Social Science Spectrum ISSN 2454-2806
Vol. 12, No. 1, March 2026, pp. 1-18

The role of breastfeeding practices in nutritional outcomes among infants and children, Uttar Pradesh, India

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Abstract

Child undernutrition and anaemia remain major public health concerns in India, especially in Uttar Pradesh. The present study assesses trends in optimal breastfeeding indicators and nutritional outcomes among children in Uttar Pradesh by using the National Family Health Survey (NFHS) data. However, it utilised data from the latest round of NFHS to assess the relationship between optimal breastfeeding practices. Bivariate analysis, chi-square tests, and multiple regression models were applied to estimate associations and adjusted odds ratios. Results show that exclusive breastfeeding was significantly associated with higher odds of stunting (AOR: 1.16) and underweight (AOR: 1.14), but not with wasting. Similarly, the minimum acceptable diet showed no statistically significant association with nutritional outcomes. Adjusted analyses yielded significant odds ratios across all models, with consistent evidence of protective or adverse associations. In the EBF model, the odds of wasting (AOR = 1.04; 95% CI: 0.90–1.20) were not statistically significant. Similar non-significant patterns were observed across all outcomes in the MAD model, including anaemia. These results suggest that while breastfeeding practices are important, they alone may not substantially influence nutritional outcomes. Broader socioeconomic, maternal, and child care determinants appear to play a more critical role. The study highlights the need for integrated interventions addressing structural factors, alongside promoting optimal feeding practices, to effectively reduce undernutrition and anaemia in young children.

Keywords: Breastfeeding, nutritional outcomes, anaemia, optimal breastfeeding practices, Uttar Pradesh.

I. Introduction

Child undernutrition and anaemia remain major public health concerns in low- and middle-income countries (LMICs), particularly in India and more so in the Empowered Action Group (EAG) States such as Uttar Pradesh. Globally, undernutrition indicators in children, such as stunting, wasting, underweight and anaemia, contribute to about half of all deaths among children under five years of age (Black et al., 2008; Black et al., 2013). Recent estimates indicate that 149.2 million children are stunted and 45.4 million are wasted worldwide, with a disproportionate burden concentrated in South Asia (WHO, 2021b).

Improving child survival and nutritional outcomes is primary to the global development agenda. Under Target 3.2 of the Sustainable Development Goals (SDGs), the United Nations (UN) aims to end preventable deaths of new-born's and children under-5 years of age by 2030 with all countries aiming to reduce neonatal mortality to 12 and under-5 mortality to 25 per thousand live births (U.N., n.d.). As per UNICEF (2023), globally the neonatal mortality and under-5 mortality rates are 18 and 38 deaths per 1,000 live births respectively. In India, the EAG states, such as Uttar Pradesh, continue to experience a high burden of child undernutrition and mortality. Despite improvements over time, the state reports higher levels of under-five and neonatal mortality

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compared with the national estimates (IIPS & ICF, 2021). These outcomes are shaped by a complex interplay of socioeconomic conditions, healthcare access, maternal characteristics and early-life feeding practices.

Optimal breastfeeding practices are widely recognized for their numerous benefits for both infants and mothers. For infants, breast milk is considered the ideal source of nourishment across diverse settings when provided in recommended durations, as it delivers essential nutrients and protective antibodies that constitute the new-born's first line of immune defence. For mothers, breastfeeding facilitates faster postpartum recovery, reduces the risk of certain cancers and contributes to natural birth spacing. Notably, breastfeeding prolongs postpartum amenorrhea through the mechanism of lactational infertility, thereby delaying the return of fertility and increasing the interval between successive births, ultimately supporting improved maternal and child health outcomes (WHO, 2023). These optimal practices are typically assessed through key indicators such as early initiation of breastfeeding (EIBF), exclusive breastfeeding (EBF) and appropriate complementary feeding (CF) which together reflect the adequacy of feeding practices among infants.

Early initiation of breastfeeding (EIBF) and exclusive breastfeeding (EBF) provide essential nutrients and immunological protection during the most vulnerable stages of life. EIBF is defined as feeding breast milk within the first hour of birth, ensuring that infants receive colostrum, the first milk produced by the mother after birth which is empirically found to be rich in nutrients and contains protective antibodies. EIBF plays a vital role in protecting new-born health by reducing the risk of illnesses such as diarrhoea, neonatal sepsis and pneumonia, and also strengthening the emotional bond between the mother and infant simultaneously (Berde & Yalcin, 2016; Debes et al., 2013; Shane et al., 2017). Some studies also indicated that EIBF contributes significantly to neonatal survival and increases the likelihood of exclusive breastfeeding continuation (Debes et al., 2013; Shane et al., 2017).

Exclusive breastfeeding (EBF) for the first six months of life is widely recommended as the optimal infant feeding practice, followed by continued breastfeeding alongside appropriate complementary feeding (CF) until the age of two years and beyond (WHO & UNICEF, 2023). After six months, CF becomes essential to meet the increasing nutritional needs of the child. It involves the introduction of solid, semi-solid and soft foods while continuing breastfeeding (WHO, 2021a). Ensuring appropriate CF is crucial for optimal growth, development, and prevention of malnutrition among children globally. It should be introduced between six and eight months of age, as both early and delayed introduction can increase the risk of undernutrition, infections and growth faltering. However, many children do not receive adequate and timely complementary feeding, both in terms of dietary diversity and feeding frequency. The World Health Organization (WHO) recommends the Minimum Acceptable Diet (MAD) as a composite indicator that captures both minimum dietary diversity and minimum meal frequency, serving as a key measure of appropriate complementary feeding practices (WHO, 2021a).

The relationship between breastfeeding practices and child nutritional outcomes operates through interconnected pathways involving nutrient intake, infection risk and feeding adequacy. While EBF improves immunity and reduces the risk of early-life infections, continued breastfeeding without adequate complementary feeding may result in inadequate caloric and micronutrient intake. Empirical evidence on the association between breastfeeding and child nutritional outcomes remains mixed. These inconsistencies in associations may be explained by factors such as reverse causality where undernourished children are generally breastfed for longer durations by mothers, as well as variations in complementary feeding practices, socioeconomic conditions and healthcare access.

Given the complex and context-dependent nature of these relationships, there is a need for a comprehensive assessment that simultaneously considers aspects of breastfeeding practices and their association with child nutritional outcomes within a broader socioeconomic context for designing effective interventions in high-burden settings such as Uttar Pradesh. Therefore, the aim of the present study was to assess the role of breastfeeding practices in physical growth and anaemia among

infants and children in Uttar Pradesh. In order to meet the same, specific objectives were (a) to assess the prevalence and patterns of optimal breastfeeding practices and nutritional outcomes, (b) to identify socioeconomic, demographic and maternal determinants of nutritional outcomes, and (c) to assess the role of optimal breastfeeding practices and key covariates in nutritional outcomes.

II. Materials and methods

Data source

This study utilized data from multiple rounds of the National Family Health Survey (NFHS), a large-scale, nationally representative survey conducted under the stewardship of the Ministry of Health and Family Welfare (MoHFW), Government of India (GOI), and the International Institute for Population Sciences (IIPS), Mumbai, serving as the nodal agency. The NFHS is a part of the Demographic and Health Surveys (DHS) programme, implemented by ICF (a U.S.- based organization) and funded primarily by the United States Agency for International Development (USAID) with survey indicators harmonised to international standards including those recommended by WHO. NFHS provides comprehensive information on population, health and nutrition at the national, state, union territory and district levels.

