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A Rank Aggregation Approach to Identify High-Priority Districts for Malnutrition Intervention in India: A Cross-Sectional Analysis of NFHS-5 Data Using the Spearman Footrule Method

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Abstract

Background

Child malnutrition remains a major public health challenge in India and continues to hinder progress toward national development priorities and the Sustainable Development Goals. Despite large-scale initiatives such as the Integrated Child Development Services and POSHAN Abhiyaan, substantial disparities in stunting, wasting, and underweight persist across states and districts. These indicators are linked to increased morbidity, mortality, impaired cognitive development, and long-term economic consequences. National averages often obscure significant subnational variation, limiting effective targeting of interventions. Furthermore, most assessments evaluate indicators separately, making it difficult to identify districts with compounded nutritional burdens. This study examined the prevalence and regional disparities of child malnutrition in India using NFHS-5 data and identified high-priority districts through a composite rank aggregation approach.

Methods

NFHS-5 data were analyzed to determine the prevalence of stunting, wasting, and underweight among children under five years of age, categorized by background characteristics such as age, sex, residence, maternal education, and socioeconomic status. State- and district-level variations were assessed, and a composite malnutrition rank was developed using the Spearman Footrule distance method, which effectively integrates multiple indicators into a single aggregated rank. This method was selected because it provides a statistically robust and transparent approach that minimizes the influence of any single indicator, ensuring that the final rankings accurately reflect the overall burden of malnutrition across districts.

Results

The findings revealed that malnutrition remains widespread, with higher prevalence observed among children from rural areas, lower wealth quintiles, and mothers with no formal education or low BMI. States such as Bihar, Jharkhand, and Gujarat and districts including Pashchimi Singhbhum (Jharkhand) and Arwal (Bihar) emerged as high-priority regions. The rank aggregation method effectively identified areas requiring urgent policy attention.

Conclusion

The study underscores persistent inequalities in child nutrition across India and highlights the need for region-specific, multi-sectoral interventions focusing on maternal health, education, and poverty reduction. The use of a composite ranking approach provides a transparent and evidence-based framework for policymakers to prioritize interventions and track progress toward national nutrition goals.

1.Introduction

Child malnutrition remains one of the most critical global public health challenges, contributing substantially to morbidity and mortality among children under five years of age. The World Health Organization reports that undernutrition continues to affect millions of children worldwide, with long-term consequences for survival and development [1]. Maternal and child undernutrition also contributes to impaired growth, reduced immunity, and increased susceptibility to infectious diseases in low- and middle-income countries [2].

In India, national efforts such as POSHAN Abhiyaan have aimed to reduce malnutrition through multisectoral coordination and targeted nutritional interventions [3]. Despite these initiatives, major challenges in child nutrition persist, as highlighted in national and international assessments [4]. According to the National Family Health Survey (NFHS-5, 2019–21), 35.5% of children under five are stunted, 19.2% are wasted, and 32.1% are underweight [5]. Economic growth alone has proven insufficient to eliminate malnutrition, underscoring the need to reposition nutrition as central to development policy [6]. Furthermore, recent analyses indicate that multiple anthropometric failures often coexist within the same child, reflecting the multidimensional nature of undernutrition [7].

Low birth weight has been identified as a significant contributor to childhood undernutrition in India [8]. Regional analyses have also shown variations in child food deficiency and nutritional deprivation across states [9]. Socioeconomic inequalities continue to shape child nutrition outcomes, with wealth gradients playing a major role [10]. Evidence further demonstrates persistent inequality in childhood undernutrition across social and demographic strata [11]. Multilevel analyses reveal that geographic context significantly influences child nutrition beyond individual household characteristics [12]. Marked regional disparities in child nutrition outcomes remain evident across Indian states [13].

Women's empowerment has been shown to positively influence child nutritional status, highlighting the importance of maternal agency and decision-making power [14]. Environmental stressors such as climate vulnerability and food inflation further affect household nutrition security and child outcomes [15]. Spatial clustering analyses demonstrate that undernutrition is concentrated in specific districts, particularly in socioeconomically disadvantaged regions [16]. Growth assessment standards based on WHO references remain central to defining stunting and wasting classifications [17].

