI]	*P*
Not meeting minimum dietary diversity	Geographical region						
	Rajshahi	1.00			1.00		
	Sylhet	3.25	(1.92, 5.48)	<0.001	4.01	(2.01, 7.99)	<0.001
	Dhaka	1.48	(1.04, 2.12)	0.029	1.69	(1.15, 2.48)	0.008
	Khulna	1.24	(0.83, 1.87)	0.293	1.39	(0.89, 2.15)	0.144
	Chittagong	1.73	(1.17, 2.55)	0.006	2.25	(1.48, 3.43)	<0.001
	Barisal	1.83	(1.15, 2.90)	0.011	1.98	(1.19, 3.26)	0.008
	Mother's education						
	Secondary and above	1.00			1.00		
	Primary	1.70	(1.32, 2.19)	0.001	1.41	(1.03, 1.94)	0.034
	No education	2.19	(1.60, 2.98)	<0.001	1.69	(1.14, 2.54)	0.01
	Household wealth index						
	Richest	1.00			1.00		
	Richer	1.07	(0.71, 1.62)	0.33	1.18	(0.74, 1.89)	0.49
	Middle	1.31	(0.85, 2.01)	0.23	1.35	(0.83, 2.19)	0.23
	Poorer	2.11	(1.33, 3.35)	0.001	2.16	(1.23, 3.77)	0.007
	Poorest	2.26	(1.34, 3.8)	0.002	2.63	(1.39, 4.94)	0.003
	Child's age in category						
	18–23	1.00			1.00		
	12–17	1.72	(1.30, 2.27)	<0.001	1.72	(1.27, 2.32)	<0.001
	6–11	6.82	(4.92, 9.46)	<0.001	7.78	(5.53, 10.94)	<0.001

CI, confidence interval; OR, odds ratio. Notes: Independent variables adjusted for are: gender, age, birth order, preceding birth interval, diarrhoea, acute respiratory infection, mother's age, mother's literacy, mother's working status, mother's body mass index, father's education, marital status, reads newspaper, listens to radio, watches television, mode of delivery, place of delivery, type of deliver, delivery assistance, antenatal check-up, post-natal check-up and residence. *P*-values for odds ratios are based on multiple logistic regression model that includes all predictor variables and takes account of clustering.

$P = 0.001$) or Barisal (AOR = 3.42; 95% CI: 1.82–6.35, $P = 0.001$) had significantly higher risks for not meeting minimum meal frequency compared to children residing in Rajshahi division.

Factors associated with not receiving minimum acceptable diet

Infants born in Sylhet (AOR = 3.44; 95% CI: 21.82–6.47), Chittagong (AOR = 2.19; 95% CI: 1.50–3.19) and Barisal (AOR = 2.14; 95% CI: 1.24–3.68) had significantly higher risk for not meeting minimum acceptable diet compared to Rajshahi and Khulna divisions. Infants of mothers with primary education (AOR = 1.36; 95% CI: 1.01–1.84) and without education (AOR = 1.73; 95% CI: 1.20–2.49) had a higher risk for not meeting the minimum acceptable diet. In the final model, we also found that father's education was significant if it replaced mother's education (AOR for no education = 1.78; 95% CI: 1.07–2.96). Infant who was born by traditional birth attendant (AOR = 3.41; 95% CI: 1.17–9.93) and other untrained assistance (AOR = 2.41; 95% CI: 1.26–4.63) had significantly higher risk for not meeting minimum acceptable diet (Table 8).

