



State-level trends in infant and young child feeding practices and child undernutrition in India: An ecological analysis of three rounds of National Family Health Survey

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Abstract

Child undernutrition remains a major public health concern in India, despite sustained efforts over the past two decades. While national-level improvements have been reported, substantial variation persists across states. This descriptive ecological study analysed state- and union territory-level data from three rounds of the National Family Health Survey (NFHS-3, 2005–06; NFHS-4, 2015–16; and NFHS-5, 2019–21). Trends in underweight, stunting, and wasting among children under five years of age were assessed. States and Union Territories were classified based on underweight trajectories as either sustained decrease or mixed/increasing trend. Percentage-point changes were calculated for selected IYCF and maternal health indicators, and average changes were compared across state groups. In addition, selected social and contextual indicators were descriptively examined to provide a broader perspective on the enabling environment for child nutrition. Results showed that, at the national level, underweight and stunting declined across survey rounds, whereas wasting showed slower and less consistent improvement. Substantial inter-state variation was observed. States with sustained declines in underweight prevalence generally showed more favourable improvements in breastfeeding practices and maternal healthcare utilization compared with states showing mixed or increasing trends. However, anaemia among women remained persistently high. Social and contextual indicators, including women's participation in decision-making, financial inclusion, and sanitation coverage, showed improvement over time, although adverse conditions such as spousal violence and low maternal BMI persisted. India has made measurable progress in reducing child undernutrition, but improvements remain uneven and incomplete. Strengthening maternal nutrition, improving early-life care, and addressing structural inequalities will be essential for achieving sustained and equitable improvements in child nutrition outcomes.

Keywords: *public health, maternal healthcare, state-level trends, maternal nutrition*

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1. Introduction

Child undernutrition remains one of the most important public health challenges in India and continues to affect millions of children during the early years of life (Black et al., 2013; Menon et al., 2021; International Institute for Population Sciences [IIPS] & ICF, 2021). Poor nutritional status in early childhood is associated with increased morbidity and mortality, impaired cognitive development, reduced educational attainment, and adverse health outcomes across the life course (Black et al., 2013; Victora et al., 2008; Prado & Dewey, 2014).

Globally, undernutrition contributes substantially to mortality among children under five years of age and remains central to child survival and development (World Health Organization [WHO], 2024; UNICEF, WHO, & World Bank, 2024). Child undernutrition is commonly assessed using three anthropometric indicators defined by the WHO: stunting, wasting, and underweight. These indicators reflect chronic, acute, and composite forms of undernutrition, respectively. Although India has recorded gradual improvements in child nutrition over time, the burden remains high and substantial disparities persist across states and union territories (WHO, 2024; Menon et al., 2021; IIPS & ICF, 2021).

Reducing child undernutrition remains central to the achievement of several global development agendas, particularly Sustainable Development Goal (SDG) 2 (Zero Hunger) and SDG 3 (Good Health and Well-being). SDG 2 aims to end all forms of malnutrition and ensure access to safe, nutritious, and sufficient food for all, while SDG 3 emphasizes improving maternal, newborn, and child health outcomes. In addition, the World Health Organization's Global Nutrition Targets 2025 call for significant reductions in stunting, wasting, low birth weight, anaemia among women of reproductive age, and childhood overweight. Progress toward these targets is widely recognized as essential for improving population health, human capital development, and long-term economic productivity.

India occupies a particularly important position within the global nutrition landscape because of its large population and substantial share of the world's burden of child undernutrition. Improvements in child nutrition outcomes in India therefore have implications not only for national public health but also for global progress toward nutrition and sustainable development targets. Although notable gains have been achieved during the past two decades, India continues to account for a considerable proportion of children affected by stunting, wasting, and underweight worldwide. Consequently, understanding the factors associated with

nutritional improvement within the Indian context remains a priority for researchers, policymakers, and international development agencies.

The scale and diversity of India further emphasize the importance of examining nutritional progress beyond national averages. States and union territories differ substantially in terms of socio-economic development, healthcare infrastructure, demographic characteristics, governance capacity, and programme implementation. As a result, nutritional transitions often occur at different rates across regions. Identifying patterns of progress and persistent challenges at the subnational level is therefore essential for designing effective interventions and accelerating progress toward both national nutrition goals and international commitments.

The National Family Health Survey (NFHS) provides nationally representative evidence on child nutrition, maternal health, and feeding practices in India (International Institute for Population Sciences [IIPS] & ICF, 2007; IIPS & ICF, 2017; IIPS & ICF, 2021). The three survey rounds, NFHS-3 (2005–06), NFHS-4 (2015–16), and NFHS-5 (2019–21), offer an important opportunity to assess how nutrition-related indicators have changed over time across states and union territories.

Although previous studies have documented trends in child undernutrition and feeding practices in India, much of the available literature has either focused on single survey rounds, specific indicators, or national-level averages (Menon et al., 2021; Rao et al., 2023; Petrikova & Kumar, 2025). Relatively fewer studies have examined how changes in feeding practices, maternal healthcare utilization, and broader contextual indicators correspond with state-level trajectories of child undernutrition across multiple NFHS rounds. Moreover, many existing analyses have emphasized national progress without sufficiently exploring the substantial heterogeneity that persists across Indian states.