Methodological advances, including rank aggregation techniques, allow improved assessment of multidimensional regional disparities [18]. Trend analyses comparing NFHS-3 to NFHS-5 indicate gradual but insufficient reductions in child undernutrition over time [19]. Persistent wasting remains a concern in several regions, indicating ongoing acute nutritional stress [20]. Determinants of wasting differ from those of chronic undernutrition, necessitating distinct policy approaches [21]. Maternal factors such as body mass index and education continue to strongly predict child nutrition outcomes [22]. Socioeconomic

and educational inequalities further reinforce disparities in malnutrition prevalence [23]. Decomposition analyses confirm that improvements in maternal education and sanitation have contributed to declines in stunting, although inequities remain [24].

Regional disparities remain pronounced, with certain eastern and central states reporting higher burdens of malnutrition [25]. Spatial clustering studies confirm concentration of undernutrition in tribal and resource-poor districts [26]. Caste- and tribe-based inequities continue to influence nutritional deprivation [27]. The COVID-19 pandemic disrupted food supply chains and health services, adversely affecting child nutrition indicators [28]. Broader regional assessments in South Asia suggest that the pandemic amplified existing vulnerabilities among low-income households [29].

Simultaneously, India is experiencing a double burden of malnutrition, characterized by persistent undernutrition alongside rising overweight and obesity [30]. Evidence indicates that undernutrition and overnutrition may coexist within the same households, reflecting dietary transitions [31]. Household food insecurity remains strongly associated with both forms of malnutrition [32]. Evaluations of POSHAN Abhiyaan report progress but identify gaps in implementation and convergence mechanisms [33]. Governance and programme delivery challenges continue to limit optimal outcomes in high-burden districts [34]. A systematic review of determinants emphasizes the need for integrated nutrition-sensitive and nutrition-specific strategies supported by robust sub-national monitoring systems [35]. Recent global estimates reaffirm the urgency of accelerating progress toward international child nutrition targets [36].

Given persistent socioeconomic inequalities, geographic clustering, and emerging nutritional transitions, comprehensive analysis of state- and district-level disparities using the most recent NFHS-5 data is essential. Therefore, this study aims to estimate the prevalence of stunting, wasting, and underweight among children under five years in India; examine demographic, socioeconomic, and maternal determinants; and assess spatial disparities through aggregated ranking and district-level analytical approaches. By generating geographically disaggregated evidence, the study seeks to inform targeted interventions and strengthen India's progress toward achieving Sustainable Development Goal 2 (Zero Hunger).

2. Methods

2.1. Study design and data source

This study is a cross-sectional secondary data analysis based on the fifth round of the National Family Health Survey (NFHS-5), conducted during 2019–2021 by the Ministry of Health and Family Welfare, Government of India. NFHS-5 is a nationally representative household survey implemented using a multistage stratified sampling design covering all states and union territories of India. The survey provides detailed information on demographic characteristics, health indicators, and nutritional status of children and women.

Anthropometric measurements of children were collected using standardized procedures. Height and weight were measured by trained field investigators following World Health Organization (WHO) guidelines. Nutritional status indicators were constructed using WHO Child Growth Standards.

2.2 Study population

The study population included children aged 0–59 months with valid anthropometric measurements recorded in NFHS-5.

2.2.1 Inclusion Criteria

(1) children aged 0–59 months at the time of survey;

(2) availability of complete and valid measurements of height, weight, and age required for calculation of anthropometric indices; and

(3) availability of district and state identifiers.

2.2.2 Exclusion Criteria

(1) children with missing or implausible anthropometric z-scores based on WHO flagging criteria; and

(2) records with incomplete background information relevant to the analysis.

A complete-case approach was applied to ensure data consistency and analytical validity.

2.3 Outcome variables

The primary outcomes were three standard indicators of child undernutrition:

(1)Stunting, defined as height-for-age z-score (HAZ) < − 2 standard deviations (SD);

(2)Wasting, defined as weight-for-height z-score (WHZ) < − 2 SD;

(3)Underweight, defined as weight-for-age z-score (WAZ) < − 2 SD.

Z-scores were calculated using WHO growth reference standards as implemented in the NFHS dataset.

2.4 District and State-Level Ranking

Malnutrition prevalence was examined at both district and state levels to capture fine-scale and broader geographic disparities. At the district level, stunting, wasting, and underweight prevalence were used to rank districts in descending order, with higher prevalence assigned lower numerical ranks to indicate higher priority for intervention. When two or more districts shared identical prevalence values, the average of the tied ranks was assigned. Similarly, for state-level analysis, prevalence of each malnutrition indicator was calculated by aggregating district-level data, and states were ranked in descending order of prevalence. This dual-level approach enables identification of both high-burden districts and high-risk states, providing a comprehensive picture of regional malnutrition patterns.