Data from five rounds of NFHS – 1, 1992-93; 2, 1998-99; 3, 2005-06; 4, 2015-16 and 5, 2019-21 were used to examine the trends in optimal breastfeeding practices and child nutritional outcomes over time (IIPS, 1995, 2000, 2007, 2017, 2021). For the assessment of associations, data from the most recent round (NFHS-5) were utilized. The analysis utilizes data from the Kids Recode (KR) file, which contains information on children born in the five years preceding the survey. The studied population includes children aged 0–23 months in Uttar Pradesh as it represents a critical window for optimal breastfeeding practices including early initiation of breastfeeding, exclusive breastfeeding, and the timely introduction of complementary feeding. These practices are specifically defined for children under two years of age and have the most immediate and profound impact on growth, development and nutritional outcomes during this stage (WHO & UNICEF, 2021b). Evidence suggests that the first two years of life constitute a "window of opportunity" for preventing undernutrition, as growth faltering, stunting, and micronutrient deficiencies largely originate during this period (Victora et al., 2021). In contrast, children aged 24–59 months are less directly influenced by breastfeeding practices as they transition to family foods and are increasingly affected by environmental, dietary and socioeconomic factors. Therefore, combining these age groups may mask the true association between breastfeeding practices and undernutrition. Analysing children aged 0–23 months separately enables a more precise understanding of the effects of feeding practices, while a different analytical approach is more appropriate for children aged 24–59 months to capture post-infancy determinants of nutritional status.

Anthropometric measurements, including height and weight, were collected using standardized procedures and equipment (SECA scales), while haemoglobin levels were assessed using the HemoCue Hb 201+ analyser from capillary blood samples obtained through finger or heel prick, following informed consent from caregivers. A total of 13,472 children aged 0–23 months were initially included in the dataset. For analyses related to different aspects of breastfeeding practices, subsamples were defined based on the outcome and exposure variables. Exclusive breastfeeding (EBF) analysis was restricted to children aged 0–5 months. The number of children in this age group was 3,867, reduced to 3,628 after accounting for 239 missing values. Complementary feeding practices (CF) analysis was restricted to 6-23 months. The number of children in this age group was 9,574, reduced to 9,214 after accounting for 360 missing values.

Nutritional outcomes (stunting, wasting, and underweight) were assessed among children aged 0–23 months. The number of children in this age group was 13,472, reduced to 12,111 for stunting, 11,756 for wasting, and 12,589 for underweight after accounting for missing values of 1,361 in stunting, 1,716 in wasting and 883 in underweight. Anaemia analysis was available for 6-23 months.

The number of children in this age group was 9,574, reduced to 8,365 after accounting for 1,209 missing values.

Dependent variables

Child nutritional outcomes were assessed using physical growth outcomes categorised as stunting, wasting, and underweight, as well as anaemia, which were considered the primary outcome variables. Physical growth was assessed using three standard anthropometric indices based on the WHO in 2006 Child Growth Standards. These included stunting (height-for-age z-score (HAZ) < −2 SD), wasting (weight-for-height z-score (WHZ) < −2 SD), and underweight (weight-for-age z-score (WAZ) < −2 SD), measured among children aged 0–23 months. Anaemia status was assessed among children aged 6–23 months using haemoglobin concentration; children were classified as anaemic if haemoglobin levels were less than 11 g/dl.

All outcome variables were dichotomized as binary variables 0 indicated absence of the condition [no stunting, no wasting, no underweight] above cut-off values (>-2SD, >-3SD), [non-anaemic] above cut-off values (>11 gram per decilitre (g/dl)) and 1 indicated its presence [stunted/severely stunted, wasted/severely wasted, underweight/severely underweight] below cut off values (<-2SD, <-3SD), [anaemic] below cut-off values (<11 gram per decilitre (g/dl)).

Independent variables

Optimal breastfeeding practices were considered as the main exposure variables. These included early initiation of breastfeeding (EIBF), exclusive breastfeeding (EBF) and complementary feeding (MAD) practices.

(a) *Early initiation of breastfeeding:* The study computes this variable by identifying children born within two years before the survey who were breastfed within the first hour after birth.

(b) *Exclusive breastfeeding:* This variable is measured by identifying children born within two years before the survey who were exclusively breastfed for six months, meaning they received only breast milk and no other liquids or solids including water.

(c) Complementary feeding adequacy was assessed using the minimum acceptable diet (MAD) indicator among children aged 6–23 months. MAD is a composite indicator developed by the WHO and UNICEF combining minimum dietary diversity (MDD) and minimum meal frequency (MMF). A child was considered to have received a MAD if both criteria were met during the 24 hours preceding the survey. MDD was defined as consumption of foods from at least five out of eight food groups, while MMF referred to the minimum number of age-appropriate feedings based on breastfeeding status. Children meeting both criteria were classified as receiving a MAD, and others as not receiving a MAD.

Covariates

A range of socio-demographic, maternal, and child-level characteristics were included as potential covariates. These included maternal factors (body mass index and education), child characteristics (age, sex, birth order, and perceived birth size), and household characteristics (wealth index, religion and place of residence). In addition, healthcare-related factors such as place of delivery, mode of delivery (caesarean section), postnatal care and number of antenatal care (ANC) visits were also considered.

Statistical analysis

All statistical analyses were conducted using Stata (StataCorp LLC, 2023). Sampling weights and the complex survey design of NFHS were accounted for using the 'svy' command to obtain

representative estimates. Descriptive statistics were first used to summarize the socio-demographic characteristics of the studied population. Bivariate analysis was performed to assess the association of outcome variables with socio-economic, demographic and maternal factors.

In order to assess the significance of association, chi-square test was applied at 5 per cent level of significance. Subsequently, to account for reverse confounding, the variables significant at 10 per cent level were selected for multiple regression. Finally, multiple regressions were performed to identify the factors independently associated with nutritional outcomes. Two separate multiple regression models were employed. The selection of these models was based on the age-specific relevance of breastfeeding indicators. The first model assessed the association between EBF and the three physical growth outcomes among infants aged 0–5 months, as EBF is a critical indicator recommended by the WHO for optimal infant nutrition and immunity during early life. The second model evaluated the association between complementary feeding and all the nutritional outcomes among children aged 6–23 months. MAD reflects both dietary diversity and meal frequency, capturing the adequacy of complementary feeding practices. Adjusted odds ratios (AORs) along with 95 per cent confidence intervals (CIs) were estimated.

III. Results

A total of 13,472 mothers with a last-born child aged 0-23 months at the time of the survey were included in the analysis. Nearly, two-thirds of the mothers (61%) had attained secondary or higher education. Socioeconomic characteristics revealed that half of the mothers belonged to the lowest wealth quintile and a large majority (84.3%) resided in rural areas highlighting a predominantly rural, economically disadvantaged sample, whereas 82 per cent were Hindu. Similarly, two-thirds (64%) of the mothers had normal BMI and more than half (58%) had birth order 2 or 4, indicating high fertility levels. Regarding maternal healthcare utilization, 41.8 per cent mothers reported at least four antenatal care (ANC) visits, while a substantial proportion (86.4%) of deliveries occurred in health facilities, reflecting improved institutional care coverage. A majority of deliveries (86.6%) were vaginal and the sex distribution of children was approximately equal. A majority of children were between 0 and 5 months of age. Most mothers (71%) perceived their child's birth size as average suggesting relatively normal birth outcomes (Table 1).

