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The Role of Maternal Care Services on Feeding Practices Among Under Five Children in India, Nepal and Bangladesh

Brajesh[1] · Chander Shekhar[2] · Mukesh Ranjan[3] · Sonpa Vishwakarma[4]

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Abstract

Background In South Asia, one in two children under the age of five are stunted or wasted due to malnutrition, which affects one in three children globally. There are close linkages between maternal health care services and child feeding practices which needs to be investigated.

Materials and Method The present study analyzed two rounds of Demographic Health Surveys cross-sectional data carried out between year 2005 and 2016 in three selected South Asian countries viz. India, Nepal, and Bangladesh respectively. This study is based on children under 5 years of age which are nested within mothers aged 15–49 years. Inferential statistical analysis like Chi-square was used to test the association, and regression model was used to analyze the effect of mother's Maternal and Child Health care services utilization on the child's feeding score after controlling for socio-economic and demographic factors. The objective of this study was to investigate the effect of utilization of maternal care services on child feeding practices in India, Nepal, and Bangladesh.

Results Our result shows that mother's secondary or higher level of education, more than four-antenatal care visits, and deliverying in a health facility was associated with a higher chance of child feeding practices. Multivariate linear regression revealed that education, antenatal care visits, and postnatal care visits had positive and significant effect on child feeding, while mothers who were 15–19 years of age were less likely to feed child. The results from this analysis imply that there are various regional and national influences on the determination of mothers' practices on child feeding. Furthermore, there are other factors that indicate that mother's practices are influenced by situational and time factors.

Conclusion Overall, with multiple maternal and child health care contacts with the health system, there is an opportunity to promote child feeding practices. The study results are critical and emphasises the need for making strategies and policies for better nutritional outcome and child feeding practices. Disadvantaged women in terms of education, antenatal care, birth at a health institution, and postnatal visits must be targeted to improve child feeding practices.

Keywords Child Feeding Index (CFI) · Maternal and Child Health (MCH) · Antenatal Care (ANC) · Postnatal Care (PNC) · India · Nepal and Bangladesh

Introduction

Maternal health care services are classified as an important health care intervention aimed at enhancing maternal and child survival and offers information that could improve infant care and nutrition (Birmeta et al., 2013; Neupane & Nwaru, 2014). Several studies have proved that maternal health care utilization fosters other components such as institutional delivery, antenatal care, postnatal care and immunization (Ogbo et al., 2019). As South Asia seeks to achieve optimal universal health care and survival for mothers and children through targeted policy-making, this study contributes in identifying vulnerable groups that require immediate policy attention. Maternal health care utilization and nutritional actions adopted towards her child are necessary reproductive health care interventions to reduce neonatal and infant mortality, particularly in the first week of life and even up to 1000 days after birth (Teshale & Tesema, 2021; UNICEF, 2016). Additionally, the important role of maternal health care utilization in infant nutrition has been displayed in numerous epidemiological surveys (Kovar et al., 1984).

A study from rural China aimed at exploring infant care practices and their relation with prenatal care utilization reported

✉ Brajesh
iipsmumbai2012@gmail.com
Extended author information available on the last page of the article

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a significant association between the timing of antenatal care initiation and some infant care practices (Nwaru et al., 2011). In Bangladesh, a study found that compared to no antenatal care visit, one to three visits protected infants by feeding prelactating foods (Sundaram et al., 2013). In addition, place of delivery is recognized as a key determinant of maternal health care utilization which has an impact on the health status and feeding practices of children., in varying populations (Arokiasamy & Pradhan, 2013; (Birmeta et al., 2013; Neuman et al., 2014; Adu, 2015; Shahabuddin et al., 2015).An antenatal care visit is one of the most important and highly cost-effective interventions to promote healthy behaviours and foster child survival (Ghimire, 2019).

As per the latest Demographic Health Survey data, the three countries i.e. India, Nepal and Bangladesh in breastfeeding indicators, the minimum meal frequency, minimum dietary diversity and minimum acceptable diet are not achieved among majority of the infants aged 6 months to 2 years of life (Senarath & Dibley, 2012). In a study carried out to compare the complementary feeding indicators and associated factors in children aged six to 23 months across five South Asian countries (Bangladesh, India, Nepal, Pakistan and Sri Lanka) it was observed that Minimum dietary diversity among children aged 6 to 23 months ranged from 15% in India to 71% in Sri Lanka, with Nepal (34%) and Bangladesh (42%). Minimum acceptable diet among breastfed children was 9% in India, 32% in Nepal, 40% in Bangladesh and 68% in Sri Lanka (Senarath et al., 2012). Maternal health care services offer mothers education to their children's infant feeding practices and health care. Studies revealed that the maternal care utilization has positive outcomes on infant health, growth and feeding (Navaneetham & Dharmalingam, 2002).

Woman's decisions on child feeding practices are usually formed during antenatal, postnatal and delivery care preparation, and counselling despite differences in socio-demographic and cultural influences (Fatema & Lariscy, 2020). Although studies vary in terms of research design, sample size, representativeness, and overall context but they have displayed the relations between feeding practices and maternal health care utilization components. Adequate dietary intake during infancy may have significant implications on infant growth, health and nutritional status (Nithya & Bhavani, 2018). Some prerequisites to achieve adequate dietary intake are shown in level three of the framework: early breastfeeding initiation, exclusive breastfeeding, complementary feeding, and continued breastfeeding Table 1 and Fig. 1.

This research adds to previous research in identifying target groups that need attention, providing recommendations to encourage behaviour change and establishing strengths and inadequacies of the maternal health care utilization package. Given the importance of maternal health care utilization and essential nutrition actions on infant health and survival, this study attempts to examine the questions like; What is the influence of seeking maternal care services received by mothers on feeding practices among children? Do individual, family, social and demographic characteristics influences such a relationship too in the selected countries? Further, this article aims to determine the association between various components of maternal health care utilization and infant feeding practices such as breastfeeding initiation, pre-lacteal feeding, bottle, and continued breastfeeding.

Materials and Methods

Data Source

For this study, we used National Family Health Surveys, 2005–2006 (NFHS-3) and 2015–2016 (NFHS-4) of India (IIPS, 2007, 2017) and Demographic and Health Survey (DHS) for the period 2005 and 2016 of Nepal (MoHP, 2007, 2017) and Bangladesh (NIPORT, 2009, 2015) respectively. The NFHS and DHS were designed to provide estimates of important indicators on family welfare, maternal and child health, and nutrition. In the DHS survey information collected on breastfeeding, complimentary feeding and meal frequencies were used to construct child feeding index. Mother retrospectively reported information for last born child-like; number of antenatal care visits, place of delivery, postnatal care, mode of delivery which formed the components of maternal health care services utilization. The

Table 1 Feeding practices among children in India, Nepal and Bangaldesh—2005–2016

Country DHS survey	India 2005–2006	India 2015–2016	Bangladesh 2007	Bangladesh 2014	Nepal 2006	Nepal 2016
Children age 0–5 months exclusively breastfed	47.3	54.9	49.8	55.3	53.0	66.1
Children age 0–5 months breastfeeding and consuming plain water only	23.8	17.8	15.6	12.3	19.1	6.1
Children age 0–5 months breastfeeding and consuming complementary foods	9.5	10.5	20.3	14.1	13.0	11.5
Children currently breastfeeding	98.2	95.5	99.5	99.1	99.7	99.1
Median duration of exclusive breastfeeding	2.1	2.8	2.3	2.8	2.5	4.2

