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Original Article

Determinants of inappropriate complementary feeding practices in young children in India: secondary analysis of National Family Health Survey 2005–2006

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Abstract

In India, poor feeding practices in early childhood contribute to the burden of malnutrition as well as infant and child mortality. This paper aims to use the newly developed World Health Organization (WHO) infant feeding indicators to determine the prevalence of complementary feeding indicators among children of 6–23 months of age and to identify the determinants of inappropriate complementary feeding practices in India. The study data on 15 028 last-born children aged 6–23 months was obtained from the National Family Health Survey 2005–2006. Inappropriate complementary feeding indicators were examined against a set of child, parental, household, health service and community level characteristics. The prevalence of timely introduction of complementary feeding among infants aged 6–8 months was 55%. Among children aged 6–23 months, minimum dietary diversity rate was 15.2%, minimum meal frequency 41.5% and minimum acceptable diet 9.2%. Children in northern and western geographical regions of India had higher odds for inappropriate complementary feeding indicators than in other geographical regions. Richest households were less likely to delay introduction of complementary foods than other households. Other determinants of not meeting minimum dietary diversity and minimum acceptable diet were: no maternal education, lower maternal Body Mass Index (BMI) (<18.5 kg/m^2), lower wealth index, less frequent (<7) antenatal clinic visits, lack of post-natal visits and poor exposure to media. A very low proportion of children aged 6–23 months in India received adequate complementary foods as measured by the WHO indicators.

Keywords: complementary feeding, India, new WHO indicators, infant and young child feeding, dietary diversity, acceptable diet.

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Introduction

Inappropriate complementary feeding increases the risk of undernutrition, illness and mortality in infants and young children less than 2 years of age. It is estimated that 6% of under-5 deaths could be prevented through the achievement of universal coverage with improved complementary feeding alone (Leutter 2003). Nutrition-related factors are responsible for about 35% of child deaths and 11% of the total global burden of disease (WHO 2000). India is the global hub for stunting with a rate of 48% or 61 million stunted children, which accounts for 34% of the global total, more than any other country [International Institute for Population Sciences (IIPS) & ORC Macro 2007].

Another disturbing aspect of the child undernutrition situation in India has been the slow rate of

improvement in rates of stunting from 52% in 1993 to 48% in 2006 (http://www.nfhsindia.org/pub1.html). Population-based studies have shown that the greatest risk of nutritional deficiency and growth retardation occurs in children between 3 and 15 months of age because of poor breastfeeding and complementary feeding practices (Shrimpton *et al*. 2001). Complementary foods are often of inadequate nutritional quality, or they are given too early or too late, in too small amounts, or not frequently enough. Premature cessation or low frequency of breastfeeding also contributes to insufficient nutrient and energy intake in infants beyond 6 months of age (WHO 2009). The World Health Organization (WHO) has recognised the need to assess Infant and Young Child Feeding (IYCF) practices for targeted interventions to at-risk populations, and to monitor and evaluate progress with feeding practices after the start of interventions. In addition to indicators that measure breastfeeding practices, WHO has recently introduced complementary feeding indicators to assess feeding practices in children 0–23 months (WHO 2008).

The most recent National Family Health Survey (NFHS) of India (2005–2006) is a valuable source of data for feeding practices in children 0–23 months. Based on these recent indicators, there are no studies that have examined the percentage of children who are appropriately fed in this age group, and the determinants of inappropriate feeding, which could be valuable information for health policy makers and programme managers (Prasad & Costello 1995; Aggarwal & Patwari 1998; Coutinho *et al*. 2005). The present analysis of NFHS-3 data aims to estimate the prevalence of complementary feeding indicators (timely introduction of solid, semi-solid or soft foods; minimum dietary diversity; minimum meal frequency; and minimum acceptable diet) among 6–23 month old children and identify the determinants of inappropriate complementary feeding practices in India.

Methods

Data sources

The International Institute for Population Sciences and Macro International conducted the National Family Health Survey (NFHS-3) in India during 2005–2006. The survey covered 29 states, and urban and rural samples within the states were drawn separately. The sample within each state was allocated proportionally to the size of the state's urban and rural populations. A uniform sample design was adopted in all states. In each state, the rural sample was selected in two stages, with the selection of primary sampling units (PSUs), which are villages, with probability proportional to population size (PPS) at the first stage, followed by the random selection of households within each PSU in the second stage. In urban areas, a three-stage procedure was followed. In the first stage, wards were selected with PPS sampling. In the next stage, one census enumeration block (CEB) was randomly selected from each sample ward. In the final stage, households were randomly selected within each selected CEB. Further details about the sampling procedures are available at the Measure DHS website (http://www.measuredhs.org) (Macro 2007). The present analysis was based on these public domain datasets of NFHS-3, which are a valid source

Key messages

- More than half (54.6%) of Indian children aged between 6 and 8 months were introduced solid foods.
- In 6–23 month-old children, the rates of complementary feeding indicators such as minimum meal frequency, minimum dietary diversity and that of minimum acceptable diet were 41.5%, 15.2% and 9.2%, respectively and that below 1 year was alarmingly low at 34.7%, 5.5% and 3.9%, respectively.
- Cereals, bread and milk were the major food groups consumed by the majority of infants and the proportion consuming vegetables, fruits, eggs and flesh foods was very small, so there is a major scope for improving feeding practices.
- The common determinant and modifiable factor that was associated with poor complementary feeding indicators was inadequate antenatal care and counselling, thus suggesting that contact with health care services has the potential to influence complementary feeding practices.

of information for determining complementary feeding indicators from a nationally representative sample of households. In this survey, 109 041 sampled households were visited, and 124 385 ever-married women aged 15 to 49 years were interviewed yielding a response rate of 94.5%. Our analysis was restricted to the last-born children between 6–23 months of age, living with the respondent (ever-married women age 15–49 years), alive and the total weighted sample size was 15 028. The women questionnaire was used to collect data regarding the respondent's background, paternal and child care practices including infant feeding (breastfeeding and complementary food), fever, diarrhoea (any child with watery or blood and mucus in the stools in the previous 2 weeks preceding survey) and acute respiratory infections (ARI, having symptoms of cough accompanied by short, rapid breathing in the previous 2 weeks preceding survey). The household questionnaire was used to collect socio-demographic information for all persons usually residing in each household, as well as an inventory of household facilities and assets. A wealth index was constructed from these data, using methods recommended by the World Bank Poverty Network and United Nations Children's Fund (Filmer & Prittchett 2001), and was divided into quintiles.