Discussion

This analysis of nationally representative data from Bangladesh reveals important gaps in meeting the recommended minimum criteria of the newly established WHO complementary feeding indicators. Overall, we found that 71% of children had received complementary foods by the age of 6–8 months. In children 6–23 months, the rate of minimum meal frequency was relatively high (81.1%), but the rate of

Table 7. Determinants of not meeting the minimum meal frequency among children aged 6–23 months: unadjusted and adjusted ORs, Bangladesh 2007

Outcome variable	Characteristic	Unadjusted			Adjusted		
		OR	[95% CI]	*P*	OR	[95% CI]	*P*
Not meeting minimum meal frequency	Geographical region						
	Rajshahi	1.00			1.00		
	Sylhet	3.13	(1.70, 5.76)	<0.001	3.40	(1.67, 6.94)	0.00
	Dhaka	1.74	(1.02, 2.97)	0.04	1.63	(0.96, 2.76)	0.07
	Khulna	1.13	(0.56, 2.27)	0.74	1.02	(0.50, 2.07)	0.96
	Chittagong	3.75	(2.13, 6.62)	<0.001	4.52	(2.57, 7.94)	<0.001
	Barisal	2.90	(1.57, 5.36)	0.00	3.40	(1.82, 6.35)	<0.001
	Mother's education						
	Secondary and above	1.00			1.00		
	Primary	1.11	(0.78, 1.58)	0.57	1.26	(0.88, 1.82)	0.21
	No education	1.51	(1.00, 2.29)	0.05	1.70	(1.09, 2.67)	0.02
	Child's age in category						
	18–23	1.00			1.00		
	12–17	2.65	(1.58, 4.45)	<0.001	2.43	(1.45, 4.08)	0.00
	6–11	7.86	(5.01, 12.32)	<0.001	8.89	(5.56, 14.21)	<0.001
	Place of delivery						
	Home	1.00			1.00		
	Health facility	1.25	(0.87, 1.78)	0.23	1.76	(1.16, 2.68)	0.01

CI, confidence interval; OR, odds ratio. Notes: Independent variables adjusted for are: gender, age, birth order, preceding birth interval, diarrhoea, acute respiratory infection, mother's age, mother's literacy, mother's working status, mother's body mass index, father's education, marital status, household wealth index, reads newspaper, listens to radio, watches television, mode of delivery, type of delivery, delivery assistance, antenatal check-up, post-natal check-up and residence. *P*-values for odds ratios are based on multiple logistic regression model that includes all predictor variables and takes account of clustering.

minimum dietary diversity was lower (41.9%) as was the rate of minimum acceptable diet (39.6%). In children less than 1 year, the rates were worse with 66.2% for minimum meal frequency, 19.8% for minimum dietary diversity and 18.5% for minimum acceptable diet. Suboptimal timing of complementary feeding has been previously reported from Bangladesh (Mihrshahi *et al*. 2010). But this is the first paper to describe complementary feeding patterns in Bangladesh based on the newly developed WHO infant feeding indicators (WHO *et al*. 2010).

There were several factors consistently identified in our analyses that were associated with poor complementary feeding practices. A low level of maternal education was associated with not introducing complementary feeds at 6–8 months of age, with lower meal frequency, lower dietary diversity and minimum acceptable diet compared to those mothers who had secondary and higher levels of education. We also found that parental education of both the father and the mother was significantly associated with not meeting the minimum dietary diversity and minimal acceptable diet, indicating that parental education plays a significant role in meeting the appropriate complementary feeding. In the long term, improvements in education leading to higher levels of parental education can result in better complementary feeding practices. In the short term, programs to improve complementary feeding need to target families with low levels of parental education and design promotional materials that take account of low parental levels of education. There is also evidence from the literature that the effect of maternal schooling on child nutritional status is conditioned by resource availability at the household level (Arimond & Ruel 2004), and that improved child nutrition is only found among households that have access to at least a minimum level of resources. Although we have not examined the relationships between maternal education level and child growth, we did find a strong association between better complementary feeding practices of minimum

Table 8. Determinants of not meeting the minimum acceptable diet among children aged 6–23 months: unadjusted and adjusted ORs, Bangladesh 2007