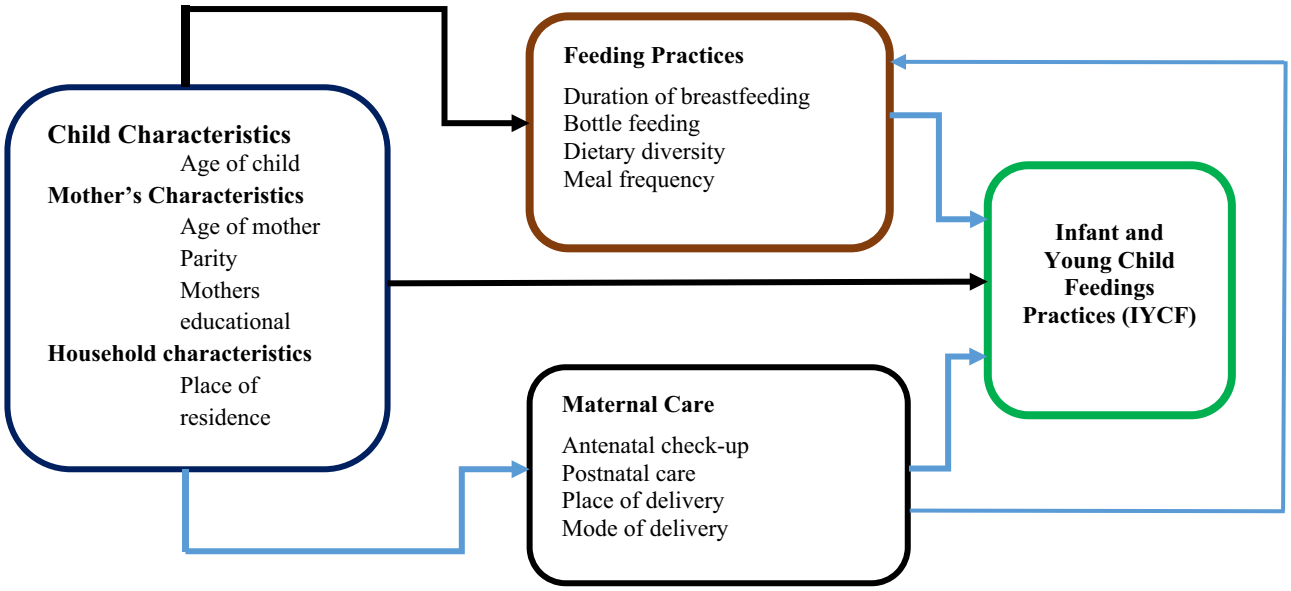

Fig. 1 Framework for maternal health care services effect on child feeding practices

mother reported whether the youngest children living with the mother were consuming specific types of foods in the day or night 3 years preceding the survey, disaggregated by whether breastfeeding or not in children recode file (Table 2). The groupings of foods have changed over time in the data and coded to make the same level for all countries.

Table 2 Intake of various food groups by children under five years' age across the countries

Child diet	India	Nepal	Bangladesh
Plain water	√	√	√
Juice or juice drinks	√	√	√
gave child tea or coffee	√	√	√
Soup	√	√	√
Milk (tinned, powdered, fresh)	√	√	√
Infant formula /baby formula	√	√	√
Any other liquids	√	√	√
Yogurt/gave child chicken, duck or other birds	√	√	√
Any brand of cereal, fortified baby food	√	√	√
Bread, rice, noodles/gave child other porridge/gruel	√	√	√
Pumpkin, carrots, squash yellow or orange inside	√	√	×
While potatoes, white yams, cassava, etc	√	√	×
Any dark green leafy vegetables	√	√	√
Ripe mangoes, ripe papayas	√	√	√
Any other fruits or vegetables	√	√	√
Liver, kidney, heart, or other organs	√	√	×
Any meat, beef, pork, etc	√	√	√
Eggs	√	√	√
Fresh or dried fish	√	√	√
Beans and lentils	√	√	√
Cheese or other foods made from milk	√	√	√
Any foods made with oil, fat, or butter	√	√	×
drank from bottle with nipple	√	√	√

Sample Design and Study Population

This research is based on Bangladesh, India, and Nepal, three South Asian countries. Data from the most recent Demographic and Health Survey for these nations included information on both children feeding and women's use of MCH services. DHS are nationally representative household surveys that are conducted on a regular basis and provide data on a wide range of demographic, health, and nutrition characteristics. These surveys usually are conducted by a national implementing agency with technical assistances provided by the DHS program. Surveys are based on two-stage stratified sampling of households — firstly, sampling census enumeration areas are selected using probability proportional to size (PPS) sampling technique through statistics provided by the respective national statistical office, and secondly, households are selected through systematic random sampling from the complete listing of households within a selected enumeration area. We limit our analysis to a few nations in the South Asian region to reduce the effects of cross-cultural differences in dietary patterns. The study used surveys pooled data of children aged 6 to 12 and 13 to 36 months collected between 2005 and 2016. The current study focused on women between the ages of 15 and 49 who had live births within the 5 years preceding the survey. The lower cutoff age of 6 months was selected as after 6 months of age children, start receiving semisolid food as a supplement to breast milk (Petrikova, 2022). The upper cutoff point was chosen because the first 2 years of children's lives are considered as the most crucial for ensuring good nutrition and has better health outcomes in later part of life.

Construction of Child Feeding Index

The study tries to understand the role of child feeding practices on child health status using a composite child feeding index (CFI). An attempt has been made to create a composite index using Ruel and Menon's method (Ruel & Menon, 2002) with some modification in the context of selected South Asian countries. We created indices by two age groups 6–12 months, and 13–36 months of children. Age-specific feeding indices were created as feeding practices hugely differ by these two broad age group among children. The variables used in the indices were (a) breastfeeding (whether the mother is currently breast-feeding the child or not); (b) use of baby bottles in the previous 24 h (yes/no); (c) dietary diversity (whether or not the child received selected food groups in the previous 24 h); and (d) feeding frequency (how many times the child was offered solid or semisolid, or soft foods other than liquids in the previous 24 h). Food frequency was ignored due to data limitation. The scoring patterns with variables are shown in the details in Table 3. The list of items was prepared, and the scoring system was used to assign scores of 0 for a potentially harmful practice and scores of 1 for a positive practice (Table 3).

Breastfeeding received a score of 2 for infants 6–12 months of age, a score of 1 for older children age 13–36, and a score of 0 for non-breastfeeding children of any age. Avoidance of baby bottles was scored 1, and their use received a score of 0. A dietary diversity score was created based on the number of food groups consumed by the child in the previous 24 h. In the absence of a specific recommendation, an arbitrary scoring, similar for all age groups, was

Table 3 Variables and scoring system used to create the child feeding index for age 6–12 months and 13–36 months

Variables	Age 6–12 months	Age 13–36 months
Breastfeeding	Yes = 2	Yes = 1
	No = 0	No = 0
Bottle feeding	Yes = 0	Yes = 0
	No = 1	No = 1
Dietary Diversity (past 24 h)	**Sum of:** (grains, tubers, milk, egg, fish/poultry, meat, other)	**Sum of:** (grains, tubers, milk, egg/fish/poultry, meat, other)
	None of food-groups = 0	None of food-groups = 0
	One to two food-groups = 1	One to three food groups = 1
	Three or more food groups = 2	Four to more food groups = 2
Feeding frequency (past 24 h)	**Food frequency** = sum of scores forstaples egg/fish/poultry meat	**Food frequency** = sum of scores for staples egg/fish/poultry meat
	0 meals/day = 0	0–1 meals/day = 0
	1 or 2 meals/day = 1	2 or 3 meals/day = 1
	3 or more meals/day = 2	4 or more meals/day = 3
Total scores	**7 points**	**7 points**

*Adjusted by the study based on Ruel & Menon, and meal frequency does not include breast-milk or any other liquids and only refers to solid, semi-solid or soft foods received in the past 24 hrs

used: none (meaning no semisolid or solid foods) was scored 0, one to three food groups received a score of 1, and four or more received a score of 2. Food group frequency scores were also created; for this, the grains and tubers groups were combined into one single group, referred to as "staples," and the other food groups were not used, leaving a total of four food groups (staples, milk, egg/fish/poultry, and meat). For the food group frequency scores, each food group was scored individually and the scores to each one were summed to derive a final food group frequency score. The scoring of meal frequency was based on current feeding recommendations, according to which 6–12-month-old infants should receive complementary foods at least twice a day, 6–12-month-old infants three times a day, and 12–36-month-old children four times a day. The children of 6–12 months' age not receiving feeding was given a score 0, once or twice "1" and three or more times "2" and, the scores for age 13–36 months was 0 for not at all or once, twice or three times "2" and four or more times "3". The value of feeding score lies between minimum and maximum.