Breastfeeding practices in Uttar Pradesh and India

According to the WHO, a prevalence of 0–29 per cent is considered poor, 30–49 per cent fair, 50–89 per cent good and 90–100 per cent very good. The percentage of children ever breastfed was almost universal in India and in Uttar Pradesh, but only 76 per cent approx. were early initiated within one hour of birth in India, whereas in the state it is lower but good at 67 per cent, indicating relatively good adherence according to WHO benchmarks. However, optimal feeding practices beyond initiation were lower. The exclusive breastfeeding (EBF) prevalence was modest at 67 per cent and 63 per cent in India and Uttar Pradesh respectively. While the MAD among children ages 6-23 months was critically low, at 9.6 per cent in India and only 5.1 per cent in Uttar Pradesh, reflecting poor complementary feeding practices (Figure 1).

The proportion of children ever breastfed remained consistently high in both India and Uttar Pradesh across all survey rounds, exceeding 97 per cent indicating near-universal breastfeeding practices. EIBF showed a substantial increase over time. In India, EIBF improved from 13.1 per cent in 1992–93 to 76.0 per cent in 2019–21. A similar but more pronounced improvement was observed in Uttar Pradesh where EIBF increased from 6.3 per cent to 67.2 per cent over the same period, reflecting progress, particularly after 2005–06. EBF in India exhibited stability till 2005-06 and an increasing trend thereafter. It increased from 44.4 per cent in 1992–93 to 67.1 per cent in 2019–21 with a notable rise after 2005–06.

In Uttar Pradesh, EBF declined between 1992–93 (54.6%) and 2015–16 (43.7%), followed by a marked improvement to 63.6 per cent in 2019–21. Complementary feeding, measured using

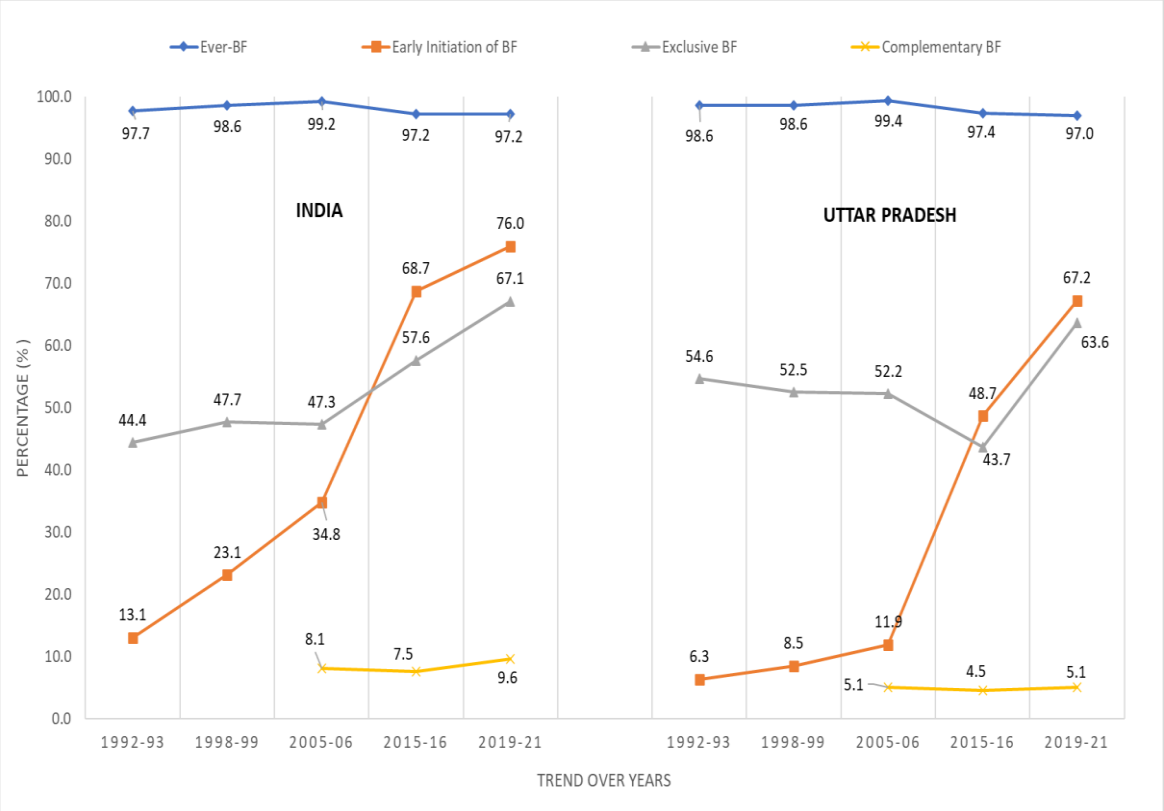
Table 1: Distribution of the sample by socio-demographic and economic characteristics in Uttar Pradesh (2019-21)

Category	Percentage	Total
Maternal characteristics		
Educational level		
No education	25.3	3,499
Primary	13.1	1,760
Secondary	43.3	5,872
Higher	18.3	2,341
BMI of mother		
Underweight (<18.5)	17.3	2,382
Normal (18.5–24.9)	63.1	8,623
Overweight (25–29.9)	12.1	1,567
Obese (≥30)	7.6	900
Household characteristics		
Wealth index		
Poor	50.4	7,119
Middle	18.7	2,558
Rich	30.9	3,795
Religion		
Hindu	81.6	11,080
Muslim	18.0	2,349
Others	0.4	43
Residence		
Urban	20.1	2,069
Rural	79.9	11,403
Child characteristics		
Sex of child		
Male	50.9	6,951
Female	49.1	6,521
Age of child		
0-5	28.7	3,898
6-11	22.8	3,021
12-17	26.8	3,619
18-23	21.7	2,934
Birth size		
Small	11.3	1,512
Regular	70.9	9,541
Large	16.8	2,291
Don’t know	1.1	128
Birth order		
1st	34.2	4,616
2-4	58.2	7,764
5 or above	7.6	1,092
Healthcare characteristics		
ANC visits		
No ANC visits	4.6	596
1-3	52.6	6,864
4+	42.6	5,377
Don't know	0.2	32
Delivery site		
Home/Non-institutional delivery	13.7	1,837
At health facility	86.3	11,635
Delivery type		
Normal	84.3	11,533
Caesarean section	15.7	1,939
Total	100	13,472

minimum acceptable diet (MAD), remained consistently low. In India MAD increased only marginally from 8.1 per cent in 2005–06 to 9.6 per cent in 2019–21. Similarly, in Uttar Pradesh,

MAD levels remained low, decreasing slightly from 5.1 per cent to 4.5 per cent from 2005-06 to 2015-16 and increasing again to 5.1 per cent in 2019-21 indicating minimal or no actual improvement in appropriate complementary feeding practices**.**

Figure 1: Percentage of different components of optimal breastfeeding practices in India & Uttar Pradesh (1992-2021).