Complementary feeding indicators

Complementary feeding practices were assessed using the key indicators recommended by the World Health Organisation (2008), which include introduction of solid, semi-solid or soft foods, minimum dietary diversity, minimum meal frequency and minimum acceptable diet calculated for the age ranges 6–11, 12–17 and 18–23 months of age, and based on a 24-h recall of the child's dietary intake. These indicators are defined as follows:

1. Timely introduction of solid, semi-solid or soft foods: the proportion of infants 6–8 months of age who received solid, semi-solid or soft foods.
2. Minimum dietary diversity: the proportion of children 6–23 months of age who received foods from four or more food groups (see Table 2 for the seven classifications of the food groups).
3. Minimum meal frequency: proportion of breastfed and non-breastfed children 6–23 months of age, who receive solid, semi-solid, or soft foods (but also including milk feeds for non-breastfed children) the minimum number of times or more. Minimum is defined as two times for breastfed infants 6–8 months, three times for breastfed children 9–23 months and four times for non-breastfed children 6–23 months.
4. Minimum acceptable diet: the proportion of children 6–23 months of age who received a minimum acceptable diet apart from breast milk. There were no variables in NFHS-3 data sets for non-breastfed children; therefore, results presented for this indicator pertain to breastfed children only. 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.

Statistical analysis

Complementary feeding indicators were expressed as dichotomous variables with category 1 for not meeting the indicator criteria and category 0 for meeting the indicator criteria. These indicator variables were examined against the set of independent variables (individual, parental, household, health care and community-level characteristics) in order to assess the prevalence of the complementary feeding indicators for the categories of the independent variables, and to identify factors associated with not meeting the indicators criteria. Data analysis was performed using the survey 'SVY' commands of Stata version 10.1 (Stata Corp., College Station, TX, USA), which allowed for adjustments for the complex sampling design when estimating confidence intervals around prevalence estimates.

Unadjusted and adjusted odds ratios (AOR) were calculated to estimate the strength of association between independent variables and four complementary indicator outcomes: non-introduction (or delayed introduction) of solid, semi-solid or soft foods at 6–8 months of age, not meeting minimum dietary diversity, not meeting minimum meal frequency and not meeting minimum acceptable diet. In our multivariate statistical modelling, we created an indicator

variable for missing data and restricted our analysis to the non-missing data. Multiple logistic regression using surveys commands was conducted using stepwise backwards elimination of variables in order to determine the factors significantly associated with not meeting the complementary feeding indicators. The odds ratios with 95% confidence intervals were calculated in order to assess the adjusted risk of independent variables, and only those variables with $P < 0.05$ were retained in the final model. We did our backward stepwise model by adjusting for sampling weights and clusters. We double-checked our backward elimination method by using the following procedure: (1) enter only variable with P-value < 0.20 in our backward elimination process; (2) tested our backward elimination by also including all variables (all potential confounders); and (3) we tested for collinearity.

Results

Characteristics of the sample

These respondents came from six regions in India: northern ($n = 1905$), central ($n = 4210$), eastern ($n = 3921$), north-eastern ($n = 551$), western ($n = 2006$) and southern ($n = 2435$). Table 1 presents the distribution of the sample according to attributes of the child, parent, household, health care and community. Majority of them i.e. 65.2% belonged to the age group 12–23 months, and the proportion of low birthweight was 21.7%. The majority of mothers in the sample were in the age bracket of 20–34 years (83.2%), and most of them (73.6%) were not working outside their homes. Most of the mothers were Hindu by religion (78.0%), and 74.4% were from rural areas. Nearly half of them (47.0%) were illiterate.

With regard to health care service provision to pregnant mothers, a quarter of the mothers (24%) had had no antenatal clinic (ANC) visits, and nearly two-thirds (58.9%) had no post-natal visits. More than half of the infants (59.2%) were delivered at home. About 40.3% were exposed to mass media almost every day.

Table 2 describes types of food given during the preceding day according to the age of the child. The rates of different food groups offered during the past 24 h were uniformly lower in the 6–8 months age group with the lowest rates reported for eggs (1.0%), flesh foods (1.3%) and legumes and nuts (3.9%). With increasing age, an increasing trend in offering food was observed in all food groups. However, only 8.1% of children aged 18–23 months had been offered eggs and 21.7% were given fruits and vegetables other than those rich in vitamin A. The rate of offering flesh food was also lower at 11.8% in the age group of 18–23 months. The rate of offering vitamin A rich foods and vegetables was 7.5% in the 6–8 months age group and 50.6% in the age group of 18–23 months. Among the common food items consumed by the children in the age group of 6–23 months, bread was the most popular item from the grain/roots and tuber group and tinned or fresh milk in the milk and milk product group. The consumption of all the food groups improved with increasing age.

Complementary feeding indicators

Table 3 presents the complementary feeding indicators by age for breastfed, non-breastfed and all children. More than half (54.6%) of the children in 6–8 months age group had received solid, semi-solid or soft foods. In the age group of 6–23 months, minimum dietary diversity was 15.2%, and the minimum meal frequency was 41.5%. However, the rate of minimum acceptable diet was available only for breastfed children (6–23 months) and was 9.2%. All these feeding indicators increased with the age of the child.

Determinants of complementary feeding indicators

The factors associated (univariate and multivariate) with poor complementary feeding indicators are given in Tables 4–7. In multivariate analysis, we had a sample size ranging from 2215 for non-introduction of complementary feeding (age group 6–8 months) to 11 536 for not meeting minimum dietary diversity (age group 6–23 months). This was due to the fact that there were four variables that had large missing percentages (indicated in parentheses), namely stunting (12.1%), wasting (12.1%), antenatal clinic visits (4.9%) and size of baby (5.2%). In urban localities, stunting and wasting attributed to 16.7%, and ANC

Table 1. Individual, parental, household, health care services and community level characteristics of children 6–23 months of age, India 2005–2006 ($n = 15\,028$)