Outcome variable	Characteristic	Unadjusted			Adjusted		
		OR	[95% CI]	*P*	OR	[95% CI]	*P*
Not meeting minimum acceptable diet	Geographical region						
	Rajshahi	1.00			1.00		
	Sylhet	3.12	(1.92, 5.06)	<0.001	3.44	(1.82, 6.47)	<0.001
	Dhaka	1.74	(1.24, 2.45)	0.001	1.74	(1.19, 2.55)	0.004
	Khulna	1.18	(0.82, 1.68)	0.370	1.30	(0.86, 1.97)	0.213
	Chittagong	1.93	(1.37, 2.71)	0.000	2.19	(1.50, 3.19)	0.000
	Barisal	1.93	(1.26, 2.95)	0.003	2.14	(1.24, 3.68)	0.006
	Delivery assistance						
	Health professional	1.00			1.00		
	Traditional birth attendant	2.36	(1.09, 5.12)	0.030	3.41	(1.17, 9.93)	0.025
	Other untrained	1.55	(1.22, 1.96)	0.001	2.41	(1.26, 4.63)	0.008
	Mother's education						
	Secondary and above	1.00			1.00		
	Primary	1.55	(1.04, 2.29)	0.03	1.36	(1.01, 1.84)	0.046
	No education	1.66	(1.66, 2.63)	0.027	1.73	(1.20, 2.49)	0.003
	Child's age in category						
	18–23	1.00			1.00		
	12–17	1.47	(1.13, 1.92)	0.004	1.54	(1.15, 2.06)	0.004
	6–11	5.17	(3.74, 7.16)	<0.001	6.22	(4.39, 8.81)	<0.001

CI, confidence interval; OR, odds ratio. Notes: Independent variables adjusted for are: gender, age, birth order, preceding birth interval, diarrhoea, acute respiratory infection, mother's age, mother's literacy, mother's working status, mother's body mass index, father's education, father's occupation, marital status, household wealth index, reads newspaper, listens to radio, watches television, mode of delivery, place of delivery, type of delivery, antenatal check-up, post-natal check-up and residence. *P*-values for odds ratios are based on multiple logistic regression model that includes all predictor variables and takes account of clustering.

dietary diversity and minimum acceptable diet and paternal education levels.

Our study also showed that occupation was associated with the introduction of complementary foods by the recommended age. Households where the fathers are engaged in agriculture-related occupations may have better food security compared to households where the fathers are wage dependent. Other studies have shown in Bangladesh that increased food security results in better infant feeding practice (Saha *et al*. 2008).

One of the important findings was the large regional variation in complementary feeding indicators. Practices such as dietary diversity, minimum acceptable diet and meal frequency were all significantly lower in areas such as Sylhet, Chittagong and Barisal divisions compared to Rajshahi. It is important to note that Chittagong and Sylhet also have lower levels of parental education, and child health indicators such as immunization coverage. It is therefore important to examine how these factors differ by geographic areas to understand why complementary feeding practices are so poor in some regions of Bangladesh. Interventions could be targeted to these areas to improve complementary feeding practices based on the understanding of the context.

Using household wealth index as a proxy indicator for household socio-economic status, we found better complementary feeding indicators among children from wealthier households (see Table 8). Similar positive associations between minimum dietary diversity and higher socio-economic status have been found in other studies from developing countries (Hatloy *et al*. 1998), and dietary diversity has been shown to be associated with total household expenditure (Andrew *et al*. 2010) These findings indicate that household capacity to purchase necessary foods and household food security are prerequisites to achieve dietary diversification for children.

A few limitations to this study should be considered when interpreting the results. This was a cross-sectional survey analysis and causality cannot be

ascribed to the factors found to be associated with inappropriate complementary feeding practices. In the BDHS, egg was combined with other animal foods, rather than it being reported separately. It is likely that not separating egg as independent group might have affected the estimates of the minimal dietary diversity rate. One major factor not accounted for in this analysis of BDHS data was illness which might have caused anorexia in the child, and reduced dietary intake (Hoyle *et al*. 1980).