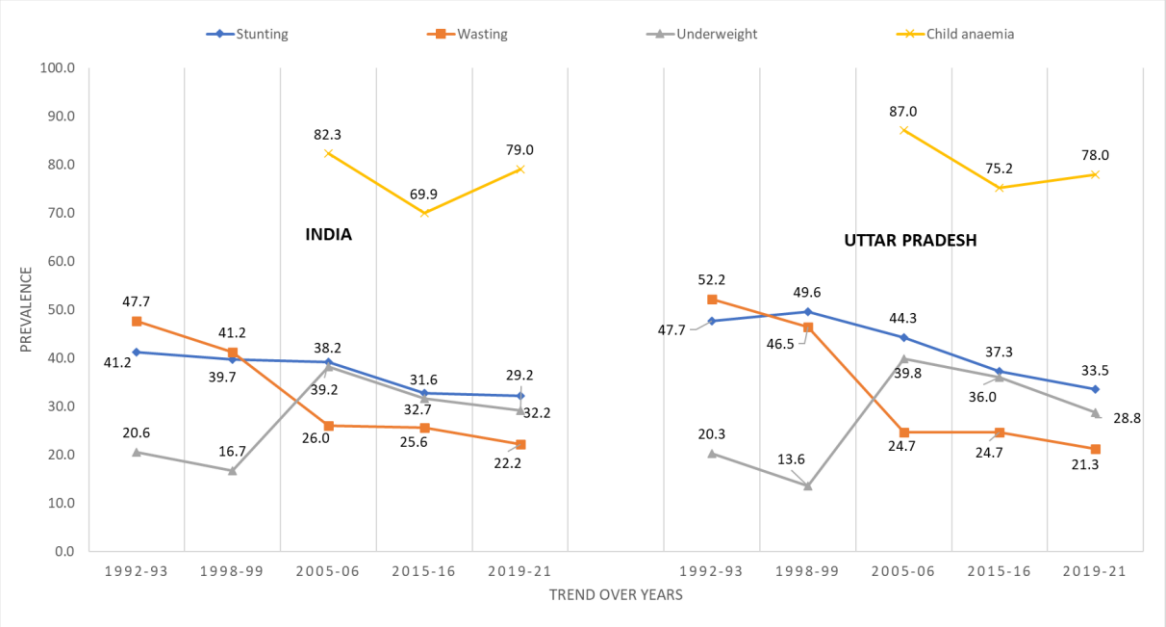
Note: Exclusive breastfeeding was calculated among children aged 0-5 months and MAD among children aged 6-23 months as per WHO guidelines; MAD: WHO 2021 compliant; Complementary feeding information is available from 2005 onwards.

Nutritional outcomes among children in Uttar Pradesh

In India the prevalence of stunting (32.2%), wasting (22.2%), and underweight (29.2%) indicates a substantial burden of both chronic and acute malnutrition. Similar patterns were observed in Uttar Pradesh with stunting (33.5%), wasting (21.3%) and underweight (28.8%). Childhood anaemia before the age of two years was alarmingly high, affecting 79 per cent children in India and 78 per cent in Uttar Pradesh (Figure 2).

Stunting showed a steady decline over time in both India and Uttar Pradesh. In India, it decreased from 41.2 per cent in 1992–93 to 32.2 per cent in 2019–21. Uttar Pradesh experienced a greater decline from 47.7 per cent to 33.5 per cent. The levels remained higher than the national average. Wasting, an indicator of acute malnutrition, declined sharply between 1992–93 and 2005–06, and showed a gradual reduction thereafter. In India, wasting decreased from 47.7 per cent to 22.2 per cent, while in Uttar Pradesh it declined from 52.2 per cent to 21.3 per cent. The prevalence of underweight children showed an overall declining trend in recent years. In India, they increased from 20.6 per cent in 1992–93 to 38.2 per cent in 2005–06, then declined steadily to 29.2 per cent in 2019–21. A similar pattern was observed in Uttar Pradesh with levels declining from 39.8 per cent in 2005–06 to 28.8 per cent in 2019–21. Childhood anaemia (6–23 months) showed a non-linear trend. In India, anaemia decreased from 82.3 per cent in 2005–06 to 69.9 per cent in 2015–16, but increased again to 79.0 per cent in 2019–21. A similar pattern was observed in Uttar Pradesh, where anaemia declined from 87.0 per cent to 75.2 per cent, followed by an increase to 78.0 per cent.

Figure 2: Prevalence (%) of the nutritional outcomes in India and Uttar Pradesh (1992–2021)



Note: Child anaemia information is available from 2005 onwards.

Association between breastfeeding practices and nutritional outcomes

Bivariate analysis examined the crude associations between breastfeeding practices, selected covariates and child nutritional outcomes in Uttar Pradesh (Table 2). EIBF showed a statistically significant association with stunting and underweight ($p < 0.01$), whereas no significant association was observed with wasting or anaemia. EBF was significantly associated with stunting and wasting ($p < 0.01$), but not with underweight. MAD did not show a statistically significant association with any of the nutritional outcomes.

Among maternal factors, both maternal education and body mass index (BMI) were significantly associated with stunting, wasting, and underweight ($p < 0.01$) with lower prevalence of undernutrition observed among children of more educated mothers and those with better maternal nutritional status. Birth order was also significantly associated with stunting, wasting and underweight with higher-order births exhibiting a higher prevalence of undernutrition. Child characteristics demonstrated strong associations with nutritional outcomes. Sex of the child was significantly associated with all outcomes with male children exhibiting a higher prevalence of undernutrition and anaemia. Age of the child showed a significant relationship with all outcomes ($p < 0.01$) with stunting and underweight increasing with age while wasting declined among older children.

Household wealth index showed a strong inverse association with all anthropometric outcomes ($p < 0.01$) indicating a lower prevalence of undernutrition among children from wealthier households. Similarly, caste and place of residence were significantly associated with stunting and underweight with higher prevalence in rural areas and among disadvantaged social groups. Religion showed a significant association with wasting and underweight, but not with stunting or anaemia. Among healthcare utilization factors, place of delivery and mode of delivery were significantly associated with stunting, wasting and underweight, while caesarean delivery was significantly associated with childhood anaemia ($p < 0.05$). Antenatal care visits were significantly associated with stunting and anaemia. Overall, no consistent significant association was observed between breastfeeding practices and childhood anaemia in the bivariate analysis.

Table 2: Prevalence (%) of nutritional outcomes according to socio-economic, demographic and maternal factors, Uttar Pradesh, 2019-21.