A child feeding index was created based on the feeding scores which were categorised into three categories low, medium and high respectively. A low value of child feeding index indicates that feeding score is negative (i.e. irrespective of mother's duration of breast feeding and bottle feeding the value of diet diversity 0 (No food) or 1 (1–2 food) and Feeding frequency 0 (not given) or 1 (1–2 times food given) Table 4.

A high value on child feeding index indicates that a value of feeding score is positive, i.e. (irrespective of mother's duration breast feeding and bottle-feeding value, the dietary diversity had always a value 2 indicating that "three or more food groups" and feeding frequency value was 2 indicating that "Three or more times" food given to child. Any other value other than low and high categories of child index is in medium category and feeding score can be either negative or positive (irrespective of duration of breastfeeding and bottle feeding, the value of diet diversity and feeding frequency can take value either 1 or 2) (Table 4). This child feeding index was obtained based on feeding score which was a result of application of Principle Component Analysis (PCA) on items like age-specific duration of breastfeeding, bottle feeding, dietary diversity and feeding frequency. So, the low, medium and high categories of child feeding index show its dependence more on dietary diversity and feeding frequency rather than on breastfeeding and bottle feeding. The PCA feeding scores were also used as a continuous variable in the regression model. The scale reliability coefficient (alpha Cronbach value) was 0.766 in India, 0.779 in Nepal and 0.670 in Bangladesh. The index is also used to compute mean score of each country, and index score is the sum of the scores obtained for each variable described above in a range from 0 to 7 for all age groups. The PCA feeding scores were also used as a continuous variable in multivariate regression model.

Variables Used in the Analysis

Outcome Variable

In this study, there is only one outcome variable,which was used as continuous and categorical. The outcome variable

Table 4 Descriptive statistics of age specific child feeding index based on Principal Component Analysis (PCA) in selected countries

Country	Age in (months)	Feeding Level	Observations	Mean	SD	Min	Max
India (2005-2006)	Age 6–12	Low	10,710	−1.51	0.57	−2.33	−0.63
		Medium	11,451	0.23	0.44	−0.45	0.57
		High	8694	1.55	0.37	0.89	2.78
	Age 13–36	Low	17,334	−1.25	0.51	−2.67	−0.45
		Medium	17,010	−0.08	0.05	−0.33	0.05
		High	17,159	1.34	0.71	0.17	3.40
Nepal (2006-2016)	Age 6–12	Low	374	−1.17	1.36	−5.40	−0.07
		Medium	465	0.78	0.09	0.15	0.83
		High	48.0	1.41	0.14	1.36	1.87
	Age 13–36	Low	1316	−0.52	1.20	−10.6	−0.13
		Medium	773	0.40	0.09	−0.06	0.42
		High	282	1.32	0.31	0.73	2.03
Bangladesh (2007-2014)	Age 6–12	Low	570	−1.44	0.84	−3.31	−0.24
		Medium	879	0.73	0.39	−0.16	1.04
		High	92.0	1.92	0.68	1.59	3.45
	Age 13–36	Low	1373	−1.13	0.84	−4.91	0.13
		Medium	1592	0.69	0.07	0.17	0.75
		High	224	2.01	0.83	0.83	4.24

feeding Index is a discrete variable that is divided into three groups to reflect the diet pattern: low, medium, and high.

Explanatory Variables

Maternal and child health care are the key predictive variables in this study. Composite child feeding index is the most important dependent variable used to see if there is an age-specific relationship between Maternal and Child Health services such like ANC, PNC, place of delivery and mode of delivery. Based on score, the child feeding index has been divided into three categories: low, medium, and high, the details description of categorization into tercile given in Table 4. Different socio-economic parameters such as mother's age, wealth index, parity, child's sex, religion, residence and mother's educational status were utilised as explanatory variables in the study.

Statistical Methods

The descriptive statistics, bivariate and multivariate methods were used for analysis. Multivariate linear regression was used to see the effect of maternal and child health care services utilization along with socio-economic variable on feeding practices scores, and chi-squared ($\chi 2$) test at an alpha level of 5% was used to assess the statistical significance of the regression coefficient estimate. The regression models estimated adjusted β-coefficient with 95% confidence intervals (CIs). We used STATA/SE version 14 to obtain design-based (weighted) point estimates for feeding practices, and computed unweighted frequencies with their weighted percentages for feeding practices and socio-economic and demographic characteristics.

Results

Distribution of Age-Specific Feeding Practices from Periods 2005–2006 to 2015–2016

Figures 2 and 3 show country-specific absolute change in the prevalence of breastfeeding and complementary feeding indicators. A downward absolute change in the prevalence of breastfeeding within the range 2–4% in age 6–12 months' children, similar downward change was observed among children age 13–36 months, i.e. maximum found in Nepal (15%), India (12%) and Bangladesh (8%), showing a similar downward absolute change with bottle feeding practices for both age groups of children. The maximum decline was observed for bottle-feeding among age 6–12 in Nepal (15%) followed by Bangladesh and India. Almost 10% bottle feeding declined in age 13–36 months across the countries. Whereas for age 6–12 months' children, dietary diversity 1–2 has been having a marginal increase or decrease, and for age 13–36 months, children increase 14% in India, 9% in Bangladesh followed by Nepal (6%). For children aged 6–12 months with dietary diversity three or more, there has been a decline of more than 9% in India (Fig. 2).

A decline of nearly 19% in India and 10% in Bangladesh followed by Nepal was observed among children aged 13–36 months with dietary diversity three or more. The maximum decline in food frequency had occurred in Bangladesh (13%) followed by Nepal (11%) and India. Among