To address this gap, the present study adopts a comparative state-grouping approach using underweight prevalence as the principal classification indicator because it reflects both chronic and acute forms of undernutrition and has been widely used in nutrition surveillance in India. By comparing states with sustained reductions in underweight prevalence against those with mixed or increasing trends, the study provides a policy-relevant ecological perspective on the uneven progress of child nutrition across India. Examining changes in infant and young child feeding practices alongside maternal health indicators may offer important insights into the factors associated with differing nutritional trajectories among states.

This study aims to examine state-level trends in child undernutrition and infant and young child feeding practices in India using data from NFHS-3 (2005–06), NFHS-4 (2015–16), and NFHS-5 (2019–21), with particular emphasis on understanding the factors associated with uneven nutritional progress across Indian states.

2. Literature Review

Infant and young child feeding (IYCF) practices are key determinants of child growth, development, and survival. Recommended infant and young child feeding practices include early initiation of breastfeeding within one hour of birth, exclusive breastfeeding during the first six months of life, and timely introduction of safe and nutritionally adequate complementary foods as recommended by the World Health Organization (WHO, 2010; WHO, 2023; Victora et al., 2016; Rollins et al., 2016). The first two years of life, often referred to as the “first 1000 days,” represent a critical window for growth and development, and nutritional deficits during this period may have long-term consequences for health, cognition, and human capital (Vaivada et al., 2020; Prado & Dewey, 2014; Vir & Suri, 2023).

IYCF practices are among the most important determinants of child growth and survival. WHO recommends initiation of breastfeeding within one hour of birth, exclusive breastfeeding during the first six months, and timely introduction of safe and nutritionally adequate complementary foods (WHO, 2010; WHO, 2023; Victora et al., 2016; Rollins et al., 2016). These practices are especially critical during the first 1,000 days of life, a period recognized as essential for optimal physical and cognitive development (Vaivada et al., 2020; Prado & Dewey, 2014; Vir & Suri, 2023). Poor feeding practices during this period may result in irreversible developmental consequences and increased risk of undernutrition.

Child nutrition outcomes are shaped by a wide range of structural and household-level determinants. Studies have consistently identified maternal education, maternal health, sanitation, women's empowerment, healthcare access, and household socioeconomic conditions as important contributors to nutritional status (Spears, 2013; Menon et al., 2021). These determinants interact to influence children's dietary intake, disease exposure, and caregiving environments. Moreover, the emergence of the double burden of malnutrition in many low- and middle-income countries highlights the complexity of nutrition transitions and the need to consider broader social and environmental influences on child nutrition (Popkin et al., 2020).

India has implemented several large-scale nutrition interventions aimed at improving maternal and child nutrition. Major initiatives include the Integrated Child Development Services (ICDS), POSHAN Abhiyaan, and programmes promoting breastfeeding, maternal healthcare, and child health services (MoWCD, 2019; MoHFW, 2016; MoHFW, 2021). These programmes seek to improve nutrition through multisectoral approaches involving health, education, sanitation, and social protection. Despite these efforts, implementation effectiveness and programme coverage continue to vary considerably across states, contributing to regional disparities in nutritional outcomes.

The NFHS has become the principal source of nationally representative data on nutrition, maternal health, and child feeding practices in India (IIPS & ICF, 2007; IIPS & ICF, 2017; IIPS & ICF, 2021). Successive rounds of the survey provide valuable evidence for monitoring trends and evaluating public health programmes. Previous studies using NFHS data have documented improvements in child nutrition while also highlighting persistent inequalities across socioeconomic groups and geographic regions (Menon et al., 2021; Rao et al., 2023; Petrikova & Kumar, 2025).

Although numerous studies have examined child undernutrition in India, most have focused on national averages, individual survey rounds, or isolated nutritional indicators. Comparatively fewer investigations have analyzed how changes in infant and young child feeding practices, maternal healthcare utilization, and related contextual factors correspond with state-level nutritional trajectories across multiple NFHS rounds. Moreover, limited research has explicitly compared states exhibiting sustained improvements with those showing stagnation or reversal in underweight prevalence. This gap limits understanding of why nutritional progress remains uneven despite nationwide nutrition programmes. The present study addresses this limitation by adopting a comparative state-grouping approach that links trends in child undernutrition with changes in infant feeding practices and maternal health indicators, thereby generating evidence to inform more targeted nutrition policies across Indian states.

3. Methods

This study employed a state-level descriptive ecological trend analysis to examine changes in child undernutrition and selected maternal and child health indicators across India. The analysis focused on changes in nutrition-related indicators across states and NFHS rounds

rather than on individual-level associations. Consequently, findings were interpreted as ecological patterns rather than evidence of individual-level or causal relationships.

The primary outcome variable was the prevalence of underweight among children under five years of age, defined as weight-for-age below -2 standard deviations (SD) according to the WHO Child Growth Standards. In addition, stunting (height-for-age below -2 SD) and wasting (weight-for-height below -2 SD) were examined to provide a broader contextual understanding of child undernutrition trends.

The following maternal and child health indicators were selected based on their policy relevance and consistent availability across survey rounds: Early initiation of breastfeeding; Exclusive breastfeeding among infants younger than six months; Adequate diet among children aged 6–23 months; Oral rehydration solution (ORS) use for childhood diarrhoea; Antenatal care during the first trimester; Postnatal care within two days of delivery; Institutional delivery; and Anaemia among women aged 15–49 years.