	Stunting		Wasting		Underweight		Anaemia	
Exposure variables	%	Total	%	Total	%	Total	%	Total
Ever breastfed								
No	27.5	339	22.4	339	27.2	357	78.6	234
Yes	33.1	11,216	21.6	10,873	28.7	11,669	77.6	7,613
p-value@	*0.132*		*0.638*		*0.248*		*0.414*	
Early initiation of breastfeeding								
No	30.4	3,535	21.4	3,421	26.7	3,670	78.1	2,397
Yes	34.5	7,685	21.7	7,456	29.7	8,003	77.3	5,219
p-value@	*0.01**		*0.223*		*<0.01**		*0.621*	
Exclusive breastfeeding								
No	22.6	1,123	27.4	1,062	28.1	1,198	**NA**	
Yes	24.6	2,052	26.7	1,881	27.9	2,188		
p-value@	*0.01**		*0.01**		*0.66*			
Complementary feeding (MAD)								
No	36.9	7,922	19.4	7,833	29.0	8,160	77.6	7,595
Yes	36.0	456	18.3	445	27.6	468	78.5	439
p-value@	*0.801*		*0.85*		*0.86*		*0.639*	
Maternal characteristics								
Mother's education								
No education	39.8	3,102	24.4	3,000	34.5	3,227	80.0	2,199
Primary	36.5	1,607	21.5	1,553	32.4	1,661	79.0	1,097
Secondary or Higher	30.3	7,402	19.9	7,203	25.7	7,701	76.9	5,069
p-value@	*0.01**		*0.01**		*0.01**		*0.05**	
BMI								
Underweight	41.4	2,218	24.6	2,181	37.7	2,308	80.0	1,699
Normal	33.2	7,986	21.8	7,719	28.4	8,295	77.8	5,456
Overweight	25.8	1,466	16.1	1,430	20.6	1,523	75.7	934
Obese	27.2	441	13.8	426	20.3	463	77.8	276
p-value@	*0.01**		*0.01**		*0.01**		*0.074*	
Birth order								
1	31.1	4,158	19.3	4,030	26.2	4,325	77.4	2,882
2-4	34.1	6,967	22.3	6,764	29.6	7,247	78.1	4,831
5 or above	39.6	986	22.3	962	33.9	1,017	79.8	652
p-value@	*0.01**		*0.05**		*0.01**		*0.218*	
Child characteristics								
Gender								
Male	35.9	6,222	22.2	6,029	31.3	6,479	79.7	4,363
Female	31.1	5,889	20.3	5,727	26.2	6,110	76.2	4,002
p-value@	*<0.01**		*<0.05**		*<0.01**		*<0.01**	
Age of child (in months)								
0-5	24.0	3,394	27.2	3,150	28.5	3,623		
6-11	26.1	2,714	23.0	2,653	27.0	2,817	74.5	2,536
12-17	38.6	3,301	17.9	3,286	27.3	3,398	80.4	3,209
18-23	46.6	2,702	16.6	2,667	32.8	2,751	78.4	2,620
p-value@	*0.01**		*0.01**		*0.01**		*0.01**	
Birth size								
Small	39.6	1,377	23.1	1,337	36.5	1,429	78.4	916
Regular	32.2	8,592	20.8	8,355	27.4	8,927	77.3	5,958
Large	34.5	2,029	21.5	1,955	29.0	2,118	80.6	1,406
don't know	36.8	113	26.7	109	37.1	115	78.9	85
p-value@	*0.01**		*0.121*		*<0.01**		*0.146*	
Household factors								
Wealth Index								
Poor	38.9	6,416	24.0	6,241	34.0	6,673	79.1	4,435
Middle	32.0	2,313	19.3	2,241	27.1	2,400	77.3	1,617
Rich/	25.4	3,382	18.0	3,274	21.1	3,516	76.4	2,313
p-value@	*0.01**		*0.01**		*0.01**		*0.146*	

Community variables								
Religion								
Hindu	33.3	10,046	20.9	9,775	28.2	10,418	78.0	6,968
Muslim	34.3	2,023	23.3	1,940	31.6	2,128	77.9	1,368
Others	33.1	42	9.0	41	14.1	43	62.8	29
p-value@	*0.52*		*0.05**		*0.01**		*0.93*	
Caste								
Schedule caste	37.4	3,280	22.9	3,209	32.2	3,401	78.5	2,282
Schedule tribe	45.4	218	25.9	210	39.9	226	74.1	157
OBC	33.0	6,617	21.3	6,378	28.4	6,868	77.9	4,532
None of the above	27.4	1,921	18.1	1,891	22.9	2,019	77.4	1,343
Don't know	32.2	30	14.2	26	22.7	29	92.3	18
p-value@	*0.01**		*0.01**		*0.01**		*0.232*	
Place of residence								
Urban	28.1	1,795	20.6	1,738	25.1	1,886	77.6	1,233
Rural	34.8	10,316	21.4	10,018	29.6	10,703	78.0	7,132
p-value@	*0.01**		*0.414*		*0.01**		*0.635*	
Health service factors								
Delivery site								
Non-institutional delivery	38.7	1,650	23.8	1,614	32.2	1,722	79.6	1,169
Institutional delivery	32.7	10,461	20.9	10,142	28.2	10,867	77.7	7,196
p-value@	*0.01**		*0.05**		*0.01**		*0.084*	
Type of delivery								
Normal	35.0	10,371	21.6	10,058	29.8	10,788	77.5	7,214
C-sec	25.6	1,740	19.2	1,698	22.9	1,801	80.9	1,151
p-value@	*0.01**		*0.01**		*0.01**		*0.05**	
No. of antenatal check-ups								
No ANC visits	36.6	527	22.5	520	29.6	556	85.7	376
1-3	34.7	6,182	20.8	6,036	29.8	6,425	76.8	4,200
4+	30.4	4,821	22.6	4,632	27.1	5,019	77.7	3,257
Don't know	44.2	29	14.3	28	21.2	30	81.2	17
p-value@	*0.01**		*0.179*		*0.098*		*<0.05**	

Note: @: chi-square test; * Significant at 5% level; Anaemia estimates for exclusive breastfeeding were not computed because anaemia assessment was not available/applicable for the corresponding age group.

The role of optimal breastfeeding practices in nutritional outcomes

Table 3a & 3b show the effect of Exclusive breastfeeding (EBF) and Early Initiation of Breastfeeding (EIBF) on children nutritional outcome among children aged 0-5 months in Uttar Pradesh. EIBF was significantly associated with increased odds of stunting (AOR: 1.14), but showed no significant association with wasting or underweight in the EBF model, whereas, in the MAD model, EIBF was not significantly associated with any of the nutritional outcomes including anaemia. The estimates were close to unity across all outcomes indicating minimal differences between children who did and did not receive EIBF. Overall, the findings from both models indicate that EIBF shows an inconsistent association with child nutritional outcomes after adjusting for maternal, socioeconomic and child-level characteristics.

Exclusive breastfeeding (EBF)

EBF during the first six months of life showed mixed associations with child nutritional outcomes in the EBF model. It was significantly associated with higher odds of stunting (AOR: 1.16) and underweight (AOR: 1.14), while no significant association was observed with wasting. Since EBF was included only in the EBF model, no corresponding estimates were observed in the MAD model. Overall, EBF had an independent association with child nutritional outcomes after adjusting for maternal, socio-economic and child-level factors.

Minimum acceptable diet (MAD)

MAD was examined in the MAD model and did not show a statistically significant association with any of the nutritional outcomes. The adjusted odds ratios were close to unity for stunting, wasting, underweight and anaemia. These findings indicate that, despite being an important indicator of child feeding adequacy, the MAD did not show an independent association with nutritional outcomes after controlling for potential confounders.

Maternal characteristics

Maternal education showed a consistent protective association with child undernutrition in both models. In the EBF model, secondary/higher maternal education was significantly associated with 15 per cent lower odds of stunting and 16 per cent lower odds underweight but was not significantly associated with wasting whereas in MAD model it was significantly associated with all the physical growth outcomes [stunting (AOR: 0.85); wasting (AOR: 0.84); underweight (AOR: 0.76)] but not with childhood anaemia.