Characteristic	*n*	Percentage
Child characteristics		
Sex of baby		
Male	7954	52.9
Female	7073	47.1
Age of child (months)		
6–8	2913	19.4
9–11	2324	15.5
12–17	5062	33.7
18–23	4729	31.5
Birth order		
First-born	4718	31.4
Second to fourth	8043	53.5
Five or more	2266	15.1
Preceding birth interval		
No previous birth	4746	31.6
<24 months	2536	16.9
≥24 months	7746	51.5
Currently breastfed (15 027)		
No	1955	13.0
Yes	13 072	87.0
Stunting (13 212)		
No	7418	56.1
Yes	5794	43.9
Wasting (13 205)		
No	10 241	77.6
Yes	2963	22.4
Size of baby (14 244)		
Small	3297	23.2
Average	8040	56.5
Large	2906	20.4
Diarrhoea (15 023)		
No	12 715	84.6
Yes	2307	15.4
ARI		
No	13 168	87.6
Yes	1860	12.4
Parental characteristics		
Mother's age		
15–19 years	1667	11.1
20–34 years	12 509	83.2
35–49 years	852	5.7
Mother's education (15 027)		
No education	7068	47.0
Primary	2081	13.9
Secondary and above	5878	39.1
Mother's working status (15 021)		
Non-working	11 061	73.6
Working (past 12 months)	3960	26.4
Mother's BMI (kg/m^2) (15 014)		
<18.5	6152	41.0
≥18.5	8863	59.0
Marital status (15 021)		
Currently married	14 891	99.1
Formerly married (divorced/separated/widow)	129	0.9
Father's occupation (14 981)		
Did not work	158	1.1
Agric-employee	4564	30.4
Skilled & unskilled manual	6230	41.6
Others	4030	26.9
Father's education (14 866)		
No education	4106	27.6
Primary	9159	61.6
Secondary and above	1601	10.8
Household characteristics		
Source of drinking water		
Improved	11 788	78.4
Not improved	3240	21.6
Reads newspaper (15 012)		
Not at all/at least once a week	14 006	93.3
Almost every day	1006	6.7
Listens to radio (15 025)		
Not at all/at least once a week	13 011	86.6
Almost every day	2014	13.4
Watches television (15 023)		
Not at all/at least once a week	9989	66.5
Almost every day	5023	33.5
Decision making at household		
Mother involved	12 005	79.9
Mother not involved	3022	20.1
Household Wealth Index		
Poorest	3709	24.7
Poorer	3331	22.2
Middle	2918	19.4
Richer	2741	18.2
Richest	2328	15.5
Health care service characteristics		
Place of delivery		
Home	8891	59.2
Health facility	6136	40.8
Mode of delivery (15 021)		
Non-caesarean	13 611	90.6
Caesarean section	1410	9.4
Type of delivery assistance (14 941)		
Health professional	5932	39.7
Traditional birth attendant	2735	18.3
Other untrained	6273	42.0
Antenatal clinic visits (14 292)		
None	3450	24.1
1–2	3738	26.2
3–6	5060	35.4
7 +	2044	14.3
Timing of post-natal check-up		
0–2 days	4754	31.6
3–6 days	930	6.2
Seventh day or later	491	3.3
No check-ups (including missing)	8853	58.9
Community level characteristics		
Religion (15 014)		
Hindu	11 706	78.0
Muslim	2571	17.1
Christian	321	2.1
Others	416	2.8
Residence		
Urban	3851	25.6
Rural	11 177	74.4
Geographical region		
North	1905	12.7
Central	4210	28.0
East	3921	26.1
Northeast	551	3.7
West	2006	13.4
South	2435	16.2

ARI, acute respiratory infections; BMI, body mass index. Weighted total was 15 028 if different then stated within brackets next to the variable.

Table 2. Age-wise distribution of type of food group received in last 24 h, India 2005–2006 ($n = 15\,028$)

Food groups/items	Age of child (months)									
	6–8		9–11		12–17		18–23		6–23	
	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
Grains/roots and tuber	52.0	(49.3, 54.7)	76.6	(74.1, 78.9)	91.3	(90.2, 92.3)	94.9	(94.0, 95.7)	82.6	(81.6, 83.5)
Cereal	16.1	(14.3, 18.1)	18.6	(16.6, 20.8)	15.6	(14.2, 17.0)	14.5	(13.1, 16.1)	15.8	(14.9, 16.7)
Other porridge/gruel	14.4	(12.6, 16.3)	19.3	(17.2, 21.7)	23.4	(21.6, 25.2)	24.6	(22.5, 26.7)	21.4	(20.1, 22.7)
Potatoes, cassava or other tubers	4.4	(3.5, 5.6)	13.7	(11.9, 15.6)	27.6	(25.7, 29.6)	32.8	(30.7, 34.9)	22.6	(21.5, 23.8)
Bread, noodles, other made from grains	39.0	(36.5, 41.5)	66.0	(63.2, 68.7)	83.6	(82.1, 84.9)	87.1	(85.7, 88.4)	73.3	(72.2, 74.4)
Legumes and nuts*	3.9	(3.1, 4.9)	11.3	(9.7, 13.1)	16.3	(14.8, 17.8)	19.7	(17.9, 21.5)	14.2	(13.3, 15.1)
Milk and milk products	43.4	(40.7, 46.1)	52.4	(49.6, 55.3)	57.0	(55.0, 59.1)	60.1	(57.9, 62.2)	54.6	(53.2, 56.0)
Cheese, yogurt, other milk products	6.0	(4.9, 7.4)	8.9	(7.5, 10.5)	12.3	(11.0, 13.7)	14.0	(12.7, 15.4)	11.1	(10.3, 11.9)
Tinned/powder or fresh milk	37.6	(35.1, 40.2)	44.7	(41.9, 47.5)	50.0	(47.9, 52.0)	53.7	(51.6, 55.9)	47.9	(46.6, 49.3)
Baby formula	10.8	(9.3, 12.4)	13.1	(11.3, 15.0)	10.0	(8.8, 11.3)	8.7	(7.6, 10.0)	10.2	(9.5, 11.0)
Flesh foods (meat, poultry, fish)	1.3	(0.9, 2.0)	4.8	(3.8, 6.2)	9.0	(7.9, 10.1)	11.8	(10.6, 13.2)	7.7	(7.1, 8.4)
Chicken, duck or other birds	0.1	(0.0, 0.5)	0.7	(0.4, 1.3)	1.1	(0.8, 1.5)	2.3	(1.8, 2.9)	1.2	(1.0, 1.5)
Any other meat	0.4	(0.1, 0.9)	0.6	(0.4, 1.0)	2.0	(1.5, 2.5)	3.3	(2.7, 4.0)	1.9	(1.6, 2.2)
Liver, heart, other organs	0.1	(0.0, 0.3)	0.8	(0.4, 1.4)	1.7	(1.3, 2.3)	2.6	(2.0, 3.3)	1.5	(1.3, 1.8)
Fresh or dried fish or shellfish	0.8	(0.5, 1.4)	3.3	(2.4, 4.6)	5.9	(5.1,6.9)	6.5	(5.6, 7.6)	4.7	(4.2, 5.3)
Eggs	1.0	(0.6, 1.5)	3.0	(2.2, 4.0)	6.3	(5.5, 7.3)	8.1	(7.1, 9.2)	5.3	(4.8, 5.9)
Vitamin-A rich fruits and vegetables	7.5	(6.3, 8.9)	22.3	(20.0, 24.7)	40.3	(38.4, 42.3)	50.6	(48.3, 52.8)	34.4	(33.1, 35.7)
Pumpkin, carrots, squash (yellow or orange inside)	2.7	(2.1, 3.6)	8.6	(7.2, 10.3)	15.8	(14.4, 17.2)	20.3	(18.5, 22.2)	13.6	(12.6, 14.5)
Any dark green leafy vegetables	4.1	(3.2, 5.2)	12.6	(10.9, 14.6)	26.3	(24.6, 28.1)	33.2	(31.2, 35.3)	22.1	(21.0, 23.2)
Mangoes, papayas, other vitamin-A fruits	2.2	(1.7, 2.9)	7.4	(6.2, 8.9)	11.6	(10.3, 13.0)	14.6	(13.2, 16.0)	10.1	(9.4, 10.8)
Other fruits and vegetables	4.8	(3.8, 6.0)	9.4	(8.0, 11.0)	18.2	(16.8, 19.7)	21.7	(20.2, 23.4)	15.4	(14.5, 16.2)
Count (n)	2913		2324		5062		4729		15 028	

CI, confidence interval. Oil, fats, butter and products made of them are not included in diet diversity because it is medium of cooking rather than a food group that is directly consumed. *Food made from beans, peas, lentils and nuts.