For each state and union territory, baseline values were obtained from the earliest available comparable survey round and compared with NFHS-5 estimates. Absolute changes were calculated as percentage-point differences. Changes between NFHS-4 and NFHS-5 were also examined to determine whether recent improvements were sustained or interrupted.

States and union territories were classified into two categories according to changes in underweight prevalence across the three NFHS survey rounds:

Sustained decrease: Underweight prevalence declined from NFHS-3 to NFHS-4 and again from NFHS-4 to NFHS-5.

Mixed/increasing trend: Underweight prevalence remained unchanged or increased during at least one survey interval.

Although stunting and wasting were also examined to contextualize broader undernutrition patterns, only underweight was used for state classification and comparative grouping.

To facilitate interpretation, changes in the selected maternal and child health indicators were summarized as favourable, unfavourable, or minimal/inconsistent between the baseline survey round and NFHS-5. This directional classification was used solely as a descriptive summary and was not intended to replace formal statistical analysis.

The analysis was descriptive and comparative. State-level trends in underweight, stunting, wasting, and the selected maternal and child health indicators were examined across

the three NFHS rounds, after which patterns of change were compared between the two state groups.

For each maternal and child health indicator, state-level percentage-point change was calculated as the difference between NFHS-5 and the earliest available comparable baseline survey round. These changes were then averaged separately for states and union territories classified as having either a sustained decrease or a mixed/increasing trend in underweight prevalence. The resulting mean percentage-point changes were presented graphically to facilitate comparison between the two groups. State- and union territory-level maps illustrating the prevalence of underweight, stunting, and wasting across the three NFHS rounds were also generated to visualize geographic variation in child undernutrition.

Because the study was based exclusively on aggregated state-level estimates, no inferential statistical tests were performed. The objective was to describe broad temporal patterns and compare trajectories across states rather than to establish statistical associations or causal relationships between nutrition-related indicators.

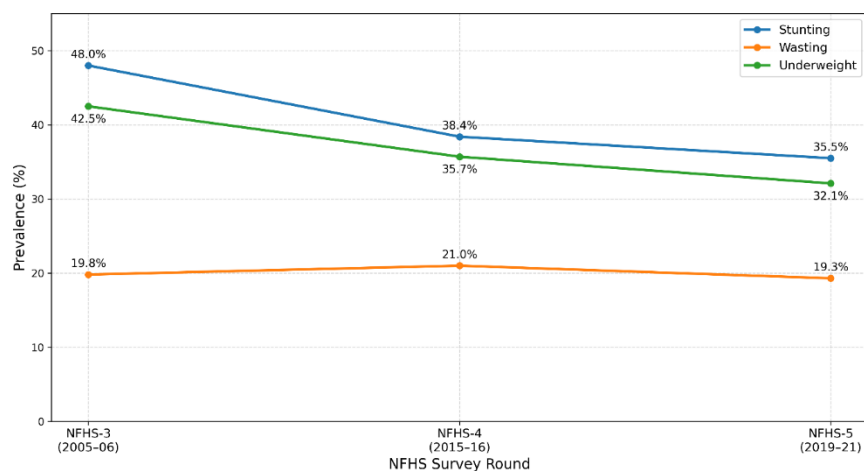
4. Results

4.1. National Trends in Child Undernutrition

At the national level, child undernutrition in India showed gradual improvement across NFHS-3, NFHS-4, and NFHS-5 (Figure 1). Underweight prevalence declined over the study period, indicating broad improvement in child nutritional status. Stunting also declined steadily across survey rounds. In contrast, wasting showed slower and less consistent improvement, indicating that acute undernutrition remains a persistent challenge.

Figure 1

National trends in stunting, wasting, and underweight among children under five years of age in India across NFHS-3 (2005–06), NFHS-4 (2015–16), and NFHS-5 (2019–21)



4.2. State-Level Variation in Undernutrition

Despite national progress, substantial inter-state variation remained evident. Several states in northern and central India continued to report comparatively higher levels of undernutrition, whereas many southern and some northeastern states had lower prevalence levels. These findings indicate that national averages mask considerable subnational heterogeneity.

Table 1

State-wise prevalence of underweight among children under five years across NFHS-3, NFHS-4, and NFHS-5, percentage-point change, and trend classification