Maternal BMI emerged as one of the strongest predictors across both models. In the EBF model, children of mothers with normal and overweight BMI had 19 per cent and 31 per cent lower odds respectively of being stunted. Chances of children being stunted decreased with increasing maternal BMI although stunting in children was not significantly associated with obesity in mothers. Wasting and underweight in children decreased with increasing maternal BMI. The more the weight of the mothers, the less the chances of their children being wasted and underweight. Children were 15 per cent, 40 per cent and 48 per cent less likely to be wasted for mothers in the normal, overweight and obese categories respectively compared with children of mothers who were underweight. Similarly, children of mothers in the normal, overweight and obese categories were 29 per cent, 46 per cent and 44 per cent less likely to be underweight respectively. In the MAD model, children of mothers with normal and overweight BMI had 22 per cent and 33 per cent lower odds respectively of being stunted. Chances of being stunted decreased with increasing maternal BMI, although no significant association was found between stunting in children and obese mothers. Wasting and underweight in children decreased with increasing maternal BMI. The more the weight of the mothers, the less the chances of their children being wasted and underweight. Children were 24 per cent, 40 per cent and 43 per cent less likely to be wasted for mothers in the normal, overweight and overweight categories respectively compared with children of mothers who were underweight. Similarly, children of mothers in the normal, overweight and obese categories were 32 per cent, 54 per cent and 50 per cent less likely to be underweight respectively. There was a significant association between overweight mothers with 23 per cent lower odds of their children being anaemic.

In the MAD model (table 3b), children with birth order two to four showed a positive association with stunting, wasting and undernutrition but not with childhood anaemia. Children whose birth order was two to four had 16 per cent higher odds of being stunted, 19 per cent higher odds of being wasted and 23 per cent higher odds of being underweight whereas children with birth order of five or more were significantly associated with 41 per cent higher odds of stunting whereas the association was on the higher side with wasting, underweight and anaemia but not statistically significant. The more the birth order, the chances of stunting increase. In the EBF model, birth order was not associated with any of the physical growth outcomes.

Child characteristics

Sex of the child was significantly associated with all outcomes in the MAD model with lower odds observed for one sex (likely females) including stunting (AOR: 0.80), wasting (AOR: 0.80), underweight (AOR: 0.77) and anaemia (AOR: 0.82). In the EBF model, sex was significantly associated with stunting (AOR: 0.81), meaning females had 19 per cent lower odds of stunting and 21 per cent lower odds of being underweight (AOR: 0.79), but not associated with wasting.

Table 3a: Adjusted odds ratio along with 95% confidence interval of child nutritional outcomes with EBF and EIBF among children aged 0-5 months in Uttar Pradesh, 2019-21 (EBF Model)

Variable	Stunting	Wasting	Underweight
Exclusive breastfeeding			
No®	1	1	1
Yes	1.16 (1.02–1.31) *	1.04 (0.90–1.20)	1.14 (1.01–1.30) *
Early initiation of breastfeeding			
No ®	1	1	1
Yes	1.14 (1.01-1.27) *	0.94 (0.83–1.08)	1.07 (0.95–1.21)
Maternal characteristics			
Mother's education			
No education ®	1	1	1
Primary	0.93 (0.79–1.10)	0.85 (0.71–1.02)	0.97 (0.84–1.13)
Secondary or higher	0.85 (0.75–0.96) *	0.89 (0.77–1.02)	0.84 (0.74–0.96) *
Maternal BMI			
Underweight ®	1	1	1
Normal	0.81 (0.71–0.92) *	0.85 (0.74–0.98) *	0.71 (0.63–0.81) *
Overweight	0.69 (0.57–0.83) *	0.60 (0.48–0.75) *	0.54 (0.44–0.66) *
Obese	0.79 (0.59–1.07)	0.52 (0.36–0.75) *	0.56 (0.41–0.76) *
Birth order			
1®	1	1	1
2–4	1.04 (0.93–1.16)	1.12 (0.99–1.26)	1.00 (0.89–1.11)
≥5	1.11 (0.92–1.35)	0.92 (0.74–1.15)	1.02 (0.84–1.23)
Child characteristics			
Sex of child			
Male®	1	1	1
Female	0.81 (0.74–0.89) *	0.90 (0.81–1.01)	0.79 (0.72–0.87) *
Age of child			
0–5 months®	1	1	1
6–11 months	1.19 (1.03–1.37) *	0.80 (0.68–0.93) *	0.96 (0.84–1.11)
12–17 months	2.32 (1.99–2.69) *	0.60 (0.50–0.70) *	1.05 (0.91–1.22)
18–23 months®	3.10 (2.65–3.63) *	0.58 (0.49–0.70) *	1.36 (1.17–1.60) *
Child size at the time of birth			
Small ®	1	1	1
Regular	0.71 (0.61–0.83) *	0.92 (0.77–1.10)	0.68 (0.58–0.79) *
Large	0.77 (0.64–0.94) *	0.95 (0.77–1.17)	0.71 (0.59–0.86) *
Household characteristics			
Wealth index			
Poor ®	1	1	1
Middle	0.81 (0.71–0.93) *	0.81 (0.71–0.93) *	0.79 (0.69–0.90) *
Rich	0.65 (0.56–0.75) *	0.77 (0.65–0.91) *	0.63 (0.54–0.73) *
Religion			
Hindu ®	1	1	1
Muslim	1.14 (0.98–1.34)	1.25 (1.07–1.47) *	1.28 (1.10–1.49) *
Others	1.26 (0.53–3.03)	0.65 (0.21–2.01)	0.73 (0.28–1.90)
Caste			
SC®	1	1	1
ST	1.39 (0.99–1.96)	1.17 (0.75–1.84)	1.37 (0.95–1.98)
OBC	0.91 (0.81–1.03)	0.95 (0.83–1.09)	0.91 (0.81–1.03)
Residence			
Urban ®	1	1	1
Rural	0.99 (0.83–1.17)	0.89 (0.72–1.09)	0.93 (0.78–1.11)
Health service factors			
Place of delivery			
Non-institutional delivery®	1	1	1
Institutional delivery	0.93 (0.80–1.07)	0.94 (0.79–1.11)	1.03 (0.89–1.20)
Type of delivery			
Normal delivery®	1	1	1
C-section	0.89 (0.76–1.05)	0.98 (0.82–1.17)	0.94 (0.79–1.11)
ANC visits			
0 visits ®	1	1	1
1–3 visits	0.94 (0.75–1.19)	0.93 (0.69–1.25)	1.07 (0.83–1.36)
≥4 visits	0.83 (0.65–1.05)	1.12 (0.83–1.52)	1.02 (0.79–1.31)

Note: Figures in the parenthesis are confidence interval; Level of significance: *p < 0.05.

Age of child demonstrated a strong and consistent association in the MAD model. Children had 85 per cent and 160 per cent higher chances of being stunted at 12-17 months and 18-23 months of age respectively than at 6-11 months of age. However, wasting and anaemia in children were consistently decreasing with increasing age and were significantly associated. Children had 27 per cent and 33 per cent lower odds of being wasted at 12-17 months and 18-23 months respectively, whereas 43 per cent higher chances of being anaemic at 12-17 months. But chances of having anaemia decrease with increasing age to 24 per cent by age 18-23 months. In the EBF model, increasing age of children showed higher odds of stunting. Children aged 6-11 months had 19 per cent, 12-17 months had 132 per cent and 18-23 months had 210 per cent higher odds of being stunted, which were all significantly associated. Wasting was consistently decreasing with increasing age and was significant across all age groups. Children had 20 per cent, 40 per cent and 42 per cent lower odds of being wasted at 6-11 months, 12-17 months and 18-23 months respectively. Children in the age group of 18-23 months had a significantly 36 per cent higher chance of being anaemic than at an early age of life. Birth size shows statistically significant associations in both models. The direction also suggests that a normal and larger birth size is protective against stunting and underweight across both models.