Table 3. Complementary feeding indicators among children 6–23 months of age, India NFHS-3, 2005–2006 ($n = 15\,028$)

Indicator	*N*	*n*	Rate (%)	95% CI
Introduction of solid, semi-solid or soft foods rate (6–8 months)	2913	1590	54.6	(52.0, 57.1)
Minimum dietary diversity rate				
Minimum dietary diversity rate, breastfed (6–11 months)	4981	263	5.3	(4.5, 6.1)
Minimum dietary diversity rate, non-breastfed (6–11 months)	256	33	12.9	(7.8, 18.0)
Minimum dietary diversity rate, all (6–11 months)	5237	296	5.6	(4.9, 6.5)
Minimum dietary diversity rate, breastfed (12–17 months)	4447	737	16.6	(15.2, 18.1)
Minimum dietary diversity rate, non-breastfed (12–17 months)	615	159	25.8	(21.6, 30.5)
Minimum dietary diversity rate, all (12–17 months)	5062	895	17.7	(16.3, 19.2)
Minimum dietary diversity rate, breastfed (18–23 months)	3644	770	21.1	(19.3, 23.0)
Minimum dietary diversity rate, non-breastfed (18–23 months)	1085	328	30.2	(26.9, 33.7)
Minimum dietary diversity rate, all (18–23 months)	4729	1097	23.2	(21.6, 24.9)
Minimum dietary diversity rate, breastfed (6–23 months)	13 072	1769	13.5	(12.7, 14.4)
Minimum dietary diversity rate, non-breastfed (6–23 months)	1955	519	26.6	(24.1, 29.2)
Minimum dietary diversity rate, all (6–23 months)	15 028	2288	15.2	(14.4, 16.1)
Minimum meal frequency rate				
Minimum meal frequency rate, breastfed (6–11 months)	4981	1768	35.5	(33.6, 37.4)
Minimum meal frequency rate, non-breastfed (6–11 months)	256	48	18.6	(12.8, 24.5)
Minimum meal frequency rate, all (6–11 months)	5237	1815	34.7	(32.9, 36.5)
Minimum meal frequency rate, breastfed (12–17 months)	4447	2007	45.1	(43.0, 47.3)
Minimum meal frequency rate, non-breastfed (12–17 months)	615	162	26.3	(21.9, 31.2)
Minimum meal frequency rate, all (12–17 months)	5062	2169	42.8	(40.8, 44.9)
Minimum meal frequency rate, breastfed (18–23 months)	3644	1939	53.2	(50.8, 55.6)
Minimum meal frequency rate, non-breastfed (18–23 months)	1085	313	28.9	(25.4, 32.7)
Minimum meal frequency rate, all (18–23 months)	4729	2253	47.6	(45.5, 49.7)
Minimum meal frequency rate, breastfed (6–23 months)	13 072	5714	43.7	(42.4, 45.1)
Minimum meal frequency rate, non-breastfed (6–23 months)	1955	523	26.7	(24.1, 29.5)
Minimum meal frequency rate, all (6–23 months)	15 028	6236	41.5	(40.2, 42.8)
Minimum acceptable diet rate				
Minimum acceptable diet rate, breastfed (6–11 months)	4981	192	3.9	(3.2, 4.6)
Minimum acceptable diet rate, breastfed (12–17 months)	4447	475	10.7	(9.5, 11.9)
Minimum acceptable diet rate, breastfed (18–23 months)	3644	530	14.6	(13.0, 16.3)
Minimum acceptable diet rate, breastfed (6–23 months)	13 072	1197	9.2	(8.5, 9.9)

CI, confidence interval.

visits had 9.8% missing values as compared with rural localities, where they were 10.5% and 3.2%, respectively for the above variables. Similarly, for reasons unknown, the southern region of India had large missing values on stunting (17.0%), wasting (17.4%) and ANC visits (10.3%) as compared with the eastern region (6.1%, 6.0% and 2.7%, respectively). But, there was no other significant pattern of missing data for these four variables.

Risk factors for non-introduction of complementary feeding (Table 4)

The adjusted rates of non-introduction of complementary feeding were higher among women who had a stunted child (AOR = 1.48) as compared with a non-stunted child. There was a 2.99 times greater risk of non-introduction of complementary feeding in mothers who did not read newspapers at all or read it at least once a week as compared with those who read it almost every day. Belonging to richer (AOR = 1.64), middle (AOR = 2.43) or poorer (AOR = 2.43) wealth quintiles also posed a higher risk as against other wealth quintiles that were at a lower risk. Compared with mothers who had ≥6 antenatal clinic visits, those mothers who had no or ≤6 antenatal clinic visits reported a higher risk for non-introduction of complementary feeding (AOR = 2.05 for no antenatal clinic visits and 1.55 for < 6 ANC visits). Those mothers who had religious affiliation other than

Table 4. Determinants of not introducing complementary food among children aged 6–8 months: unadjusted and adjusted odds ratio, India 2005–2006

Characteristic	Risk for not introducing complementary food (n^* = 2251)					
	Unadjusted			Adjusted		
	OR	95% CI	*P*	AOR	95% CI	*P*
Child characteristics						
Age of child (months)	0.59	(0.51, 0.68)	<0.001	0.54	(0.46, 0.62)	<0.001
Stunting						
No	1.00			1.00		
Yes	1.63	(1.25, 2.13)	<0.001	1.48	(1.11, 1.97)	0.007
Diarrhoea						
No	1.00			1.00		
Yes	0.83	(0.62, 1.11)	0.206	0.70	(0.51, 0.96)	0.026
Household level factors						
Reads newspaper						
Almost every day	1.00			1.00		
Not at all/at least once a week	6.05	(3.00, 12.18)	<0.001	2.99	(1.43, 6.26)	0.004
Household Wealth Index						
Richest	1.00			1.00		
Richer	1.93	(1.25, 2.98)	0.003	1.64	(1.01, 2.68)	0.046
Middle	2.83	(1.82, 4.39)	<0.001	2.42	(1.42, 4.13)	0.001
Poorer	3.35	(2.15, 5.22)	<0.001	2.43	(1.39, 4.24)	0.002
Poorest	2.49	(1.59, 3.89)	<0.001	1.58	(0.91, 2.75)	0.106
Health care service characteristics						
Antenatal clinic visits						
7+	1.00			1.00		
3–6	2.29	(1.55, 3.36)	<0.001	1.55	(1.01, 2.38)	0.043
1–2	3.44	(2.29, 5.17)	<0.001	1.82	(1.13, 2.91)	0.013
None	3.35	(2.17, 5.17)	<0.001	2.05	(1.23, 3.42)	0.006
Community level factors						
Religion						
Christian	1.00			1.00		
Hindu	4.13	(1.91, 8.93)	<0.001	2.77	(1.24, 6.19)	0.013
Muslim	3.08	(1.35, 7.03)	0.008	2.15	(0.93, 4.98)	0.074
Others	5.48	(2.20, 13.62)	<0.001	4.24	(1.63, 10.99)	0.003
Geographical region						
South	1.00			1.00		
North	3.53	(2.26, 5.49)	<0.001	3.60	(2.15, 6.00)	<0.001
Central	3.75	(2.48, 5.67)	<0.001	2.77	(1.71, 4.50)	<0.001
East	2.49	(1.61, 3.86)	<0.001	1.92	(1.16, 3.17)	0.011
Northeast	1.96	(1.09, 3.52)	0.025	1.64	(0.83, 3.21)	0.151
West	3.20	(1.91, 5.37)	<0.001	3.05	(1.75, 5.31)	<0.001