State/UT	NFHS-3 (%)	NFHS-4 (%)	NFHS-5 (%)	Change (pp)	Trend Category
Andhra Pradesh	32.5	31.9	29.6	-2.9	Sustained Decrease
Arunachal Pradesh	32.5	19.4	15.4	-17.1	Sustained Decrease
Assam	36.4	29.8	32.8	-3.6	Mixed/Increasing
Bihar	55.9	43.9	41.0	-14.9	Sustained Decrease
Chhattisgarh	47.1	37.7	31.3	-15.8	Sustained Decrease
Goa	25.0	23.8	24.0	-1.0	Mixed/Increasing
Gujarat	44.6	39.3	39.7	-4.9	Mixed/Increasing
Haryana	39.6	29.4	21.5	-18.1	Sustained Decrease
Himachal Pradesh	36.5	21.2	25.5	-11.0	Mixed/Increasing
Jharkhand	56.5	47.8	39.4	-17.1	Sustained Decrease
Karnataka	37.6	35.2	32.9	-4.7	Sustained Decrease
Kerala	22.9	16.1	19.7	-3.2	Mixed/Increasing
Madhya Pradesh	60.0	42.8	33.0	-27.0	Sustained Decrease
Maharashtra	37.0	36.0	36.1	-0.9	Mixed/Increasing
Manipur	22.1	13.8	13.3	-8.8	Sustained Decrease
Meghalaya	48.8	28.9	26.6	-22.2	Sustained Decrease
Mizoram	19.9	12.0	12.7	-7.2	Mixed/Increasing
Nagaland	25.2	16.7	26.9	+1.7	Mixed/Increasing
Odisha	40.7	34.4	29.7	-11.0	Sustained Decrease
Punjab	24.9	21.6	16.9	-8.0	Sustained Decrease
Rajasthan	39.9	36.7	27.6	-12.3	Sustained Decrease
Sikkim	19.7	14.2	13.1	-6.6	Sustained Decrease
Tamil Nadu	29.8	23.8	22.0	-7.8	Sustained Decrease
Telangana*	—	28.4	31.8	+3.4	Mixed/Increasing
Tripura	39.6	24.1	25.6	-14.0	Mixed/Increasing
Uttar Pradesh	42.4	39.5	32.1	-10.3	Sustained Decrease
Uttarakhand	38.0	26.6	21.0	-17.0	Sustained Decrease
West Bengal	38.7	31.6	32.2	-6.5	Mixed/Increasing
Andaman & Nicobar Islands (UT)	—	21.6	23.7	+2.1	Mixed/Increasing
Chandigarh (UT)	—	24.5	20.6	-3.9	Sustained Decrease
Dadra & Nagar Haveli and Daman & Diu (UT)	—	35.8	38.7	+2.9	Mixed/Increasing
Delhi (NCT)	26.1	27.0	21.8	-4.3	Mixed/Increasing
Jammu & Kashmir (UT)	25.6	16.6	21.0	-4.6	Mixed/Increasing
Ladakh (UT)	—	—	20.4	—	Mixed/Increasing†
Lakshadweep (UT)	—	23.6	25.8	+2.2	Mixed/Increasing
Puducherry (UT)	22.0	15.3	15.3	-6.7	Sustained Decrease
India	42.5	35.7	32.1	-10.4	Sustained Decrease

Note: *NFHS-3 estimates were not available separately for Telangana; NFHS-4 was treated as the earliest comparable baseline. Ladakh was formed after NFHS-4; only NFHS-5 data were available, so trend classification is descriptive.

The change (pp) indicates the percentage-point difference between the earliest available comparable survey round and NFHS-5. The “sustained decrease” refers to states/UTs where underweight prevalence declined across successive available rounds, while “mixed/increasing trend” refers to states/UTs where underweight prevalence stagnated or increased in at least one interval.

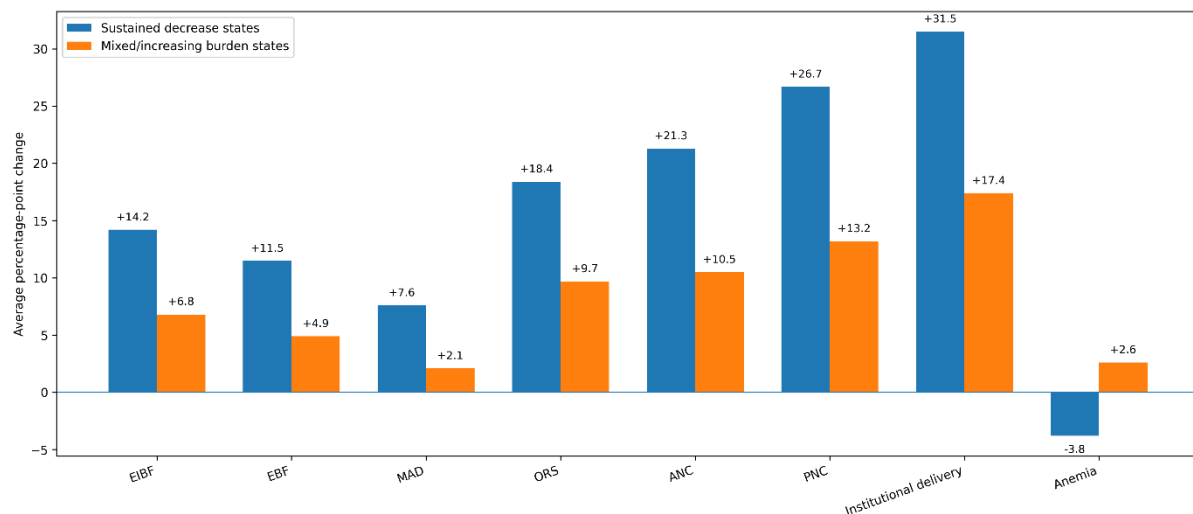
4.3. Changes in Selected IYCF and Maternal Health Indicators

States classified in the ‘Sustained Decrease’ group generally showed broader improvements in selected IYCF and maternal health-related indicators. These included early initiation of breastfeeding, exclusive breastfeeding, antenatal care in the first trimester, postnatal care within two days of delivery, institutional delivery, and ORS use for childhood diarrhea. In contrast, states in the ‘Mixed/Increasing Trend’ category also showed improvements in several indicators, but progress was comparatively less consistent. Across nearly all states, anaemia among women remained a major public health concern and, in several settings, showed little improvement or deterioration over time.

Comparative patterns in average change across selected indicators by state trend category are shown in Figure 2.