2.5 Rank Aggregation Using Spearman Footrule method

To derive a single composite measure of malnutrition burden for each district and state, a median-based Spearman Footrule approach was employed. The median rank minimizes the sum of absolute deviations from individual indicator ranks, providing robustness against outliers and extreme values. This composite rank integrates stunting, wasting, and underweight prevalence into a unified measure, allowing consistent cross-district and cross-state comparisons and prioritization for policy interventions [18].

2.6 Visualization

Aggregated ranks at both district and state levels were visualized using choropleth maps, where color intensity reflects the magnitude of malnutrition burden. Districts or states with higher nutritional vulnerability were shaded with darker colors, while those with lower burden appeared lighter. These maps enable identification of spatial clusters and geographic concentrations of high-priority regions, facilitating evidence-based planning and targeted interventions.

2.7 Statistical Analysis

All statistical analyses were conducted using R software (version 4.3).Composite ranks for each district and state were derived using rank aggregation procedures. Spearman Footrule distances were computed to quantify divergence between individual indicator ranks and aggregated ranks.Spearman rank correlation coefficients were calculated to assess agreement between composite and individual malnutrition indicators. Statistical significance was evaluated using two-sided tests with a significance level of $p < 0.05$.Survey sampling weights provided in the NFHS dataset were applied where appropriate to ensure nationally representative estimates.

2.8 Ethical considerations

This study utilized publicly available, de-identified secondary data from NFHS-5. Ethical approval for NFHS-5 was obtained by the implementing agencies prior to data collection. As the present study involved secondary analysis of anonymized data, additional institutional ethics committee approval was not required.

3. Results

3.1 Background Characteristics

Table 1 provides the prevalence of stunting, wasting, and underweight varied across age, sex, residence, and maternal and socioeconomic factors. Stunting increased with age, peaking at 18–23 months (43.4%), while wasting decreased from 27.0% in children under six months to 16.7% at 48–59 months. Underweight prevalence was highest among children aged 36–47 months (34.1%).

Male children (36.2%, 20.0%, 32.9%) were more affected than females (34.6%, 18.5%, 31.2%), and rural children had higher stunting (37.3%) and underweight (33.8%) than urban counterparts. Short birth intervals (< 24 months) and higher birth order were associated with increased malnutrition. Children reported as very small at birth had the highest stunting (44.4%), wasting (25.2%), and underweight (46.1%).

Maternal education and nutritional status were inversely related to malnutrition, with children of uneducated or underweight mothers being most affected. Socioeconomic disparities were evident: children from the lowest wealth quintile had the highest stunting (46.1%), wasting (22.5%), and underweight (43.1%), while those from the highest quintile had the lowest prevalence (22.9%, 16.2%, 20.1%).

Maternal nutritional status significantly influenced child malnutrition. Children of underweight mothers (BMI < 18.5 kg/m²) had the highest prevalence of stunting (43.4%), wasting (24.3%), and underweight (43.2%), while children of overweight mothers (BMI ≥ 25.0 kg/m²) had the lowest prevalence (stunting 27.3%, wasting 12.9%, and underweight 32.0%).

Socioeconomic status, assessed through wealth quintiles, showed a clear gradient in malnutrition. Children from the lowest wealth quintile had the highest prevalence of stunting (46.1%), wasting (22.5%), and underweight (43.1%), whereas those from the highest quintile exhibited the lowest prevalence rates (stunting 22.9%, wasting 16.2%, and underweight 20.1%).

Religious and caste/tribe differences were also observed, with Sikh and Jain children exhibiting lower malnutrition rates and children from scheduled castes and tribes being more affected.