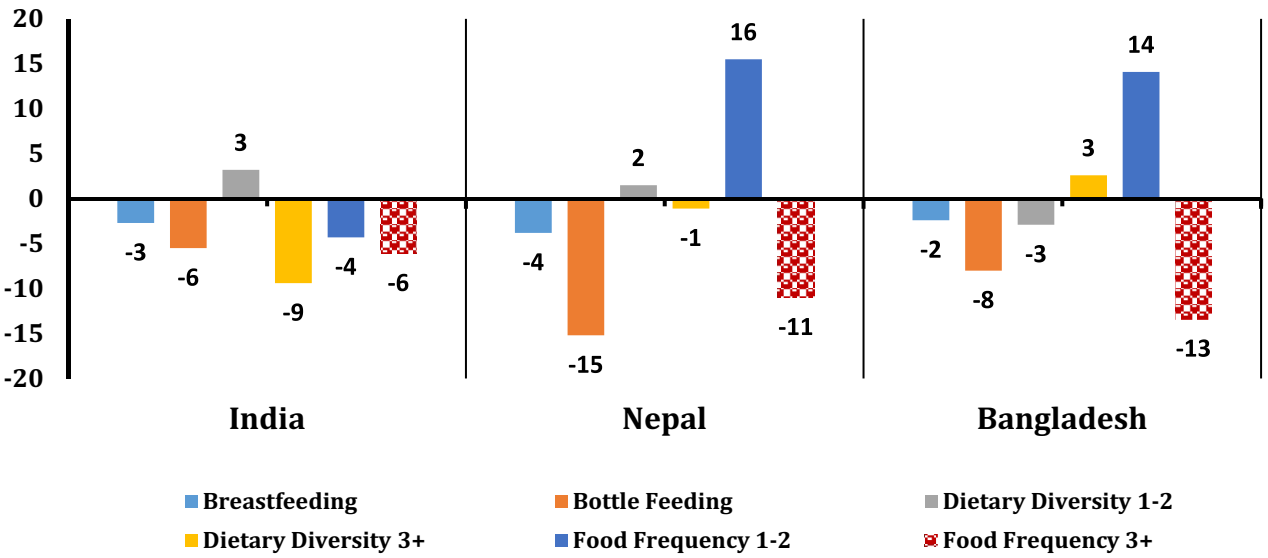

Fig. 2 Absolute change in prevalence of feeding practices among children age 6–12 months across the countries

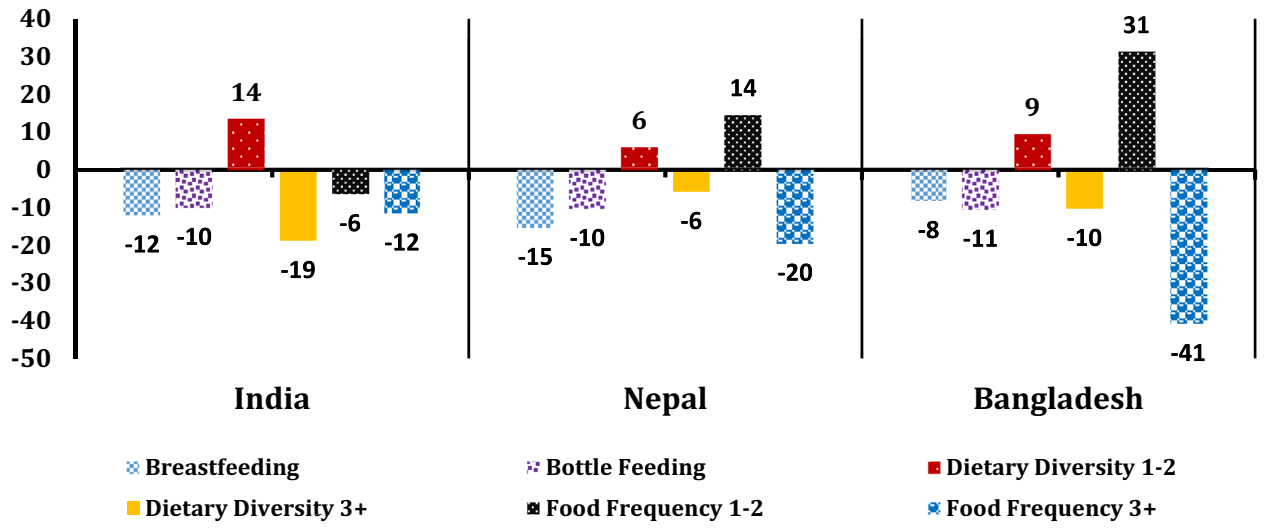

Fig. 3 Absolute change in prevalence of feeding practices among children age 13–36 months across the countries

the children aged 13–36 months, the maximum difference in three or more food frequencies was seen in Bangladesh (41%) followed by Nepal (20%) and India (12%) in Fig. 4.

Mean Feeding Scores Across the Selected Countries

Figure 4 shows that Nepalese mothers had consistently higher child-feeding practices scores than Indian and Bangladeshi mothers. The mean of child feeding index scores for children aged 6–12 months is 6.10 in Nepal, 5.78 in Bangladesh, and 4.91 in India. Mean feeding index scores among children aged 13–36 months were also the highest, 5.13 in Nepal followed by 4.58 in Bangladesh and 3.08 in India.

Utilization of Maternal and Child Health Services and its Influence on Feeding Practices Among Children Aged 6–36 Months

Table 5 shows that the utilization of maternal and child health services is significantly associated with child feeding practices across the countries for the child 6–12 months. This study found that about two-fifths of children in India, six out of ten in Nepal and Bangladesh, were scored as average in the index for children aged 6–12 months old across all the predictors. This may be due to the increase in continuous breastfeeding and accelerated complementary feeding as the child grows. However, the trend of bottle use and

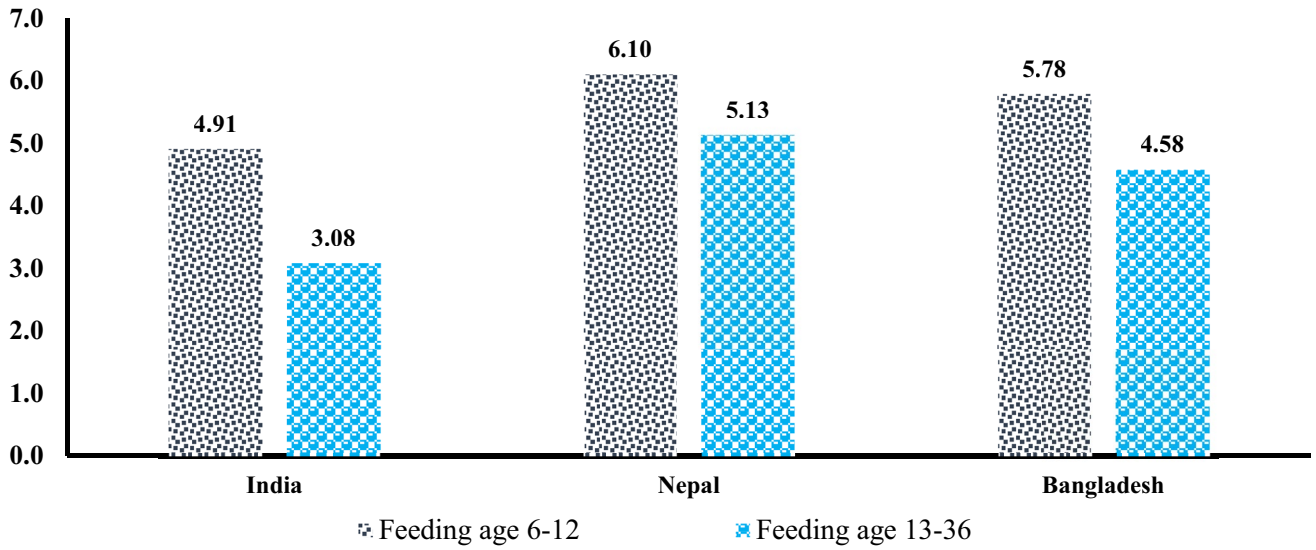

Fig. 4 Mean of child feeding score across the selected countries

Table 5 Maternal and child health services utilization and feeding index among children age 6–12 and 13–36 months in India, Nepal and Bangladesh