Figure 2

Average percentage-point change in selected maternal and child health indicators across states group by underweight trend category



Legend: Early Initiation of Breastfeeding (EIBF); Exclusive Breastfeeding (EBF); Minimum Acceptable Diet (MAD); Oral Rehydration Solution (ORS); Antenatal Care (ANC); Postnatal Care (PNC)

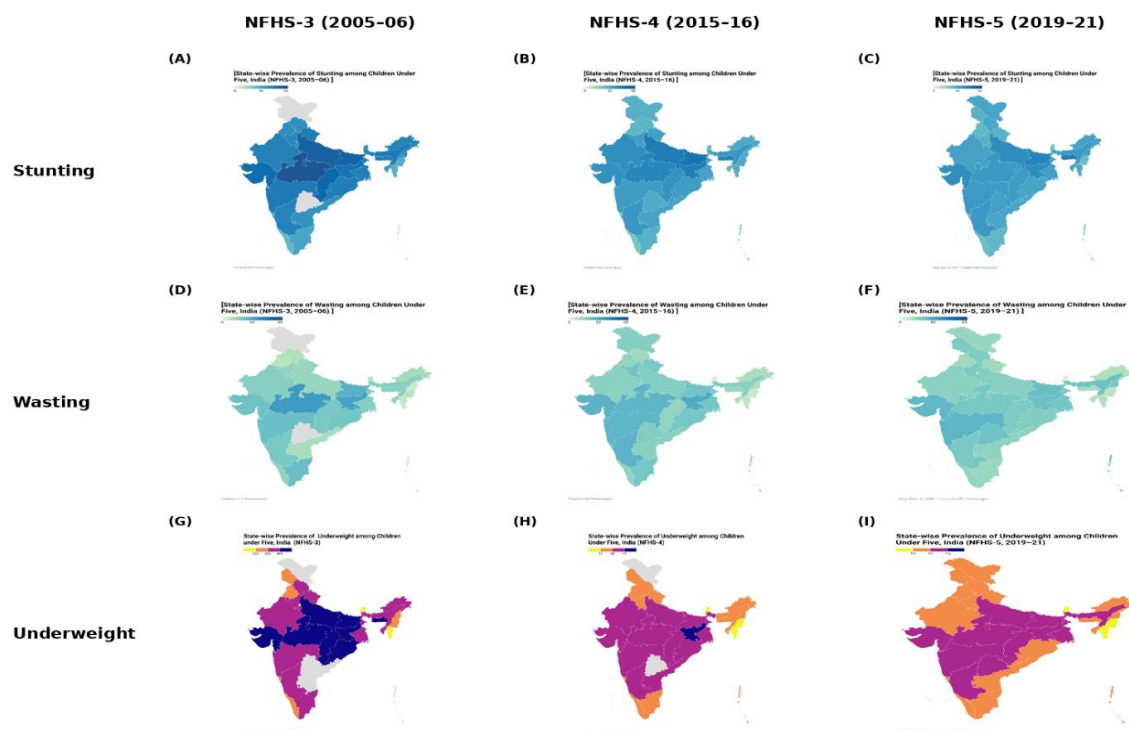
Figure 2 illustrates the average percentage-point change in selected maternal and child health indicators across the two underweight trend groups. States with a sustained decrease in underweight prevalence showed larger average improvements across most indicators, particularly antenatal care, postnatal care, institutional delivery, and ORS use.

4.4. Geographic Distribution of Undernutrition

The geographic distribution of stunting, wasting, and underweight across states and union territories is presented in Figure 3. The maps highlight persistent regional clustering of child undernutrition across survey rounds, with relatively higher prevalence observed in several northern and central states, while lower prevalence was seen in many southern and some northeastern states. Although overall improvement was evident over time, the spatial pattern suggests that progress remained uneven across the country.

Figure 3

State-wide prevalence of stunting, wasting, and underweight among children five years of age across NFHS-3 (2005–06), NFHS-4 (2015–16), and NFHS-5 (2019–21)



Notes: Maps are arranged in three rows corresponding to stunting, wasting, and underweight, and three columns corresponding to the three survey rounds. Darker shades indicate higher prevalence of the respective anthropometric indicator across states and union territories. Grey areas indicate regions where comparable data were not available in the respective survey round.

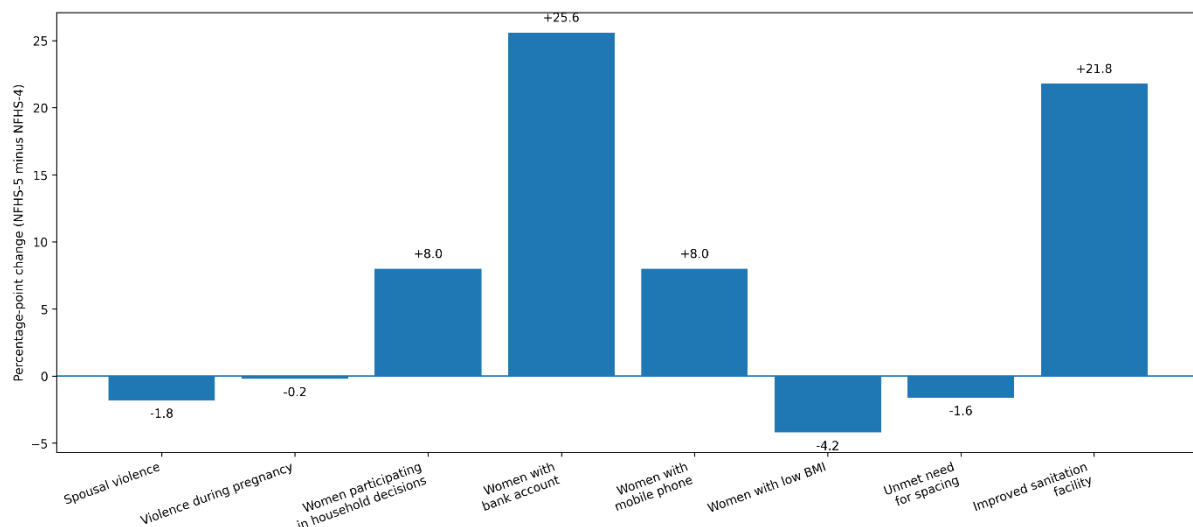
Source: National Family Health Survey (NFHS-3, NFHS-4, and NFHS-5), International Institute for Population Sciences (IIPS), Mumbai, India.