Table 1
Prevalence of Malnutrition (Stunting, Wasting, and Underweight) among Children by Background Characteristics

Background characteristic		Stunted	wasting	Underweight
Age in months	< 6	24.4	27	28.5
	6–8	23.2	23.1	25.1
	9–11	26.2	23.3	27.5
	12–17	36.3	20.5	29.2
	18–23	43.4	18.8	33.1
	24–35	38.1	18.7	33.7
	36–47	39.2	16.6	34.1
	48–59	35.4	16.7	34.2
Sex	Male	36.2	20	32.9
	Female	34.6	18.5	31.2
Residence	Urban	30.1	18.5	27.3
	Rural	37.3	19.5	33.8
Birth interval (months)	First birth	31.5	18.4	28.6
	< 24	43.2	19.4	37.9
	24–35	40.6	20	36.8
	36 or more	33.4	19.8	30.7
	Don't know	35.3	26.9	38.6
Birth order	1	31.5	18.4	28.6
	2–3	36.2	19.7	33
	4–5	44.9	20.4	40
	6 or more	48.6	20.6	41.8
Size at birth	Very small	44.4	25.2	46.1
	Small	40.6	22	39.1
	Average or larger	34.7	18.8	31
	Don't know	44.7	21.1	39.4
Mother's schooling	No schooling	46.3	21.5	42.1
	< 5 years complete	42.1	21.3	38.9
	5–7 years complete	40.1	19.7	35.7
	8–9 years complete	35.6	19.3	32.4
	10–11 years complete	31	18.9	28.2
	12 or more years complete	25.7	17	23.1
Religion	Hindu	35.5	19.3	32.3
	Muslim	36.8	20	32.8
	Christian	31.3	16.4	26.2
	Sikh	23.6	11.9	18.3
	Buddhist/Neo-Buddhist	35.4	23	35.5
	Jain	28.5	12.8	15.5
	Other	40.3	21.2	42.3
Caste/Tribe	Scheduled caste	39.2	19.7	35.1
	Scheduled tribe	40.9	23.2	39.5
	Other backward class	34.8	18.9	31.2

Background characteristic		Stunted	wasting	Underweight
	Other	30.1	17.5	27
	Don’t know	40.2	21.5	36.8
Mother's nutritional status	Underweight (BMI < 18.5 kg/m²)	43.4	24.3	43.2
	Normal (BMI 18.5–24.9 kg/m²)	35.5	19.6	43.2
	Overweight (BMI ≥ 25.0 kg/m²)	27.3	12.9	32
Wealth quintile	Lowest	46.1	22.5	43.1
	Second	39.7	19.9	35.6
	Middle	34.4	18.4	30.3
	Fourth	28.1	17.7	25.4
	Highest	22.9	16.2	20.1

3.2 State-Level Distribution of Malnutrition

Table 2 The state-wise analysis of child malnutrition indicators showed that for stunting, the highest prevalence was observed in Meghalaya (46.5%, rank 1), followed by Bihar (42.9%, rank 2) and Uttar Pradesh (39.7%, rank 3), while the lowest prevalence was recorded in Puducherry (20%, rank 36) and Sikkim (22.3%, rank 35). For wasting, Maharashtra had the highest prevalence (26%, rank 1), followed by Gujarat (25%, rank 2) and Bihar (23%, rank 3), whereas the lowest prevalence was seen in Chandigarh (8%, rank 36) and Manipur (10%, rank 32). In terms of underweight, Bihar showed the highest prevalence (41%, rank 1), followed by Gujarat (40%, rank 2) and Jharkhand (39%, rank 3), while the lowest prevalence was in Mizoram (13%, rank 36) and Sikkim (13%, rank 35).

Based on the aggregated rank, which combines stunting, wasting, and underweight, Bihar exhibited the highest overall burden (aggregated rank 2, Footrule distance 4), followed by Gujarat (3.33, Footrule distance 8) and Jharkhand (3.67, Footrule distance 2). The lowest overall burden was observed in Manipur (33.33, Footrule distance 4). Meghalaya had the highest Footrule distance (58), indicating substantial variation among individual indicators, while Jharkhand and Uttarakhand had the lowest Footrule distances (2), reflecting strong consistency between individual and aggregated rankings.

Overall, these results demonstrate considerable variation in malnutrition across states, with some states such as Bihar, Gujarat, and Jharkhand consistently showing high burden across indicators, whereas others like Manipur, Mizoram, and Puducherry have comparatively lower prevalence. Footrule distances indicate the degree of alignment between individual indicators and aggregated ranks across states.