	India (2005–2016)				Nepal (2006–2016)				Bangladesh (2007–2014)			
	Low	Medium	High	N	Low	Medium	High	N	Low	Medium	High	N
Age 6–12 months												
ANC visit												
No visits	46.8	35.9	17.3	5094	45.3	53.0	1.7	153	45.3	51.7	3.0	392
1–2 visits	46.9	35.4	17.7	6344	48.0	49.7	2.3	203	42.7	50.5	6.9	501
3–4 visits	38.3	39.5	22.2	8299	35.5	57.0	7.5	339	31.9	60.9	7.1	345
5 or more visits	29.3	40.7	30.0	11,083	43.3	49.3	7.4	192	25.3	63.2	11.5	303
	$\chi 2 = 698.958$, $P \leq 0.000$				$\chi 2 = 18.6914$, $P \leq 0.005$				$\chi 2 = 53.129$, $P \leq 0.000$			
Postnatal care												
No postnatal care	45.2	38.0	16.7	10,364	43.1	52.9	4.0	547	42.3	55.0	2.8	696
Postnatal care	34.2	38.8	27.0	20,457	39.8	53.0	7.2	340	33.9	55.8	10.3	845
	$\chi 2 = 365.539$, $P \leq 0.000$				$\chi 2 = 5.8875$, $P \leq 0.053$				$\chi 2 = 29.025$, $P \leq 0.000$			
Place of delivery												
Public health facility	38.5	37.3	24.2	16,220	43.3	49.3	7.5	226	33.7	59.9	6.4	183
Private health facility	31.0	39.2	29.8	6,915	33.7	51.7	14.6	66	29.9	54.5	15.6	311
Delivery at home	44.2	40.4	15.4	7720	42.3	54.4	3.3	595	40.6	55.0	4.5	1047
	$\chi 2 = 272.143$, $P \leq 0.000$				$\chi 2 = 23.7503$, $P \leq 0.000$				$\chi 2 = 36.310$, $P \leq 0.000$			
Mode of delivery												
No caesarean	39.9	38.6	21.6	26,074	41.6	53.5	4.9	851	39.6	55.3	5.1	1263
Caesarean	29.1	38.2	32.7	4,781	44.6	43.2	12.2	36	29.6	55.9	14.4	278
	$\chi 2 = 245.082$, $P \leq 0.000$				$\chi 2 = 5.4411$, $P \leq 0.056$				$\chi 2 = 30.549$, $P \leq 0.000$			
Parity												
One to two	36.1	38.9	25.0	21,104	38.0	54.6	7.4	537	35.2	57.0	7.9	1066
Three to five	40.9	38.0	21.2	7295	51.2	46.4	2.4	211	44.1	50.8	5.1	359
Five above	46.2	36.7	17.2	2456	42.2	56.4	1.4	139	41.6	56.7	1.8	116
	$\chi 2 = 92.8917$, $P \leq 0.000$				$\chi 2 = 13.0313$, $P \leq 0.011$				$\chi 2 = 14.531$, $P \leq 0.006$			
Mothers' education												
No education	47.1	36.9	16.1	8959	46.6	50.5	2.9	428	47.7	49.0	3.3	272
Primary	38.6	39.5	21.9	4122	44.0	51.8	4.2	172	43.2	51.5	5.2	431
Secondary and above	33.0	39.2	27.9	17,774	33.5	57.1	9.4	287	31.6	59.7	8.8	838
	$\chi 2 = 615.350$, $P \leq 0.000$				$\chi 2 = 27.9785$, $P \leq 0.000$				$\chi 2 = 53.229$, $P \leq 0.000$			
Mother age												
15–24 years	37.8	39.7	22.5	14,684	38.8	54.4	6.9	492	35.7	57.5	6.7	920
25–34 years	37.8	37.3	24.9	14,351	48.9	48.7	2.4	319	40.4	52.7	6.9	538
35 & above years	40.7	36.7	22.6	1820	32.1	60.8	7.2	76	44.3	49.6	6.2	83
	$\chi 2 = 37.846$, $P \leq 0.000$				$\chi 2 = 10.222$, $P \leq 0.037$				$\chi 2 = 9.7629$, $P \leq 0.045$			
Religion												
Major®	38.1	38.4	23.5	22,462	41.0	53.2	5.8	769	41.8	50.6	7.6	129

Table 5 (continued)

	India (2005–2016)				Nepal (2006–2016)				Bangladesh (2007–2014)			
	Low	**Medium**	**High**	**N**	**Low**	**Medium**	**High**	**N**	**Low**	**Medium**	**High**	**N**
Other	37.3	39.0	23.7	8393	46.3	51.1	2.6	118	37.4	55.9	6.7	1412
	$\chi2=74.410$, $P\leq0.000$				$\chi2=1.286$, $P\leq0.526$				$\chi2=0.3756$, $P\leq0.829$			
Wealth categories												
Poor	45.7	37.6	16.7	9809	42.4	54.4	3.2	299	41.4	56.2	2.5	496
Middle	37.8	39.6	22.6	10,371	41.5	53.7	4.8	288	40.7	53.2	6.1	521
Rich	30.7	38.4	30.9	10,675	41.5	50.8	7.7	300	31.0	57.1	12.0	524
	$\chi2=610.669$, $P\leq0.000$				$\chi2=6.6653$, $P\leq0.155$				$\chi2=38.273$, $P\leq0.000$			
Residence												
Rural	40.6	38.4	21.0	23,168	40.2	56.5	3.4	612	39.0	55.6	5.4	1032
Urban	30.4	38.8	30.8	7,687	47.4	40.6	12.0	275	33.9	54.9	11.2	509
	$\chi2=223.89$, $P\leq0.000$				$\chi2=19.2002$, $P\leq0.056$				$\chi2=5.771$, $P\leq0.056$			
Age 13–36 months												
ANC visit												
No visits	40.0	32.4	27.7	9104	52.1	38.6	9.3	550	47.8	48.8	3.4	972
1–2 visits	37.9	33.9	28.2	10,269	50.0	39.6	10.5	497	42.4	51.1	6.5	943
3–4 visits	35.2	34.0	30.9	13,484	56.9	30.2	13.0	809	40.0	51.0	9.0	656
5 or more visits	35.2	30.0	34.8	18,368	62.4	22.9	14.7	483	36.4	51.6	12.0	613
	$\chi2=113.899$, $P\leq0.000$				$\chi2=77.148$, $P\leq0.000$				$\chi2=74.961$, $P\leq0.000$			
Postnatal care												
No postnatal care	38.1	34.1	27.8	18,652	54.2	36.1	9.7	1,553	43.3	53.0	3.7	1682
Postnatal care	35.8	31.0	33.2	32,679	59.6	25.2	15.2	818	41.7	47.4	11.0	1503
	$\chi2=109.191$, $P\leq0.000$				$\chi2=48.7776$, $P\leq0.000$				$\chi2=68.083$, $P\leq0.000$			
Place of delivery												
Public health facility	38.2	30.9	30.9	25,267	60.3	21.6	18.2	475	43.5	49.3	7.2	353
Private health facility	34.8	29.3	36.0	11,364	60.8	25.0	14.2	164	43.4	39.2	17.3	544
Delivery at home	35.6	36.5	27.9	14,872	54.7	35.6	9.8	1732	42.2	53.0	4.8	2291
	$\chi2=226.557$, $P\leq0.000$				$\chi2=65.659$, $P\leq0.000$				$\chi2=103.991$, $P\leq0.000$			
Mode of delivery												
No caesarean	37.3	32.7	30.0	43,947	56.6	32.3	11.1	2280	42.7	51.9	5.5	2668
Caesarean	32.6	29.3	38.0	7556	47.8	25.7	26.5	91	41.9	42.5	15.6	520
	$\chi2=138.887$, $P\leq0.000$				$\chi2=19.734$, $P\leq0.000$				$\chi2=80.404$, $P\leq0.000$			
Parity												
One to two	35.9	31.1	33.0	33,944	55.5	30.3	14.2	1,326	41.6	49.7	8.7	2034
Three to five	38.2	33.7	28.1	12,853	59.1	32.2	8.8	676	41.8	53.5	4.7	830
Five above	37.0	34.9	28.2	4,706	53.6	38.0	8.5	369	50.3	46.6	3.1	325
	$\chi2=69.4085$, $P\leq0.000$				$\chi2=35.725$, $P\leq0.000$				$\chi2=25.022$, $P\leq0.000$			