4.5. Changes in Selected Social and Contextual Indicators

At the national level, selected social and contextual indicators also showed notable changes between NFHS-4 and NFHS-5 (Figure 4). Improvements were observed in women's participation in household decision-making, bank account ownership, mobile phone ownership, and access to improved sanitation. In contrast, adverse indicators such as spousal violence, violence during pregnancy, low body mass index among women, and unmet need for spacing showed slower or less favourable change. These descriptive patterns provide additional context for understanding the broader social and household environment within which child nutrition outcomes may evolve.

Figure 4

National-level percentage-point change in selected social and contextual indicators between NFHS-4 and NFHS-5 in India



5. Discussion

This study examined state-level trends in child undernutrition and selected infant and young child feeding and maternal health indicators in India using three rounds of the NFHS. The findings show that India has made measurable progress in reducing underweight and stunting over the past 15 years; however, progress has been uneven across states and incomplete across indicators. While national averages suggest improvement, states have followed markedly different trajectories over time. Some demonstrated sustained reductions in underweight prevalence, whereas others showed slower, interrupted, or reversing trends. This

is broadly consistent with previous evidence showing that improvements in child nutrition in India have not occurred uniformly and that substantial subnational disparities continue to shape the burden of undernutrition (Menon et al., 2021; Rao et al., 2023; IIPS & ICF, 2021). It also reinforces the importance of moving beyond national averages, as state-level trajectories may better reflect differences in implementation capacity, service delivery, social conditions, and broader health-system performance. Geographic clustering and uneven state-level progress persisted across survey rounds (see Figure 3).

Differences in state-level governance capacity, programme implementation, healthcare infrastructure, and social welfare delivery may also contribute to the uneven nutritional trajectories observed across India. Variability in the implementation of nutrition and maternal-child health programmes across states may partly explain why some states achieved sustained improvement while others showed stagnation or reversal in indicators. In addition, the overlap of NFHS-5 with the COVID-19 pandemic period may have influenced healthcare utilization, food security, and household livelihoods in several settings, potentially affecting recent nutritional patterns.

Stunting showed a broad decline across survey rounds, reflecting gradual improvement in chronic undernutrition. This is consistent with existing evidence suggesting that reductions in stunting occur gradually as a result of longer-term improvements in living conditions, maternal education, food security, sanitation, and health service access (Vaivada et al., 2020; Menon et al., 2021; Black et al., 2013). However, the persistence of high levels of stunting in several states remains a major concern, indicating that sustained improvements require long-term and multisectoral efforts.

Wasting emerged as the most resistant form of undernutrition (Getu et al., 2023; Ewune et al., 2022; El Moussaoui et al., 2024). Compared with underweight and stunting, progress in reducing wasting was slower and less consistent across states. Wasting is often more responsive to acute shocks, illness, seasonal food insecurity, and environmental stressors than to gradual improvements in service coverage (Black et al., 2013; Vaivada et al., 2020; UNICEF, WHO, & World Bank, 2024). The persistence of wasting therefore indicates the need for stronger preventive and therapeutic responses for acute malnutrition, particularly in vulnerable settings.

The study also found that states with more favourable undernutrition trajectories often showed improvements in broader determinants of child undernutrition, including

breastfeeding-related indicators and maternal healthcare utilization such as antenatal care, postnatal care, and institutional delivery. States with sustained declines in underweight prevalence tended to show more consistent improvements across these indicators. Although these ecological patterns do not establish causal relationships, they suggest that improvements in child nutrition may be embedded within a wider continuum of maternal care, early-life feeding support, and health-system performance. Child undernutrition should not be interpreted solely as a consequence of inadequate food intake but rather as an outcome shaped by multiple interacting dimensions of maternal and child health.

Child nutrition outcomes are influenced not only by feeding practices but also by the continuum of maternal and child healthcare (Shrestha et al., 2025; Masilela & Modjadji, 2023; Prasetyo et al., 2023). Previous studies have highlighted the importance of early breastfeeding support, maternal service uptake, and healthcare access in shaping child survival and growth outcomes (Victora et al., 2016; Rollins et al., 2016; Smith et al., 2017). At the same time, these improvements should not be interpreted as sufficient in themselves, since child undernutrition is shaped by multiple pathways including maternal nutrition, sanitation, food security, recurrent childhood illness, and household-level vulnerability. In this sense, child undernutrition may be better understood not only as a nutrition-specific problem, but also as an indicator of the broader functioning of maternal and child health systems.