CI, confidence interval; AOR, adjusted odds ratio. Adjusted model fit test statistic = 0.60; *P*-value = 0.80. Data on 662 cases were missing and were excluded from the analysis. *P*-values for odds ratio (OR) of unadjusted and adjusted are estimated after taking account of clustering. Notes: Independent variables adjusted for AOR are: currently breastfed, mother's working status, marital status, stunting, wasting, sex of baby, mother's body mass index, place of birth, mode of delivery, had diarrhoea, had acute respiratory infection, source of drinking water, listens to radio, reads newspaper, watches television, decision making at household, place of residence, partner's occupation, mother's education, partner's education, age of mother, birth order, birth preceding interval, child age in months, size of baby, delivery assistance, no. of antenatal clinic visits, timing of post-natal visits, Household Wealth Index, religion, place of residence and geographical region. *Population sample size for the logistic model.

Table 5. Determinants of inappropriate minimum dietary diversity among children aged 6–23 months: unadjusted and adjusted odds ratio, India 2005–2006

Characteristic	Risk for inappropriate dietary diversity (n^* = 11 536)					
	Unadjusted			Adjusted		
	OR	95% CI	*P*	AOR	95% CI	*P*
Child characteristics						
Currently breastfed						
No	1.00			1.00		
Yes	2.38	(2.00, 2.84)	<0.001	1.36	(1.10, 1.67)	0.004
Stunting						
No	1.00			1.00		
Yes	1.30	(1.13, 1.50)	<0.001	1.23	(1.04, 1.44)	0.013
Age of child (months)						
18–23	1.00			1.00		
12–17	1.36	(1.17, 1.58)	<0.001	1.35	(1.14, 1.60)	<0.001
6–11	5.35	(4.35, 6.58)	<0.001	6.34	(5.05, 7.95)	<0.001
Preceding birth interval						
No previous birth	1.00			1.00		
<24 months	1.65	(1.34, 2.03)	<0.001	1.20	(0.96, 1.50)	0.110
>24 months	1.36	(1.17, 1.57)	<0.001	0.90	(0.76, 1.06)	0.205
Parental characteristics						
Mother's education						
Secondary and above	1.00			1.00		
Primary	1.66	(1.35, 2.04)	<0.001	1.11	(0.89, 1.39)	0.362
No education	3.24	(2.76, 3.80)	<0.001	1.70	(1.40, 2.08)	<0.001
Mother's BMI (kg/m^2)						
≥18.5	1.00			1.00		
<18.5	1.58	(1.36, 1.83)	<0.001	1.18	(1.00, 1.39)	0.045
Household level factors						
Reads newspaper						
Almost every day	1.00			1.00		
Not at all/at least once a week	3.99	(3.25, 4.89)	<0.001	1.75	(1.37, 2.25)	<0.001
Listens to radio						
Almost every day	1.00			1.00		
Not at all/at least once a week	1.89	(1.59, 2.26)	<0.001	1.29	(1.06, 1.57)	0.011
Watches television						
Almost every day	1.00			1.00		
Not at all/at least once a week	2.50	(2.18, 2.87)	<0.001	1.27	(1.07, 1.51)	0.006
Household Wealth Index						
Richest	1.00			1.00		
Richer	1.60	(1.33, 1.93)	<0.001	1.00	(0.80, 1.24)	0.994
Middle	2.41	(1.96, 2.96)	<0.001	1.28	(0.99, 1.65)	0.057
Poorer	2.78	(2.24, 3.44)	<0.001	1.19	(0.90, 1.59)	0.226
Poorest	4.86	(3.79, 6.22)	<0.001	1.84	(1.31, 2.60)	<0.001
Health care service characteristics						
Antenatal clinic visits						
7+	1.00			1.00		
3–6	2.22	(1.87, 2.62)	<0.001	1.52	(1.24, 1.85)	<0.001
1–2	3.75	(3.05, 4.62)	<0.001	1.76	(1.36, 2.26)	<0.001
None	4.51	(3.53, 5.77)	<0.001	1.92	(1.40, 2.63)	<0.001
Timing of post-natal check-up						
0–2 days	1.00			1.00		
3–6 days	1.19	(0.91, 1.55)	0.203	0.97	(0.73, 1.30)	0.842
Seventh day or later	1.03	(0.71, 1.48)	0.879	0.58	(0.39, 0.84)	0.004
No check-ups (including missing)	2.32	(1.99, 2.69)	<0.001	1.25	(1.02, 1.52)	0.029

Table 5. Continued

Characteristic	Risk for inappropriate dietary diversity (n^* = 11 536)					
	Unadjusted			Adjusted		
	OR	95% CI	*P*	AOR	95% CI	*P*
Community level factors						
Geographical region						
South	1.00			1.00		
North	2.24	(1.80, 2.79)	<0.001	1.34	(1.04, 1.72)	0.022
Central	2.77	(2.22, 3.46)	<0.001	1.12	(0.86, 1.46)	0.382
East	1.58	(1.28, 1.96)	<0.001	0.59	(0.46, 0.76)	<0.001
Northeast	1.63	(1.22, 2.17)	0.001	0.81	(0.60, 1.11)	0.188
West	2.48	(1.84, 3.36)	<0.001	2.17	(1.55, 3.02)	<0.001

CI, confidence interval; AOR, adjusted odds ratio. Adjusted model fit test statistic = 0.12; *P*-value = 0.99. Data on 3492 cases were missing and were excluded from the analysis. *P*-values for odds ratio (OR) of unadjusted and adjusted are estimated after taking account of clustering. Notes: Independent variables adjusted for AOR are: currently breastfed, mother's working status, marital status, stunting, wasting, sex of baby, mother's body mass index (BMI), place of birth, mode of delivery, had diarrhoea, had acute respiratory infection, source of drinking water, listens to radio, reads newspaper, watches television, decision making at household, place of residence, partner's occupation, mother's education, partner's education, age of mother, birth order, birth preceding interval, child age in months, size of baby, delivery assistance, no. of antenatal clinic visits, timing of post-natal visits, Household Wealth Index, religion, place of residence and geographical region. *Population sample size for the logistic model.