One of the most important findings was the large regional variation in the rates of complementary feeding indicators. Minimal dietary diversity, minimum acceptable diet and meal frequency were all significantly lower in Sylhet, Chittagong and Barisal divisions. This could be related to cultural practices particularly in Sylhet division where adults' education levels are low, and other indicators like contraceptive prevalence are also low but neonatal mortality is high (El Arifeen 2008). In light of these results, specific interventions could be targeted in these areas to improve complementary feeding practices. Formative research would be needed to design these interventions in order to understand the community and caretaker perceptions about complementary feeding.

Our findings indicate that a key problem with complementary feeding in Bangladesh is the lack of dietary diversity in the foods given to infants and young children. Two-thirds of the children aged 6–23 months did not meet the minimum dietary diversity of four food groups per day. About 60% of children did not meet the minimum acceptable diet despite high percentage of children have a minimum meal frequency. However, the available data do not provide full details about the quality of the diet, such as energy density, protein energy ratio or the quantitative intake, and thus limit our understanding of the specific nutrient gaps in the diets of these young children in Bangladesh. Although the WHO complementary feeding indicators have been validated as part of their development (WHO *et al*. 2008), they have not specifically been validated for Bangladesh, in particular minimum acceptable diet needs validation as a specific indicator of appropriate complementary feeding and as a predictor of child growth.

In Bangladesh, poor infant and young child feeding practices are major factors contributing to poor nutrition. Infants 6–8 months old are mostly breastfed, hence the need for frequent feeding of extra solid food is not perceived by the mothers and caretakers as important or as a priority for feeding infants of this age. Also data from Bangladesh show an increase in the proportion of undernourished children starting from 6 to 12 months and continuing to higher levels well beyond 2 years of age (BDHS 2007). A study from Bangladesh has shown that child caretakers believe children will make a self-transition with increased capability for chewing and swallowing from breastfeeding to family feeding, and that there is no reason to force them to eat family food at a particular age like 6 months (Zeitlyn & Rowshan 1997). The quality and quantity of food needed by infants transitioning to family foods are often not understood by mothers, and food taboos are maintained by older family members specially the grandmothers who do not recommend oils and fats and eggs suitable for young children, thus further restricting food diversity (Roy *et al*. 1993). A trial from Bangladesh has shown that nutrition education for caretakers changed feeding behaviours and led to improved child health and growth (Roy *et al*. 2008). The addition of oils, eggs and other foods was accepted by the child caregivers and their changed feeding behaviours led to better recovery from malnutrition (Roy *et al*. 2008).

Overall, our study showed that slightly more than one-third of the children aged 6–23 months in Bangladesh had a minimal acceptable diet, and the situation was worse for those under 12 months of age. The poor complementary food practices were widespread across the country and are likely to be a major contributing factor to child undernutrition. Our analysis showed several factors that were consistently associated with poor complementary feeding indicators including low household wealth, low levels of parental education, especially father's education, and selected geographic areas in the country. Appropriate IYCF interventions are required across the country but also targeted to poorer households and parents of lower education levels to improve complementary feeding practices.

Acknowledgements

The authors wish to thank the National Institute for Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare, Dhaka, Bangladesh, for allowing access to the data. The authors also gratefully acknowledge Dr Upul Seranath, Department of Community Medicine, University of Colombo, Sri Lanka, for his review and comments on this paper.

Source of funding

The Public Sector Linkage Programme of the Australian Agency for International Development (AusAID) for financial assistance in facilitating the South Asia Infant Feeding Research Network.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

Iqbal Kabir, SK Roy and Mansura Khanam had the major responsibility to write up the manuscript; Kingsley Agho contributed to data analysis. All the authors had contributed in data analyses, interpretation and write-up of the manuscript.

References

Andrew L., Thorne-Lyman N.V., Sun K., Semba R.D., Klotz C.L., Kraemer K. *et al*. (2010) Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis. *The Journal of Nutrition* **140**, 1–7. (supplement).

Arimond M. & Ruel M.T. (2004) Dietary diversity is associated with child nutritional status: evidence from demographic and health surveys. *The Journal of Nutrition* **134**, 2579–2585.

Bangladesh Demographic and Health Survey (2004) Dhaka, Bangladesh and Calverton, Maryland, USA: National Institute of Population Research and Training, Mitra and Associates, and Macro International.