The observed improvements in child undernutrition may also be situated within broader social and structural changes in India. As shown in Figure 4, indicators reflecting women's empowerment, financial inclusion, and access to sanitation have improved between NFHS-4 and NFHS-5. Increased participation of women in household decision-making, greater access to bank accounts and mobile phones, and improved sanitation coverage may contribute to a more enabling environment for maternal and child health. Previous studies have emphasized that such social determinants play a crucial role in shaping child nutrition outcomes by influencing care practices, health service utilization, and household-level resource allocation (Menon et al., 2021; Victora et al., 2016; Black et al., 2013).

These findings may also be interpreted through the lens of the Social Determinants of Health framework, which emphasizes that health and nutritional outcomes are shaped not only by individual behaviours and healthcare access but also by broader social, economic, and environmental conditions. Improvements in women's empowerment, financial inclusion, and sanitation may therefore contribute to child nutrition through multiple pathways, including

enhanced caregiving capacity, greater access to health services, and improved household living conditions. Conversely, the persistence of gender inequality, maternal undernutrition, and social vulnerability may continue to constrain nutritional progress in several states. The uneven trajectories observed across India may therefore reflect deeper structural inequalities that extend beyond nutrition-specific interventions alone.

At the same time, the persistence of adverse conditions such as spousal violence, low maternal body mass index, and unmet need for spacing highlights ongoing structural vulnerabilities that may constrain nutritional progress. Gender-based inequalities and maternal undernutrition have been consistently linked to poor child growth and survival outcomes, indicating that improvements in nutrition require integrated approaches addressing both health and social determinants (Bhutta et al., 2013; WHO, 2023). These findings reinforce the importance of multisectoral strategies that extend beyond direct nutrition interventions to include women's empowerment, reproductive health services, and broader socio-economic development.

Another important finding was the persistence of anaemia among women of reproductive age. In many states, maternal anaemia showed limited improvement and, in some cases, worsened over time. This has important implications for child nutrition, as maternal nutritional disadvantage can influence foetal growth, birth outcomes, breastfeeding, and intergenerational nutritional vulnerability (Nadhiroh et al., 2023; Black et al., 2013). The continued burden of maternal anaemia highlights the need to integrate maternal nutrition interventions more closely within broader child nutrition strategies.

Improvements in child undernutrition are more likely to occur when gains in breastfeeding, maternal healthcare, and service utilization are embedded within a broader supportive ecosystem. Child undernutrition should therefore be understood as a multidimensional maternal–child health challenge requiring coordinated action across nutrition, primary healthcare, maternal health, and social support systems. Unlike analyses limited to single indicators or single survey rounds, the present study provides a longer-term ecological perspective on how nutrition trajectories may align with changes in selected maternal and child health indicators across states. Although the findings should not be interpreted causally, they offer a useful policy-relevant perspective on how uneven progress in child nutrition may reflect wider differences in maternal–child health environments across India.

6. Implications of the Study

The findings have important implications for public policy and programme implementation aimed at improving child nutrition outcomes across India. Although India has implemented several large-scale nutrition and maternal-child health initiatives, including the Integrated Child Development Services (ICDS), POSHAN Abhiyaan, Janani Suraksha Yojana, and breastfeeding promotion programmes, the considerable variation in nutritional trajectories across states suggests that national programmes alone are insufficient to ensure uniform progress. Their effectiveness depends largely on governance capacity, administrative efficiency, resource allocation, healthcare infrastructure, and local implementation mechanisms. States demonstrating sustained declines in underweight prevalence may have benefited from stronger programme implementation, better coordination between health and nutrition sectors, and greater investments in maternal and child health services, whereas states with stagnating or mixed trends may require strengthened implementation quality, improved service delivery, and greater investment in health systems.

The findings also underscore the need for state-specific and context-sensitive nutrition strategies rather than relying solely on national averages. India's diverse demographic, cultural, economic, and geographic conditions require interventions tailored to local nutritional challenges and implementation realities. High-burden states may benefit from intensified investments in maternal nutrition, community-based behaviour change interventions, nutrition-sensitive social protection programmes, strengthened monitoring systems, and improved resource allocation. At the same time, successful states provide valuable lessons regarding programme implementation, community engagement, and health system strengthening that may inform policy in other regions.

The study further emphasizes the importance of adopting a life-course and multisectoral approach to child nutrition. Nutritional outcomes are influenced by factors operating before conception, during pregnancy, at birth, and throughout infancy and early childhood. Maternal nutritional status, antenatal care, institutional delivery, breastfeeding support, complementary feeding practices, sanitation, women's empowerment, financial inclusion, education, and household socio-economic conditions collectively shape child growth and development. Consequently, interventions focusing exclusively on child feeding practices are unlikely to achieve sustained reductions in undernutrition unless accompanied by strengthened maternal health services, nutrition-sensitive development programmes, and

broader social interventions. Particular attention should be given to improving antenatal nutrition services, iron and folic acid supplementation, dietary counselling, early initiation and exclusive breastfeeding, appropriate complementary feeding, and community-based counselling delivered through frontline health workers.