Christian or Muslim, like Hindu or others (AOR = 2.77 and 4.24 for Hindu and others, respectively) were at a greater risk of non introduction of complementary foods at 6–8 months. Residence in northern (AOR = 3.60), central (AOR = 2.77), eastern (AOR = 1.92) or western (AOR = 3.05) part of India posed a greater risk of non introduction of complementary foods at 6–8 months as compared with southern and north-eastern regions of India.

Risk factors for not meeting minimum dietary diversity (Table 5)

The adjusted rates of not meeting minimum dietary diversity were higher among women who had a currently breastfed child (AOR = 1.36). A declining trend in the risk of inappropriate minimum dietary diversity was observed with increasing age. As opposed to mothers with secondary or higher level of education, no education (AOR = 1.70) remained a significant risk factor for inadequate dietary diversity. BMI below 18.5 kg/m^2 (AOR = 1.18) was also associated with risk of inadequate dietary diversity. Mothers who did not read the newspaper almost every day (AOR = 1.75), did not listen to the radio almost every day (AOR = 1.29) or did not watch television almost every day (AOR = 1.27) reported a higher risk for poor diversity. The poorest wealth quintile (AOR = 1.84) was a significant risk factor for inadequate dietary diversity as compared with the richest wealth quintile. Of the health care attributes, fewer antenatal clinic visits (AOR for none = 1.92; one to two visits = 1.76; three to six visits = 1.52) and no post-natal check-ups (AOR = 1.25) were predictive of inappropriate dietary diversity. As compared with the southern region of India, the western (AOR = 2.17) and northern (AOR = 1.34) regions of India had higher rates of not meeting minimum dietary diversity, whereas the eastern (AOR = 0.59) region of India had lower rates.

Risk factors for not meeting minimum meal frequency (Table 6)

As shown in Table 6, the adjusted rates of not meeting minimum meal frequency were higher among women who had a child of 6–17 months of age (AOR for 6–11 months = 2.15; for 12–17 months = 1.37), and had no or lower education (AOR for no education = 1.26; for primary education = 1.28). A higher risk was

Table 6. Determinants of inappropriate minimum meal frequency among children aged 6–23 months: unadjusted and adjusted odds ratio, India 2005–2006

Characteristic	Risk for inadequate meal frequency (n^* = 11 536)					
	Unadjusted			Adjusted		
	OR	95% CI	*P*	AOR	95% CI	*P*
Child characteristics						
Currently breastfed						
No	1.00			1.00		
Yes	0.51	(0.43, 0.61)	<0.001	0.36	(0.30, 0.44)	<0.001
Age of child (months)						
18–23	1.00			1.00		
12–17	1.29	(1.14, 1.45)	<0.001	1.37	(1.21, 1.55)	<0.001
6–11	1.82	(1.60, 2.07)	<0.001	2.15	(1.87, 2.46)	<0.001
Parental characteristics						
Mother's working status						
Non-working	1.00			1.00		
Working (past 12 months)	0.92	(0.81, 1.03)	0.158	0.85	(0.74, 0.96)	0.012
Mother's education						
Secondary and above	1.00			1.00		
Primary	1.37	(1.17, 1.60)	<0.001	1.28	(1.08, 1.53)	0.005
No education	1.32	(1.18, 1.49)	<0.001	1.26	(1.08, 1.46)	0.002
Household level factors						
Reads newspaper						
Almost every day	1.00			1.00		
Not at all/at least once a week	1.81	(1.48, 2.23)	<0.001	1.33	(1.05, 1.69)	0.017
Listens to radio						
Almost every day	1.00			1.00		
Not at all/At least once a week	1.39	(1.20, 1.60)	<0.001	1.25	(1.08, 1.45)	0.002
Decision making						
Mother involved	1.00			1.00		
Mother not involved	1.25	(1.08, 1.43)	0.002	1.20	(1.04, 1.38)	0.015
Household Wealth Index						
Richest	1.00			1.00		
Richer	1.41	(1.20, 1.67)	<0.001	1.35	(1.11, 1.63)	0.002
Middle	1.48	(1.25, 1.76)	<0.001	1.44	(1.16, 1.79)	0.001
Poorer	1.45	(1.22, 1.73)	<0.001	1.44	(1.14, 1.82)	0.002
Poorest	1.38	(1.16, 1.64)	<0.001	1.39	(1.09, 1.78)	0.008
Health care service characteristics						
Antenatal clinic visits						
7+	1.00			1.00		
3–6	1.46	(1.26, 1.70)	<0.001	1.32	(1.11, 1.58)	0.002
1–2	1.70	(1.44, 2.01)	<0.001	1.43	(1.17, 1.76)	0.001
None	1.33	(1.11, 1.59)	0.002	1.18	(0.94, 1.48)	0.164
Community level factors						
Religion						
Christian	1.00			1.00		
Hindu	1.81	(1.35, 2.43)	<0.001	1.46	(1.07, 1.98)	0.016
Muslim	2.00	(1.43, 2.79)	<0.001	1.62	(1.16, 2.26)	0.005
Others	2.16	(1.46, 3.21)	<0.001	1.73	(1.15, 2.61)	0.009
Geographical region						
South	1.00			1.00		
North	1.42	(1.19, 1.70)	<0.001	1.24	(1.01, 1.51)	0.040
Central	1.34	(1.14, 1.59)	0.001	1.12	(0.92, 1.36)	0.269
East	0.88	(0.74, 1.05)	0.156	0.74	(0.60, 0.90)	0.003
Northeast	1.01	(0.83, 1.24)	0.887	0.99	(0.78, 1.26)	0.938
West	1.56	(1.23, 1.97)	<0.001	1.55	(1.21, 1.99)	0.001

CI, confidence interval; AOR, adjusted odds ratio. Adjusted model fit test statistic = 0.57; *P*-value = 0.83. Data on 3492 cases were missing and were excluded from the analysis. *P*-values for odds ratio (OR) of unadjusted and adjusted are estimated after taking account of clustering. Notes: Independent variables adjusted for AOR are: currently breastfed, mother's working status, marital status, stunting, wasting, sex of baby, mother's body mass index, place of birth, mode of delivery, had diarrhoea, had acute respiratory infection, source of drinking water, listens to radio, reads newspaper, watches television, decision making at household, place of residence, partner's occupation, mother's education, partner's education, age of mother, birth order, birth preceding interval, child age in months, size of baby, delivery assistance, no. of antenatal clinic visits, timing of post-natal visits, Household Wealth Index, religion, place of residence and geographical region. *Population sample size for the logistic model.