Bangladesh Demographic and Health Survey (2007) Dhaka, Bangladesh and Calverton, Maryland, USA: National Institute of Population Research and Training, Mitra and Associates, and Macro International.

Black R.E., Morris S.S. & Bryce J. (2003) Where and why are 10 million children dying every year? *Lancet* **361**, 2226–2234.

Black R.E., Allen L.H., Bhutta Z.A., Caulfield L.E., Onis M.D., Ezzati M. *et al*. (2008) Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet* **371**, 243–260.

Daelmans B., Dewey K. & Arimond M. (2009) New and updated indicators for assessing infant and young child feeding. *Food and Nutrition Bulletin* **30**, S256–S262.

Dewey K.G. & Adu-Afarwuah S. (2008) Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. *Maternal and Child Nutrition* **4** (Suppl. 1), 24–85.

El Arifeen S. (2008) Child health and mortality. *Journal of Health, Population, and Nutrition* **26**, 273–279.

Filmer D. & Pritchett L. (1998) *Estimating Wealth Effects without Expenditure Data or Tears: An Application to Educational Enrolments in States of India*. World Bank Policy Research: Washington, DC.

Hatloy A., Torheim L.E. & Oshaug A. (1998) Food variety – a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. *European Journal of Clinical Nutrition* **52**, 891–898.

Hoyle B., Yunus M. & Chen L.C. (1980) Breast-feeding and food intake among children with acute diarrheal disease. *American Journal of Clinical Nutrition* **33**, 2365–2371.

Mihrshahi S., Kabir I., Roy S.K., Agho K.E., Senarath U. & Dibley M.J. (2010) Determinants of infant and young child feeding practices in Bangladesh: secondary data analysis of Demographic and Health Survey 2004. *Food and Nutrition Bulletin* **31**, 295–313.

Pan American Health Organization & World Health Organization (2003) *Guiding Principles for Complementary Feeding of the Breastfed Child*. Pan American Health Organization/World Health Organization: Washington, DC/Geneva.

Roy S.K., Rahaman M.M., Mitra A.K., Mohammad A., Alam A.N. & Akbar M.S. (1993) Can mothers identify malnutrition in their children? *The London School of Hygiene and Tropical Medicine* **8**, 143–149.

Roy S.K., Jolly S.P., Shafique S., Fuchs G.J., Mahmud Z., Chakraborty B. *et al*. (2007) Prevention of malnutrition among young children in rural Bangladesh by a food-health-care educational intervention: a randomized, controlled trial. *Food and Nutrition Bulletin* **28**, 375–383.

Roy S.K., Bilkes F., Islam K., Ara G., Tanner P., Wosk I. *et al*. (2008) Impact of pilot project of Rural Mainte-

nance Programme (RMP) on destitute women: CARE, Bangladesh. *Food and Nutrition Bulletin* **29**, 67–75.
Saha K.K., Frongillo E.A., Alam D.S., Arifeen S.E., Persson L.Å. & Rasmussen K.M. (2008) Appropriate infant feeding practices result in better growth of infants and young children in rural Bangladesh. *American Journal of Clinical Nutrition* **87**, 1852–1859.
UNICEF (2010) *Multiple Indicator Cluster Survey (MICS) 2010*. rom Available at: http://www.unicef.org/statistics/index_24302.html (Accessed 1 July 2011).
WHO, UNICEF, IFPRI, UC Davis, FANTA, AED *et al*. (2008) Indicators for Assessing Infant and Young Child Feeding Practices. World Health Organization: Geneva.
WHO, UNICEF, IFPRI, UC Davis, FANTA, AED *et al*. (2010) Indicators for Assessing Infant and Young Child Feeding Practices. World Health Organization: Geneva.
Zeitlyn S. & Rowshan R. (1997) Privileged knowledge and mothers' 'perceptions': the case of breast-feeding and insufficient milk in Bangladesh. *Medical Anthropology Quarterly* **11**, 56–68.