The findings also highlight the importance of strengthening monitoring and surveillance systems to identify emerging nutritional challenges, evaluate programme effectiveness, and support evidence-based decision-making. Greater use of district-level data, digital monitoring platforms, and routine nutrition surveillance may facilitate the identification of high-risk populations, improve resource allocation, and strengthen programme accountability.

Child undernutrition should be viewed not only as a public health concern but also as a long-term human capital and development issue. Undernutrition during early childhood is associated with developmental delays, reduced educational attainment, lower productivity, and increased susceptibility to chronic diseases later in life. Sustained improvements therefore require continued political commitment, adequate financing, robust monitoring systems, and strong intersectoral coordination. India's experience further demonstrates that meaningful progress is achievable within resource-constrained settings when nutrition interventions are supported by effective health systems, community engagement, and multisectoral development initiatives. Understanding the factors associated with successful state-level trajectories may therefore inform future nutrition policy both within India and in other low- and middle-income countries facing similar challenges.

7. Implications for Future Research

Future research should build upon the findings of the present study by examining child nutrition at more disaggregated levels of analysis. Although state-level comparisons provide important policy insights, substantial variation often exists within states. District-level analyses may therefore help identify localized pockets of nutritional vulnerability that remain concealed within broader state averages, thereby supporting more targeted planning and resource allocation for high-burden populations.

Future studies may also benefit from employing multilevel and inferential analytical approaches to better understand the complex relationships between child nutrition outcomes and their determinants. While the present study intentionally adopted a descriptive ecological

framework, multilevel analyses could examine how individual, household, community, and state-level factors interact to influence nutritional outcomes and provide a more comprehensive understanding of the pathways linking maternal health, feeding practices, socio-economic conditions, and child undernutrition.

The availability of future survey rounds, including NFHS-6 and other national datasets, will provide opportunities to examine whether the observed improvements are sustained over time. Longitudinal assessments may further enhance understanding of the long-term effects of policy interventions, socio-economic transitions, and public health emergencies such as the COVID-19 pandemic on child nutrition.

Further research is also needed to evaluate the effectiveness of major nutrition programmes, including ICDS, POSHAN Abhiyaan, and maternal-child health initiatives. Comparative evaluations across states may help identify successful implementation strategies, governance practices, and service delivery models associated with favourable nutritional outcomes. In addition, mixed-methods and qualitative research may provide deeper insights into the contextual factors influencing programme implementation and nutritional change, thereby contributing to the development of more effective and context-sensitive policies for reducing child undernutrition in India.

8. Limitations of the Study

Several limitations should be considered while interpreting the findings of this study. First, the analysis was ecological and based on aggregated state-level estimates; therefore, the findings should not be interpreted as evidence of individual-level associations or causal relationships. Second, the study relied on descriptive comparisons and did not perform inferential statistical testing. Third, although NFHS surveys are nationally representative, differences in survey timing, implementation, and contextual conditions across rounds may affect comparability. In particular, NFHS-5 overlapped with the COVID-19 pandemic period, which may have influenced nutritional outcomes, healthcare utilization, and household conditions in some states. Fourth, the analysis was limited to state- and union territory-level patterns and did not capture important district-level heterogeneity within states. Finally, the study focused on selected indicators available consistently across survey rounds and therefore could not account for all social, economic, dietary, and policy-related determinants of child undernutrition.

9. Conclusion

India has made measurable progress in improving child nutrition and selected infant and young child feeding practices over the past 15 years. Reductions in underweight and stunting, together with improvements in breastfeeding and maternal healthcare indicators, suggest that sustained public health efforts have contributed to important gains. However, progress has remained uneven across states and incomplete across indicators. The persistence of wasting and the continued burden of maternal anaemia stress important unresolved challenges in India's nutrition landscape. Marked variation in state-level trajectories further suggests that improvements in child nutrition are closely linked to broader differences in maternal care, health-system performance, and early-life support.

There is a need for a more differentiated and integrated nutrition strategy in India, one that combines support for optimal infant feeding with stronger maternal nutrition interventions, improved complementary feeding practices, enhanced nutrition surveillance systems, and targeted attention to high-burden states. Strengthening sanitation, women's empowerment, reproductive healthcare, and maternal health services may further support sustained improvements in child nutrition outcomes. Accelerating progress toward national and global nutrition targets will require not only sustaining gains where improvement has occurred but also addressing persistent structural and programmatic gaps that continue to hinder progress in many parts of the country.

Beyond its implications for India, the findings of this study contribute to the broader global discussion on reducing child undernutrition in low- and middle-income countries. The experience of India demonstrates that improvements in child nutrition require sustained investments across multiple sectors, including health, nutrition, sanitation, education, and social protection. While national programmes have contributed to measurable progress, persistent regional disparities indicate that implementation quality and local context remain critical determinants of success. Future efforts should therefore focus not only on expanding programme coverage but also on strengthening accountability, equity, and evidence-based decision-making. Such an approach will be essential for ensuring that nutritional gains are sustained and shared across all populations, thereby contributing to the achievement of both national development priorities and global nutrition targets.

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AI Declaration

The authors used artificial intelligence tools (ChatGPT, OpenAI) solely for language editing, grammar correction, formatting assistance, and improving the clarity and readability of the manuscript. AI tools were not used to generate study data, conduct analyses, interpret findings, or develop the scientific conclusions of the study. All study design decisions, data analysis, interpretation of results, and manuscript content were independently developed and verified by the authors. The authors take full responsibility for the accuracy, integrity, and originality of the work.

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