Table 7. Determinants of inappropriate minimum acceptable diet among breastfed children aged 6–23 months: unadjusted and adjusted odds ratio, India 2005–2006

Characteristic	Risk for inadequate acceptable diet (n^* = 10 164)					
	Unadjusted			Adjusted		
	OR	95% CI	*P*	AOR	95% CI	*P*
Child characteristics						
Age of child (months)						
18–23	1.00			1.00		
12–17	1.44	(1.18, 1.77)	<0.001	1.46	(1.17, 1.82)	0.001
6–11	4.38	(3.39, 5.65)	<0.001	5.14	(3.94, 6.71)	<0.001
Parental characteristics						
Mother's education						
Secondary and above	1.00			1.00		
Primary	1.51	(1.17, 1.94)	0.002	0.98	(0.74, 1.29)	0.889
No education	2.91	(2.36, 3.59)	<0.001	1.47	(1.12, 1.93)	0.005
Mother's BMI (kg/m^2)						
≥18.5	1.00			1.00		
<18.5	1.61	(1.33, 1.96)	<0.001	1.29	(1.05, 1.60)	0.016
Household level factors						
Reads newspaper						
Almost every day	1.00			1.00		
Not at all/at least once a week	3.74	(2.87, 4.85)	<0.001	1.55	(1.15, 2.08)	0.004
Listens to radio						
Almost every day	1.00			1.00		
Not at all/at least once a week	1.88	(1.51, 2.33)	<0.001	1.34	(1.06, 1.70)	0.014
Household Wealth Index						
Richest	1.00			1.00		
Richer	1.67	(1.32, 2.11)	<0.001	1.26	(0.96, 1.64)	0.092
Middle	2.71	(2.07, 3.56)	<0.001	1.86	(1.37, 2.53)	<0.001
Poorer	2.64	(2.01, 3.46)	<0.001	1.56	(1.12, 2.16)	0.008
Poorest	5.57	(4.01, 7.73)	<0.001	3.07	(1.98, 4.77)	<0.001
Health care service characteristics						
Antenatal clinic visits						
7+	1.00			1.00		
3–6	2.55	(2.05, 3.16)	<0.001	1.95	(1.53, 2.49)	<0.001
1–2	4.45	(3.44, 5.77)	<0.001	2.64	(1.94, 3.60)	<0.001
None	4.46	(3.25, 6.13)	<0.001	2.58	(1.77, 3.76)	<0.001
Community level factors						
Geographical region						
South	1.00			1.00		
North	2.27	(1.74, 2.97)	<0.001	1.48	(1.10, 1.98)	0.009
Central	2.56	(1.96, 3.35)	<0.001	1.15	(0.85, 1.56)	0.363
East	1.49	(1.14, 1.93)	0.003	0.65	(0.48, 0.87)	0.003
Northeast	1.85	(1.34, 2.54)	<0.001	1.08	(0.77, 1.53)	0.657
West	2.67	(1.75, 4.05)	<0.001	2.19	(1.43, 3.37)	<0.001

CI, confidence interval; AOR, adjusted odds ratio. Adjusted model fit test statistic = 1.45; *P*-value = 0.16. Data on 2908 cases were missing and were excluded from the analysis. *P*-values for odds ratio (OR) of unadjusted and adjusted are estimated after taking account of clustering. Notes: Independent variables adjusted for AOR are: mother's working status, marital status, stunting, wasting, sex of baby, mother's body mass index (BMI), place of birth, mode of delivery, had diarrhoea, had acute respiratory infection, source of drinking water, listens to radio, reads newspaper, watches television, decision making at household, place of residence, partner's occupation, mother's education, partner's education, age of mother, birth order, birth preceding interval, child age in months, size of baby, delivery assistance, no. of antenatal clinic visits, timing of post-natal visits, Household Wealth Index, religion, place of residence and geographical region. *Population sample size for the logistic model.

significantly associated with mothers who did not read the newspaper almost every day (AOR = 1.33), did not listen to radio almost every day (AOR = 1.25) and if the mother was not involved in household decisions (AOR = 1.20). Health care characteristic-wise, mothers who had no or ≤ 6 antenatal clinic visits (AOR for no visits = 1.18; for one to two visits = 1.43; for three to six visits = 1.32). It was also associated with those who belonged to lower than richest wealth quintile and were from a non-Christian community or resided in western or northern part of India.

Risk factors for not meeting minimum acceptable diet (Table 7)

Table 7 summarises the risk factors for poor acceptable diet in children 6–23 months. Consistent with the poor minimum meal frequency, determinants of inadequate acceptable diet were: 6–17 month-old child (AOR for 6–11 months = 5.14; for 12–17 months = 1.46), no maternal education (AOR = 1.47), BMI < 18.5 kg/m^2 (AOR = 1.29), not reading the newspaper at all or reading it only once a week (AOR = 1.55), not listening to radio at all or only once a week (AOR = 1.34) and belonging to poorest (AOR = 3.07) and middle (AOR = 1.86) wealth quintiles. Those having no or ≤ 6 antenatal clinic visits (AOR for no visits = 2.58; for one to two visits = 2.64; for three to six visits = 1.95) were also susceptible for poor minimal acceptable diet. As compared with the southern region of India, the northern (AOR = 1.48) and western regions (AOR = 2.19) of India had higher rates for not meeting minimum acceptable diet as compared with the eastern region (AOR = 0.65).

Discussion

This analysis of the NFHS-3 data for complementary feeding indicators and determinants showed that only half (54.6%) of Indian children aged between 6–8 months had been introduced to solid foods. The rate of minimum meal frequency was 41.5% and minimum dietary diversity (15.2%) and minimum acceptable diet (9.2%) were alarmingly low in children 6–23 months. In children less than 1 year, the rates were even worse with 34.7% for minimum meal frequency, 5.6% for minimum dietary diversity and 3.9% for minimum acceptable diet.

Several technical consultations and documents on complementary feeding (WHO 1998, 2000; WHO/UNICEF 2001; Dewey 2003) recommend that complementary feeding needs to be started when breast milk alone is no longer sufficient to meet all nutritional requirements. This late introduction of complementary foods has been cited as a factor contributing to the downward trend of the growth curves seen among infants after 6 months of age (Philips *et al*. 2000). Based on this recommendation, this survey shows that 46% of Indian children in the age of 6–8 months would be at risk of undernutrition. Indian mothers traditionally practice prolonged breastfeeding, for example the rate of continued breastfeeding in the second year of life was 73.1% (Patel *et al*. 2010). But for a variety of reasons, families tend to delay introduction of complementary foods.

Our data shows that the factors significantly associated with delayed introduction of solid foods were age (an 8-month-old would be more likely to receive solid foods as compared with a 6-month-old), presence of stunting, no and lower antenatal clinic visits, did not read the newspaper almost every day and in mothers of all religions except Christians. It is possible that mothers perceive stunted children as too small to be introduced foods other than breast milk. This potentially has important implications for the Infant and Young Child Feeding programme as these are the children who would most likely benefit from early identification and encouragement of their mothers to introduce solid foods by 6–8 months (Dewey & Brown 1998). A recent study assessed the impact of timely introduction of solid foods in the age group 6–8 months and concluded that while the timing of complementary feeding by itself may not lead to improved nutritional status, timely introduction of foods of appropriate quantity and quality in a hygienic environment, along with increased maternal interaction time, would likely have desired positive effects on the growth of young children. This maternal interaction could be compromised in a working mother leading not only to delay in introduction of solids but also limit the interaction itself (Kramer *et al*. 2003).