Table 5 (continued)

	India (2005–2016)				Nepal (2006–2016)				Bangladesh (2007–2014)			
	Low	Medium	High	N	Low	Medium	High	N	Low	Medium	High	N
Mothers' education												
No education	37.7	34.6	27.7	15,852	53.6	36.8	9.5	1,258	47.4	49.3	3.3	613
Primary	39.2	32.6	28.2	7320	54.5	33.6	12.0	441	47.6	47.4	5.0	961
Secondary and above	35.2	30.4	34.4	28,331	62.0	22.3	15.7	672	37.7	52.6	9.8	1615
	$\chi2 = 173.422$, $P \leq 0.000$				$\chi2 = 90.755$, $P \leq 0.000$				$\chi2 = 67.964$, $P \leq 0.000$			
Mother age												
15–24 years	36.4	31.9	31.8	20,319	55.7	31.9	12.4	1080	41.7	51.5	6.9	1708
25–34 years	36.7	32.1	31.2	27,234	58.6	29.7	11.7	1022	43.4	49.0	7.6	1251
35 years and above	37.1	33.6	29.3	3950	48.8	41.9	9.4	269	44.5	49.4	6.1	230
	$\chi2 = 11.419$, $P \leq 0.022$				$\chi2 = 14.346$, $P \leq 0.006$				$\chi2 = 1.470$, $P \leq 0.832$			
Religion												
Major	36.7	32.2	31.1	36,972	57.1	31.1	11.8	2,058	41.1	52.6	6.3	260
Other	36.1	31.9	32.0	14,531	51.2	37.3	11.5	313	42.7	50.2	7.1	2929
	$\chi2 = 45.195$, $P \leq 0.000$				$\chi2 = 3.965$, $P \leq 0.135$				$\chi2 = 2.508$, $P \leq 0.285$			
Wealth categories												
Poor	38.8	34.5	26.6	16,416	52.4	34.0	13.6	787	50.7	45.8	3.6	1004
Middle	37.0	33.1	29.9	17,165	54.6	34.9	10.5	783	42.2	52.5	5.3	1083
Rich	33.8	28.8	37.4	17,922	61.1	27.5	11.4	801	34.0	53.2	12.9	1102
	$\chi2 = 383.993$, $P \leq 0.000$				$\chi2 = 23.8558$, $P \leq 0.000$				$\chi2 = 127.789$, $P \leq 0.000$			
Residence												
Rural	37.3	33.2	29.5	37,283	55.3	34.7	10.0	1,705	44.5	50.2	5.3	2079
Urban	34.7	29.2	36.1	14,220	59.9	21.1	19.0	666	36.4	51.0	12.6	1110
	$\chi2 = 67.0573$, $P \leq 0.000$				$\chi2 = 26.068$, $P \leq 0.056$				$\chi2 = 48.272$, $P \leq 0.056$			

ANC antenatal care visits, *other-religion* other than major religion group

breastfeeding practices were not consistent. Therefore, less feeding was reported among children in the high feeding group with low socio-demographic background and maternal child health services. Mother's antenatal care visits had a significant association with child feeding, and percent of children in India (30%), Nepal (7%), and Bangladesh (12%) lies in the high feeding group for four or more antenatal care visits as compared to no antenatal care visits. Mother's attendance for postnatal care services is significantly associated with feeding. This proportion in the high feeding group for postnatal care was 27% in India, 7% in Nepal, and 10% in Bangladesh compared to no postnatal care services.

Mother's institutional delivery was in the range of 24 to 29% in India, 7 to 15% in Nepal and 6 to 16% in Bangladesh, respectively for public and private compared to delivery at home and was positively associated with the feeding of children. The mode of delivery had a significant association in India and Bangladesh. A large proportion of children of mothers with three or more parities belonged to low and medium feeding groups; however, the proportion of children of mothers with 1–2 parity was large in high feeding groups across the countries. The educational attainment of mother and child's feeding practices were positively associated. A large proportion of mothers, who were either uneducated or had primary education, were in low and medium feeding groups compared with secondary educated mothers. The proportion of children in high feed scores was large (25%) for mothers in the 25–34 years' age group in India and 15–24 years in Nepal and Bangladesh, but this proportion for feeding in the medium is high in mother's age 15–24 years in countries. Richer women were more likely to be in higher feeding score groups as compared to poor or middle wealth status. However, the wealth status of the mother was found insignificant in Nepal. A large majority of the urban children had high feeding than their counterparts in all the three countries' settings.

Mother's antenatal care visits were significantly associated with the feeding of children in India, Nepal and Bangladesh for ages 13–36 months (Table 5). The proportion of children ranges 34–40% in low, 29–35% in medium and 27–38% in high feeding groups in India; and 48–62% in low, 22–42% in medium and 9–26% in high in Nepal; and two-fifths in low feeding and a half or more in medium, and less than 16% in high feeding group in Bangladesh respectively, distributed across various background. ANC visits had significant associations across the countries with the feeding index of the child. This proportion of children found in the high feeding group was 35%, 15%, and 12% for four or more ANC visits compared to no ANC visits; 28%, 9%, and 3% respectively in India, Nepal, and Bangladesh. A similar child proportion pattern for postnatal care services existed and significantly associated with the child feeding index across the countries.

The proportion of mothers of the children belonging to the medium feeding index that delivered in the private and public healthcare facilities in India was 36% and 30%, and in Bangladesh was 17% and 7% respectively. In contrast, mothers of the children from the high feeding index group in Nepal had delivered in public facility and private facility in the proportion of 18% and 14% respectively. In the same category, as high as 28% of mothers in India, 10% in Nepal and 5% in Bangladesh delivered at home. The institutional delivery of mothers was statistically associated with child feeding. Across the countries, mothers with normal delivery did not make any positive impact on the child feeding practices. The proportion of mothers with five or more live birth children that contributed to low child feeding practices was 37% in India, 54% in Nepal and 50% in Bangladesh. Compared to their counter parts, the mothers with secondary or higher education had relatively better child feeding practices. Across all categories of mother's age, nearly half of the mothers in Bangladesh and Nepal contributed to medium feeding score and low feeding index category, respectively, while the low feeding index (35–39%) was observed in India. Religion, wealth category and residence were significantly associated with feeding practices among 13–36-month-old children. Most of the middle and rich wealth groups were associated ($P \leq 0.001$) with medium or high feeding practices across the countries.

Maternal and Child Health Factors Affecting Feeding Score: Children Age 6–12 Months

To establish a relationship between feeding and MCH services, multiple regression models were estimated with feeding scores as the dependent variable (Table 6). The regression coefficients indicate that the mother's five or more ANC visits had a significant positive effect on feeding scores of the child in ($\beta = 0.22$, $P \leq 0.0.001$) India, ($\beta = 0.53$ $P \leq 0.0.010$) Nepal and ($\beta = 0.12$ $P \leq 0.0.010$) Bangladesh holding the rest of the factors constant in the model. Mother's postnatal care services consumption also had significant positive effect on feeding scores of children of age 6–12 months in India. It revealed that the children's feeding scores increased 20% in India but found the lesser effect in Nepal and Bangladesh. Place of delivery also had a significant impact on child feeding scores. It was measured for private health facilities ($\beta = 0.06$, $P \leq 0.0.068$) and delivery at home ($\beta = 0.15$, $P \leq 0.0.001$) in India, private facilities ($\beta = 0.10$, $P \leq 0.0.045$) in Nepal and private health facilities ($\beta = 0.31$, $P \leq 0.0.034$) in Bangladesh. Caesarean section mode of delivery had a positive effect on feeding practices scores in India, Nepal, and Bangladesh. Mothers' education level (primary or more) had a statistically significant positive effect on children's feeding scores.