Socio-economic factors

Household wealth index also showed a strong and consistent protective effect across both models. In the MAD model, children belonging to rich households were significantly associated with lower odds of stunting (AOR: 0.65), wasting (AOR: 0.64) and underweight (AOR: 0.59) but not with anaemia. An increasing wealth index decreases the chances of having lower physical growth outcomes, although wealth has no significant impact on improving child anaemia. Similar significant protective associations were observed in the EBF model for children from rich households for stunting (AOR: 0.65), wasting (AOR: 0.77), and underweight (AOR: 0.63). Religion was significantly associated with wasting and underweight in both models with higher odds observed among certain religious groups relative to the reference category, but an association was observed with stunting only in the MAD model. Caste did not show any significant association in the EBF model across all anthropometric outcomes, whereas in the EBF model children from the OBC category had 13 per cent lower odds of being stunted. Place of residence did not show a statistically significant association with any outcome in either model.

Healthcare utilization factors

Place of delivery did not show statistically significant associations in the MAD model and similarly in the EBF model. The type of delivery was not significantly associated with stunting, wasting, or underweight in either model. However, in the MAD model the type of delivery was only found significantly associated with 45 per cent higher odds of childhood anaemia. Antenatal care (ANC) visits were significantly associated with anaemia in the MAD model, where children of mothers who had 1-3 ANC visits were found to have 43 per cent lower odds of being anaemic (AOR: 0.57) and 40 per cent lower chances when mothers had four or more ANC visits. No significant associations were observed in the EBF model.

IV. Discussion

The present study examined breastfeeding practices and their association with child nutritional outcomes among children aged 0-23 months in Uttar Pradesh using data from NFHS (2019-2021). Previous evidence indicates that early introduction of supplementary feeding significantly increases the risk of wasting among infants (Kumar et al., 2020), while large-scale analyses using NFHS data highlight the broader socio-demographic determinants influencing breastfeeding practices across infancy (Reddy et al., 2023). This study adopts a comprehensive perspective by analysing the entire breastfeeding journey, including early initiation (colostrum feeding), exclusive breastfeeding during the first six months, and minimum acceptable diet (MAD).

Table 3b: Adjusted odds ratio (AOR) along with 95% confidence interval (CI) of child nutritional outcomes with MAD and EIBF, among children aged 6-23 months of age in Uttar Pradesh, 2019-21 (MAD Model).

Variable	Stunting	Wasting	Underweight	Anaemia
Minimum acceptable diet				
No®	1	1	1	1
Yes	0.87 (0.69–1.10)	0.98 (0.74–1.29)	0.98 (0.74–1.29)	1.05 (0.80–1.37)
Early initiation of breastfeeding				
No®	1	1	1	1
Yes	1.11 (0.98–1.27)	1.00 (0.86–1.16)	1.10 (0.96–1.25)	1.04 (0.90–1.19)
Maternal Characteristics				
Mother's education®				
No education	1	1	1	1
Primary	0.93 (0.78–1.11)	0.82 (0.66–1.03)	0.94 (0.79–1.12)	0.95 (0.77–1.17)
Secondary or higher	0.85 (0.74–0.98) *	0.84 (0.71–0.99) *	0.76 (0.66–0.88) *	0.89 (0.75–1.05)
Maternal BMI				
Underweight®	1	1	1	1
Normal	0.78 (0.68–0.89) *	0.76 (0.65–0.88) *	0.68 (0.59–0.77) *	0.87 (0.74–1.03)
Overweight	0.67 (0.54–0.82) *	0.60 (0.46–0.77) *	0.46 (0.37–0.57) *	0.77 (0.60–0.97) *
Obese	0.73 (0.53–1.01)	0.57 (0.37–0.88) *	0.50 (0.35–0.72) *	0.89 (0.61–1.31)
Birth order				
1®	1	1	1	1
2–4	1.16 (1.02–1.31) *	1.19 (1.03–1.37) *	1.23 (1.08–1.39) *	1.05 (0.91–1.21)
≥5	1.41 (1.13–1.75) *	1.05 (0.82–1.36)	1.18 (0.93–1.48)	1.06 (0.81–1.39)
Child characteristics				
Sex of child				
Male®	1	1	1	1
Female	0.80 (0.72–0.89) *	0.80 (0.70–0.91) *	0.77 (0.69–0.87) *	0.82 (0.72–0.93) *
Age of child				
6–11 months®	1	1	1	1
12–17 months	1.85 (1.62–2.12) *	0.73 (0.63–0.85) *	1.02 (0.89–1.16)	1.43 (1.23–1.66) *
18–23 months	2.60 (2.26–3.00) *	0.67 (0.58–0.79) *	1.37 (1.17–1.60) *	1.24 (1.06–1.46) *
Birth size				
Small®	1	1	1	1
Regular	0.70 (0.59–0.84) *	0.90 (0.73–1.11)	0.64 (0.54–0.76) *	0.92 (0.74–1.15)
Large	0.80 (0.65–0.99) *	0.94 (0.73–1.20)	0.67 (0.54–0.83) *	1.13 (0.87–1.45)
Household characteristics				
Wealth index				
Poor®	1	1	1	1
Middle	0.75 (0.65–0.87) *	0.73 (0.62–0.88) *	0.72 (0.62–0.84) *	0.97 (0.82–1.15)
Rich	0.65 (0.56–0.75) *	0.64 (0.52–0.78) *	0.59 (0.51–0.70) *	0.88 (0.75–1.04)
Religion				
Hindu®	1	1	1	1
Muslim	1.25 (1.06–1.47) *	1.39 (1.16–1.67) *	1.36 (1.16–1.60) *	1.04 (0.86–1.26)
Others	1.47 (0.49–4.45)	0.42 (0.12–1.48)	0.47 (0.16–1.36)	0.40 (0.13–1.20)
Caste				
SC®	1	1	1	1
ST	1.33 (0.88-2.01)	1.03 (0.61–1.75)	1.44 (0.93–2.24)	0.77 (0.49–1.21)
OBC	0.87 (0.77-0.99) *	0.86 (0.74–1.01)	0.92 (0.80–1.05)	1.00 (0.85–1.17)
Residence				
Urban®	1	1	1	1
Rural	1.01 (0.84-1.21)	0.82 (0.65–1.04)	0.90 (0.75–1.09)	0.96 (0.79–1.18)
Health service factors				
Place of delivery				
Non-institutional delivery®	1	1	1	1
Institutional delivery	0.91 (0.78-1.07)	0.99 (0.82–1.20)	1.05 (0.89–1.23)	0.90 (0.74–1.09)
Type of delivery				
Normal delivery ®	1	1	1	1
C-section	0.86 (0.72-1.02)	0.99 (0.81–1.23)	0.90 (0.74–1.09)	1.45 (1.17–1.79) *
ANC visits				
0 visits ®	1	1	1	1
1–3 visits	1.06 (0.83-1.36)	1.09 (0.78–1.53)	1.17 (0.91–1.51)	0.57 (0.41–0.80) *
≥4 visits	0.90 (0.70-1.16)	1.36 (0.96–1.92)	1.13 (0.87–1.47)	0.60 (0.43–0.84) *

Note: Figures in the parenthesis are confidence interval; level of significance: *p < 0.05.