The variables that mainly contributed to the missing data were stunting, wasting, ANC visits and size of the baby. Unavailability of anthropometric measurement scale at the visit might lead to no observations on stunting and wasting. Similarly, the rural urban differences in the amount of missing data of stunting and wasting (16.7% in urban vs. 10.5% in rural) and ANC visits (9.8% for urban and 3.2% for rural) are attributable to the disparities in the penetration of health services in these areas, with services being sparsely distributed and underserved in the urban areas. The lack of availability of data on the size of baby could be probably due to the fact that 59.2% of the babies were delivered at home, in which case some of them would not have been weighed after birth accounting for the missing data.

In the Indian context where a very large proportion of children are stunted, it was observed that significantly less number of stunted children received timely introduction of complementary food and antenatal clinic visits were consistently highly significant with all the complementary feeding indicators so it is important to consider these variables in the adjusted model in spite of the missing values. The data were reanalyzed using the adjusted logistic model after removing four variables, namely stunting, wasting, antenatal visits and size of baby, following which the results were not changed. Hence, excluding missing data does not lead to any bias in the findings.

Previous studies have shown that using public health services will augment desirable infant and young child feeding practices and this was confirmed by our study, which shows that antenatal care visits positively influence the introduction of solid foods in the age group 6–8 months (Dewey & Brown 1998; Kramer *et al*. 2003; Bahl *et al*. 2005; Patel *et al*. 2010). Television has an impact on improving introduction of solid foods, and this could be related to the standard of living as well as improved awareness among mothers who have access to media. The mothers from the Christian community were more likely to introduce solid foods in the age group of 6–8 months. The literacy rate (primary and more) in this community is 82.6% and 81.5% having at least one antenatal visit. However, this is a minority community in India, which indicates that appropriate infant and young child feeding practices are needed in the majority of the households in India.

The minimum dietary diversity was very poor in the children less than a year at 5.3% in the breastfed and 12.9% in the non-breastfed group. Dietary diversity is an important component of infant and young child feeding, as it is associated with overall dietary quality, micronutrient intake of young children, household food security and better nutritional status of children in developing countries (Tulloch 1999; Haltoy *et al*. 2000; Arimond & Ruel 2004; Sawadogo *et al*. 2006; Steyn *et al*. 2006; Kennedy *et al*. 2007; Moursi *et al*. 2008). Thus, it is not surprising that due to poor rates of minimum dietary diversity, Indian infants 6–23 months have high rates of wasting (19.7%) and stunting (38.6%) [International Institute for Population Sciences (IIPS) & ORC Macro 2007]. Children in the age group of 6–8 months predominantly received grains and tubers of which bread products were predominant (73.3%), and among milk products, tinned milk/fresh milk was more commonly consumed (47.9%). These foods remain the predominant foods in all age groups but as children got older, vegetables, fruits, legumes and nuts begin to get consumed. Only a very small proportion of children were given flesh foods and eggs, and the foods were largely vegetarian. Even though 35–40% of Indian families consume eggs and meat, it is traditionally believed that meat products and eggs cannot be given to infants due to the fact that infants fail to digest animal foods (Paul *et al*. 2010). It is suggested that meat, poultry, fish or eggs should be eaten daily, or as often as possible, as vegetarian diets may not meet nutrient needs at this age unless nutrient supplements or fortified products are used (WHO 2000). However, given the earlier traditional beliefs, it may be difficult to implement such a recommendation. The factors significantly associated with poor minimum dietary diversity were stunted child, younger age group, illiteracy, fewer number of antenatal clinic visits, no exposure to media almost every day (newspaper, radio and television), poorest wealth quintiles and north, east and west regions compared with the southern region of India. These factors were similar to those associated with delayed introduction of solid foods (Bhandari *et al*. 2004). The mothers from households of the

poorest wealth quintiles had the highest odds of poor minimum dietary diversity as this group also has food insecurity (Saha *et al*. 2008). Further studies are needed to understand the regional differences in dietary diversity in India.

The minimum meal frequency increased with age and was observed to be higher in breastfed infants as compared with the non-breastfed. This is by virtue of its definition that requires breastfed infants to have a lower frequency (only two in 6–8 months and three times for 9–23 months) as compared with four meals for non-breastfed from 6 to 23 months (WHO 2008).

Minimum acceptable diet is a composite indicator that includes infants who have both adequate minimum meal diversity and minimum meal frequency. It was therefore not surprising that because of the alarmingly low rates of minimum meal diversity and minimum meal frequency, the minimum acceptable diet was exceptionally low (9.2%) especially in infants below 12 months (3.9%). Therefore, the factors significantly associated with inappropriate minimal acceptable diet were similar to those for minimum meal diversity and minimum meal frequency. These factors included age <12 months, mother's illiteracy, BMI below 18.5 kg/m^2, less frequent antenatal visits, did not read the newspaper almost every day, did not listen to radio almost every day, and eastern and western regions of India. Additional factors that emerged were households from the lower wealth quintiles and northern region of India. It is possible that both food security and traditional barriers impact on meal diversity and therefore not only the infants of the poorest households did not receive minimal acceptable diet (Paul *et al*. 2010).

An important strength of this study is the ability to determine the most susceptible age group and the modifiable factors that affect inappropriate practices in a large sample size which allows for control of confounders. These results from a large nationally representative sample can help policy makers and researchers to design interventions to improve infant and young child feeding practices in India. One of the weaknesses of the study is that cause and effect relationships cannot be established because of the cross-sectional design. It also relied on a 24-h maternal recall of different types of food groups and the frequency with which they were given. This may not accurately reflect their past feeding experience. Future studies should include prospective data collection to address these limitations.

Overall, this study showed that a very low proportion of children aged 6–23 months in India received adequate complementary foods as measured by the WHO indicators. Children under 12 months were particularly vulnerable, and this inadequacy of complementary foods is likely to negatively impact their subsequent growth velocity. It is possible that the reason for not receiving minimal acceptable diet is food insecurity in the poorest households, whereas traditional barriers could exist in the middle household wealth quintiles (Tulloch 1999). Factors that consistently impacted inappropriate feeding indicators were the low level of the mother's education, lower frequency of antenatal visits and no exposure to media. The importance of the study is that it identified these factors that are modifiable by appropriate interventions to improve IYCF practices.

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Conflicts of interest

None of the authors have any conflict of interest on the content of this manuscript.

Contributions

Dr. Archana Patel designed the study, obtained datasets, guided analysis and wrote the manuscript. Dr. Yamini Pusdekar obtained literature, checked results and reviewed and revised the manuscript. Jitesh Borkar wrote the results section, interpreted results and revised the manuscript. Neetu Badhoniya converted data files, conducted statistical analysis and compiled results tables. Dr. Kingsley E. Agho checked results and provided feedback on the analysis and Dr. Michael Dibley conceptualised the research question, designed and guided the analysis and edited the manuscript.

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