Table 6 Effect of maternal and child health services on feeding practices scores among children age 6–12 and 13–36 months in India, Nepal and Bangladesh

Background characteristics	Child age 6–12 months						Child age 13–36 months					
	India (2005–2006)		Nepal (2015–2016)		Bangladesh (2007–2014)		India (2005–2006)		Nepal (2015–2016)		Bangladesh (2007–2014)	
	Beta (β), *P*-value	S.E	Beta (β), *P*-value	S.E	Beta (β), *P*-value	S.E	Beta (β), *P*-value	S.E	Beta (β), *P*-value	S.E	Beta (β), *P*-value	S.E
Constant	−0.54***	0.05	−0.24	0.26	−0.74*	0.33	−0.22***	0.03	0.13	0.15	−0.59***	0.17
ANC visit												
No visits®												
1–2 visits	0.01	0.04	0.14	0.18	−0.06	0.15	−0.02	0.02	0.06	0.06	0.14**	0.07
3–4 visits	0.03	0.04	0.46*	0.20	−0.11*	0.18	0.07***	0.03	0.03	0.06	0.08	0.09
5 or more visits	0.22***	0.04	0.53*	0.24	0.12*	0.19	0.05**	0.03	−0.17*	0.10	0.30***	0.09
Postnatal care												
No Postnatal Care®												
Postnatal Care	0.20***	0.03	−0.16	0.13	−0.08	0.14	0.04*	0.02	0.02	0.07	0.25***	0.07
Place of delivery												
Public facility®												
Private facility	0.06*	0.03	0.10*	0.24	0.31*	0.23	0.09***	0.03	−0.07	0.18	0.10	0.12
Home	0.15***	0.03	−0.03	017	0.23	0.21	0.21***	0.02	0.16	0.12	0.12	0.11
Mode of delivery												
No Caesarean®												
Caesarean	0.14***	0.04	0.21	0.29	0.01	0.22	0.15***	0.03	0.24	0.21	−0.08	0.11
Mothers' education												
Illiterate®												
Primary	0.16***	0.04	0.08	0.16	0.22**	0.16	−0.04*	0.03	−0.15*	0.07	0.16*	0.08
Secondary and above	0.24***	0.03	0.57***	0.14	0.55***	0.17	0.04*	0.02	-0.28***	0.07	0.23**	0.09
Mother age												
15–24 years®												
25–34 years	0.06*	0.03	−0.01	0.15	0.01	0.14	−0.03*	0.02	−0.09	0.07	0.02	0.07
35 & above years	0.12*	0.06	0.51*	0.20	0.15	0.22	−0.04	0.04	−0.10	0.10	0.04	0.12
Parity												
One to two®												
Three to five	0.01	0.03	−0.01	0.16	0.10	0.15	−0.01	0.02	−0.07	0.07	0.05	0.07
Five above	0.03	0.05	0.14	0.19	−0.13	0.24	0.11***	0.03	0.00	0.08	−0.06	0.12
Wealth												
Poor®												
Middle	0.04	0.03	0.05	0.14	0.12	0.13	0.07***	0.02	−0.08*	0.04	0.05	0.07
Rich	0.12***	0.04	−0.09	0.16	0.13	0.16	0.18***	0.03	−0.14*	0.06	0.19**	0.08
Residence												
Rural®												
Urban	0.14***	0.03	−0.25*	0.14	0.14	0.12	−0.03	0.02	−0.02	0.07	0.13**	0.06
Religion												
Other®												
Major	−0.14***	0.03	0.02	0.16	0.01	0.19	−0.02	0.02	0.05	0.09	0.02	0.09

®, Reference category; *ANC* antenatal care visits, β regression coefficient, + $P<0.10$, * $P<0.05$, ** $P<0.0$ l, *** $P<0.0001$, *S.E.* standard error, *other religion* other than major religion group

Children's feeding increased with mother's primary level education, ($\beta=0.16$, $P\leq0.0.001$) in India and Nepal and ($\beta=0.08$, $P\leq0.0.034$) in Bangladesh, whereas with secondary and above education level ($\beta=0.24$, $P\leq0.0.001$) in India, ($\beta=0.57$, $P\leq0.0.001$) in Nepal and ($\beta=0.55$, $P\leq0.0.001$) in Bangladesh had a significant effect on

feeding scores. Mother's age, household wealth status, and residing in urban area had a significant effect on feeding scores of the children in India. The feeding was comparably associated with the low status of MCH services, mothers' education and household wealth status among children. The negative coefficient in the regression model indicated that feeding scores declined (i.e. irrespective of mother's duration of breastfeeding and bottle feeding, the value of diet diversity 0 (No food) or 1 (1–2 food) and feeding frequency 0 (not given) or 1 (1–2 times food given).

Maternal and Child Health Factors Affecting Feeding Score: Children Age 13–36 Months

As showcased in Table 6, results of multiple regression analyses confirm findings from bivariate analyses showing that child feeding practices were associated with MCH services. Results found that three to four ANC visits predicted a greater feeding chance ($\beta = 0.07$, $P \leq 0.0.075$) in India. In contrast, its positive effects were insignificant in Nepal, and Bangladesh 1–2 ANC visits had a significant effect. The mothers with four or more antenatal care visits had a high probability of feeding practices ($\beta = 0.05$, $P \leq 0.0.075$) in India, and ($\beta = 0.30$, $P \leq 0.0.001$) Bangladesh but reverse relationship ($\beta = -0.17$, $P \leq 0.0.084$) in Nepal. Mother's PNC care visits also directly affected feeding practices and was significant ($\beta = 0.04$, $P \leq 0.0.086$) in India and ($\beta = 0.25$, $P \leq 0.0.001$) Bangladesh. Place of delivery and mode of delivery presented a significant positive effect on child feeding scores in India but was not significant in Nepal and Bangladesh.

Mother's educational level (primary and above) positively affected the feeding practices scores of children in Bangladesh, whereas significant negative effects were observed for educational level in Nepal and for primary education in India. The secondary or higher level of education also had a significant effect ($\beta = 0.04$, $P \leq 0.011$) on the feeding scores of children in India. Many of the predictor variables, postnatal care, place of delivery, mode of delivery, parity, and religion, had reverse effect on feeding practices scores of the child in Nepal and Bangladesh. Household wealth status also had a significant positive effect on the feeding practices of children. The overall results show a positive relationship between children's feeding and maternal and child health services after accounting for the influences of individual, maternal, household-level factors. This implies that better sociodemographic conditions promote the consumption of a variety of foods among infants and young children with breastfeeding. Mother's ANC visits, postnatal care visits and institutional delivery had a significant effect on feeding practices of children (Table 6).