The findings of the study indicate that breastfeeding is nearly universal in both India and Uttar Pradesh, with more than 97 per cent children ever breastfed. This reflects strong cultural acceptance of breastfeeding practices and their continuity across time. National-level evidence from India demonstrates high and stable breastfeeding patterns across successive NFHS rounds, indicating that breastfeeding remains a socially normative and sustained practice (Reddy et al., 2023; Singh et al., 2024). Early initiation of breastfeeding has improved substantially over the past decades, particularly after 2005–06, likely due to increased institutional deliveries and improved maternal healthcare services, as recent evidence highlights the significant role of facility-based births, antenatal counselling and healthcare support in promoting timely breastfeeding initiation (Sharma et al., 2023; Meshram et al., 2024). Exclusive breastfeeding has also shown improvement at the national level, although fluctuations were observed in Uttar Pradesh, reflecting regional disparities across states. Evidence indicates that exclusive breastfeeding practices increased between NFHS-4 and NFHS-5, while continuing to vary considerably across and within states in India (Reddy et al., 2023). In contrast, complementary feeding practices remain critically inadequate with low levels of minimum acceptable diet highlighting a persistent gap in feeding practices beyond the first six months of life. Recent evidence indicates that dietary adequacy improvements have been modest and complementary feeding continues to represent the weakest link in child nutrition in India (Aggarwal & Agrawal, 2024; Nguyen et al., 2020).

Despite improvements in breastfeeding indicators, undernutrition remains a major public health concern. Approximately one-third of children were stunted and nearly one-fourth were wasted or underweight in both India and Uttar Pradesh. Childhood anaemia was alarmingly high, affecting nearly four out of five children, indicating a substantial burden of micronutrient deficiencies. Recent evidence shows that over half of children aged 6–59 months are anaemic with increasing prevalence observed in NFHS-5 and even higher levels reported in several high-burden states (Bhattacharya et al., 2023; Kulkarni & Shinde, 2023). Trend analysis showed a gradual decline in stunting and underweight, suggesting improvements in long-term nutritional conditions, while wasting continues to persist, reflecting ongoing vulnerability to acute malnutrition. The recent increase in anaemia further underscores the need to strengthen interventions targeting dietary quality and micronutrient intake. Anaemia among children in India is largely driven by deficiencies in key micronutrients such as iron, vitamin B12 and folic acid (Yadav et al., 2024).

The multiple regression revealed statistically significant associations between early initiation of breastfeeding and stunting in the EBF model. Still, no other associations were found between EIBF and nutritional outcomes in either model, consistent with recent evidence from India suggesting that early initiation is more strongly associated with survival outcomes than with broader nutritional indicators (Hammad & Rahman, 2025). Although early initiation is critical for neonatal survival and immune protection, its independent effect on anthropometric outcomes appears limited after adjusting for maternal, socioeconomic, and child-level factors. Similarly, children who were exclusively breastfed were highly likely to be stunted and underweight in the adjusted model, but there was no association found between EBF and wasting, which aligns with recent evidence from India indicating that analyses of NFHS data primarily identify determinants of breastfeeding practices rather than consistent associations with anthropometric outcomes after adjustment (Reddy et al., 2023). The direction of this relationship suggests the possibility of reverse causality or residual confounding rather than a true adverse effect. It is also important to recognize that the benefits of exclusive breastfeeding may not be immediately reflected in growth indicators but may operate through pathways such as improved immunity and reduced infections as evidence from India indicates that breast milk plays a protective role against respiratory and gastrointestinal infections in early life (Pai et al., 2025).

The minimum acceptable diet did not show a statistically significant association with the nutritional outcomes. Although the direction of the estimates suggested a potential protective effect for undernutrition, the lack of statistical significance may be attributed to the low prevalence of adequate complementary feeding, measurement limitations based on short-term recall, and the overriding influence of socioeconomic and maternal factors as recent evidence highlights modest

improvements in dietary adequacy alongside significant regional disparities and alarmingly low levels of minimum acceptable diet in India (Aggarwal & Agrawal, 2024). These findings do not undermine the importance of complementary feeding but rather highlight the complexity of its relationship with child growth outcomes. A key finding of this study is that socio-demographic and maternal factors were stronger predictors of child nutritional outcomes than breastfeeding practices. Maternal education and mother's nutritional status, measured through body mass index, emerged as important determinants, particularly in the MAD model. Higher maternal education and better nutritional status were associated with significantly lower odds of stunting, wasting and underweight, reflecting the intergenerational nature of malnutrition and the role of maternal health and awareness in shaping child outcomes.

Child-level factors also demonstrated strong associations. Increasing age was associated with higher odds of stunting and underweight but lower odds of wasting, reflecting the chronic nature of stunting and the acute nature of wasting. Female children showed lower odds of stunting and underweight in the EBF model, while lower odds of all nutritional outcomes in the MAD model, suggesting possible biological or care-related differences. Higher birth order was associated with increased risk of undernutrition, likely due to resource constraints within larger households. Socioeconomic status played a significant role with household wealth showing a consistent protective effect across outcomes. Children from wealthier households were less likely to experience undernutrition, likely due to better access to food, healthcare, and sanitation. Religion showed significant associations in the adjusted models, indicating underlying social inequalities influencing child health outcomes. But caste was not found to have an effect on undernutrition and anaemia. Similarly, place of residence did not show a significant association, suggesting that rural–urban differences may be mediated through other socioeconomic factors. Healthcare utilization variables showed mixed associations. Antenatal care visits were associated with lower odds of anaemia, which may reflect reverse causality, where women with high-risk pregnancies are more likely to seek care or survival bias. This can be connected to the use of iron-folic acid tablets recommended during pregnancy. The more the ANC visits, the better the monitoring of the health of mothers. Caesarean delivery was significantly associated with higher odds of childhood anaemia possibly due to delayed initiation of breastfeeding or maternal health complications. These findings suggest that while maternal healthcare utilization is important, it must be complemented by effective postnatal and child nutrition interventions.

Overall, the findings suggest that although breastfeeding practices are essential for child survival and health, they do not independently determine nutritional outcomes in early childhood. The presence of mixed associations between breastfeeding practices and anthropometric outcomes in this study should not be interpreted as a lack of importance but rather as an indication of the multifactorial nature of undernutrition, as recent evidence from India highlights that child malnutrition is shaped by a complex interplay of socio-demographic, maternal and health-related factors (Singh et al., 2026).

In conclusion, improving child nutrition requires a comprehensive approach that extends beyond breastfeeding promotion. Strengthening maternal nutrition, improving complementary feeding practices, enhancing dietary diversity and addressing socioeconomic inequalities are critical for reducing undernutrition and anaemia. While breastfeeding remains a vital component of child health, its full benefits may extend beyond early childhood and may not be fully captured within the 0–23 months' age group. Future research should adopt a life-course perspective to better understand the long-term effects of infant feeding practices on child growth and development.

Limitations

This study has several limitations. The cross-sectional design limits causal inference and reliance on maternal recall may introduce reporting bias. Additionally, limited information on dietary quality, infections and household food security may have influenced the observed associations. The

low prevalence of a minimum acceptable diet may also have reduced the statistical power to detect significant relationships.

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