Discussion

According to the findings of this study which measures the composite feeding score more comprehensively, including breastfeeding, meal frequency, dietary diversity, and food variety. The implications of this research are clear and confirmed that antenatal care visits, postnatal care visits and institutional delivery were associated with better feeding practices. Mothers that availed four or more ANCs were found to be significantly more likely to practice good child feeding habits among both the age group of children in all three countries. Study found that the rate of increase the likelihood of feeding practices among children aged 6–36 months was higher among women who have five or more ANC visits. In addition, studies conducted among South Asian countries have demonstrated a significant positive association between antenatal and postnatal care visits and feeding practices. Our findings confirm earlier research that found that women who had more ANC and PNC visits had a higher likelihood of moving forward with their child-feeding practices (Devasenapathy et al., 2017; Oluleke et al., 2018; Ghimire, 2019; Adhikari et al., 2021; Wu et al., 2021).

Findings are consistent with a previous study in these countries reporting that children whose mothers received less than four ANCs, three PNC visits and did not deliver in health facilities, did not receive the recommended minimum meal frequency (Benedict et al., 2018a, b). In the absence of antenatal or postnatal care visits and institutional delivery, mothers might have missed the opportunity to receive nutrition education and counseling on feeding practices. As per national protocol in India, Nepal and Bangladesh, mothers are recommended to attend at least four ANCs and three PNCs visits and opt for institutional delivery. During these routine visits, mothers receive nutrition education and context-specific feeding counseling from trained health workers (Dhami et al., 2019). Nutrition education in the health facility might have influenced to improve feeding practices to the children (Nguyen et al., 2014; Rahman et al., 2016; Dhami et al., 2019). A study in Bangladesh, which also suggested that children whose mothers received Maternal and Child Health care services and intensive nutrition education had better growth among children (Rahman et al., 2016). Continuous nutrition counseling during antenatal and postnatal care visits, institutional delivery might have been effective in adopting adequate feeding practices. Similarly, this study finds a higher probability among mothers that gave birth at a private health facility, which concurs with reports issued in other developing countries (Pokhrel et al., 2016; Hossain et al., 2018). In particular, Indian, Nepalese and Bangladeshi study identified that institutional delivery increased feeding practices (Bhandari et al., 2019), and

another study by Sharma & Byrne (2016) found that home delivery was associated with low child feeding practices.

The study indicated that delivery at home or in a private institution were positively associated with child feeding practices, and statistically significant during 2005–2006 in India. PNC visits, C-section delivery had significant effect on child feeding practices in India, a mother who delivered through C-section gave more supplementary feeds other than breastmilk to their child. At the same time, many other factors were associated with feeding practices in both groups of children; those factors included belonging to an underprivileged, low wealth index score, low maternal education level, non-institutional delivery and lower age of the mother. Maternal education level (primary and higher education) increased the chance of children feeding more compared with those with no education, and thus education level of a mother significantly associated with better feeding practices among children. An older mother was more likely to feed more as compared to a younger mother.

Specifically, our study demonstrated that mothers of five and more born children were more likely to feed better compared with mothers with less than five children in the India and Nepal. Mothers from all the three countries belonging to middle wealth status demonstrated good feeding practices with their 6–12-month-old children. In the 13–36-month-old category, children age appropriate feeding practices were followed by the mothers belonging to rich wealth category in India and Bangladesh. Therefore, the promotion of MCH services, should pay due consideration to the socioeconomic health of the family and feeding practices to tackle child undernutrition. Frequency of feeding and feeding the children with animal products varied widely across age groups and religions. Similarly, the maternal factors influencing feeding practices included maternal age, mother's education and type of delivery and the study highlighted that both teenage and elder mothers had more chance to interrupt exclusive feeding as compared to younger mothers (Iqbal et al., 2017a, b). The dietary data on children are subject to recall errors on the mother's part, and a mother may not be able to report fully on a child's intake of food and liquids in case the child was fed by other than the mother during the period.

This study has a number of advantages, including the use of the most recent nationally representative data from India, Nepal and Bangladesh which made the study relevant, and the robust estimates of the variables under consideration provided by the large-scale dataset. This study fills gaps in the literature by comparing the most recent two DHS rounds. The cross-sectional nature of the data in our study prevented us from drawing any conclusions about causality. The causal relationship between feeding practices, MCH services, and different socioeconomic characteristics needs to be investigated through longitudinal research.

Limitations

When interpreting the study's findings, various methodological limitations need to be taken into account. First, because the survey's data was derived from interviews with mothers and their subjective responses, recall bias could have an impact on the findings. To lessen the potential impact of recall bias on the observed association, the analyses were limited to the most recent child who was alive and residing with the respondent. Second, the mother reported recalling the number of ANC visits, which may have been exaggerated or understated. The association between the frequency of ANC visits and feeding practices may then be underestimated or overestimated as a result, which could result in measurement bias. Third, we were unable to evaluate all potential confounding variables, including family support systems and dynamics, the kinds of regional foods and cultural practices related to feeding, the knowledge of feeding practices among health workers.

The relationship between the exposure and outcome variables may be impacted by this. Last but not least, the use of cross-sectional data, where both the exposure and outcome variables were collected concurrently, makes it impossible to establish a temporal association in this study. The study has advantages despite these drawbacks. The most recent DHS data that was nationally representative were used in this study. In comparison to earlier national surveys, the DHS data were collected from a larger sample, indicating that our findings are more representative of the Indian population and should be used to inform current, evidence-based policy interventions. Given that they were gathered by trained personnel who used standardized questionnaires and methodology, the data used are comparable across regions of the nation.

Conclusion

Our study presents important findings on infant and young child feeding practices and their associated maternal factors among mothers of under 5 years children in selected countries. In comparison to mothers without formal education, mothers from poorer households, and mothers who made no maternal health care services visits, mothers with higher education, mothers from wealthier households, and mothers who frequently visited for ANC and PNC services were more likely to have appropriate feeding practices. Evidence shows that Maternal and Child Health (MCH) services improve maternal and child health across different socio-economic group, nonetheless there is a wide variation within the socioeconomic group as well as country. Understanding of this variation within different groups and

countries would require a detailed study of inequality in dietary feeding practices for further overall improvement in MCH services. Accessibility of Maternal and Child Health care services improve exposure of women about different and healthy ways of child feeding practices. Therefore, this study recommends for better implementation of healthcare setting–based interventions to promote child feeding practices across the selected South Asia countries.

Author Contribution The first author conducted the study as part of his PhD thesis. The second author mentored and the third and fourth authors provided guidance to the first author in writing this paper, and did review and editing. All authors have read and approved the final manuscript.

Availability of Data and Materials The study uses a secondary source of data that is freely available in the public domain through: https://dhsprogram.com/data/available-datasets.cfm

Declarations

Ethics Approval and Consent to Participate This study uses the secondary data which is available at request in the public domain on the measure DHS website and a prior consent was taken from the respondents before their interviews. The Institutional Review Board of ICF International and the relevant human subject committees in each country approved the data collection procedures. The protocol was also reviewed by the U.S. Centers for Disease Control and Prevention (CDC).

Conflict of Interest The authors declare no competing interests.

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Authors and Affiliations

Brajesh[1] · Chander Shekhar[2] · Mukesh Ranjan[3] · Sonpa Vishwakarma[4]

Chander Shekhar
shekharc@iipsindia.ac.in

Mukesh Ranjan
mukeshranjan@pucollege.edu.in

Sonpa Vishwakarma
drsonpavishwakarma@gmail.com

[1] Department of Statistics, Kishinchand Chellaram College, Churchgate, Mumbai 400020, Maharashtra, India

[2] Department of Fertility and Social Demography, International Institute for Population Sciences (IIPS), Mumbai 400088, Maharashtra, India

[3] Department of Statistics, Pachhunga University College, Mizoram University (A Central University), Aizawl, Mizoram 796001, India

[4] Guru Prasad Homeopathic Clinic, Parri, Bhaiyyathan Road, Surajpur, Chhatisgarh 497229, India