Table 2

Nutritional status and rank of children by state: Prevalence of stunting, wasting, and underweight along with state-level aggregated ranks and Footrule distan

State	Stunted	ranking_stunted	wasted	ranking_wasting	underweight	ranking_underweight	Aggregated_Rank	Footrule_Distan
Bihar	42.9	2	23	3	41	1	2	4
Gujarat	39	6	25	2	40	2	3.33	8
Jharkhand	39.6	4	22	4	39	3	3.67	2
Dadra & Nagar Haveli and Daman & Diu	39.4	5	22	7	39	4	5.33	6
Maharashtra	35.2	10	26	1	36	5	5.33	18
Assam	35.3	9	22	5	33	8	7.33	8
Karnataka	35.4	8	20	9	33	7	8	4
Madhya Pradesh	35.7	7	19	14	33	6	9	16
West Bengal	33.8	12	20	8	32	9	9.67	8
Telangana	33.1	13	22	6	32	11	10	14
Uttar Pradesh	39.7	3	17	20	32	10	11	34
Chhattisgarh	34.6	11	19	13	31	12	12	4
Nagaland	32.7	14	19	10	27	16	13.33	12
Meghalaya	46.5	1	12	30	27	17	16	58
Odisha	31	19	18	16	30	13	16	12
Tripura	32.3	15	18	15	26	19	16.33	8
Lakshadweep	32	16	17	19	26	18	17.67	6
Rajasthan	31.8	17	17	21	28	15	17.67	12
Andhra Pradesh	31.2	18	16.1	22	30	14	18	16
Himachal Pradesh	30.8	21	17	18	26	20	19.67	6
Goa	25.8	28	19	11	24	21	20	34
Jammu & Kashmir	26.9	27	19	12	21	26	21.67	30
Ladakh	30.5	22	18	17	20	29	22.67	24
Delhi	30.9	20	11	32	22	24	25.33	24
Tamil Nadu	25	30	15	25	22	23	26	14
Andaman & Nicobar Islands	22.5	34	16	23	24	22	26.33	24
Uttarakhand	27	26	13	27	21	27	26.67	2
Haryana	27.5	25	12	31	22	25	27	12
Arunachal Pradesh	28	24	13	28	15	32	28	16
Kerala	23.4	33	16	24	20	30	29	18
Chandigarh	25.3	29	8	36	21	28	31	16
Mizoram	28.9	23	10	35	13	36	31.33	26
Punjab	24.5	31	11	33	17	31	31.67	4
Sikkim	22.3	35	14	26	13	35	32	18
Puducherry	20	36	12	29	15	33	32.67	14
Manipur	23.4	32	10	34	13	34	33.33	4

3.3 District-Level Priority Ranking

Table 3

The analysis of the top 50 districts based on aggregated rankings of stunting, wasting, and underweight revealed substantial variation in child malnutrition. Pashchimi Singhbhum (Jharkhand) had the highest overall burden (aggregated rank 11.33, Footrule distance 62), followed by Panch Mahals (Gujarat, 20.33, Footrule distance 72) and Dohad (Gujarat, 23.67, Footrule distance 118). Other high-burden districts included Arwal (Bihar, 24.33, Footrule distance 116), Nandurbar (Maharashtra, 29, Footrule distance 112), and Chhota Udaipur (Gujarat, 34, Footrule distance 72). Among the top 50 districts, Aravali (Gujarat, 37.33, Footrule distance 50) and Buldana (Maharashtra, 39.33, Footrule distance 102) also ranked prominently.

Footrule distances, which measure the degree of alignment among stunting, wasting, and underweight, varied considerably. The Dangs (Gujarat, 76, Footrule distance 442), Dhule (Maharashtra, 87.67, Footrule distance 444), and Chandrapur (Maharashtra, 88.33, Footrule distance 460) showed the largest discrepancies, indicating that the individual indicators differed markedly from the aggregated rank. Conversely, districts with lower Footrule distances had more consistent malnutrition patterns across indicators.

Overall, these results highlight both within- and across-state variation in child malnutrition. Some states have districts appearing among the highest-burden areas, while others from the same state rank lower, revealing localized pockets of malnutrition. These findings emphasize the need for district-specific interventions rather than uniform state-wide measures.Table 3: District-wise malnutrition ranking in India: Stunting, Wasting, and Underweight prevalence, aggregated ranks, and Footrule distance.

Table 3
District-wise malnutrition ranking in India: Stunting, Wasting, and Underweight prevalence, aggregated ranks, and Footrule distance.

District Names	State/UT	Rank_Stunted	Rank _Wasted	Rank_UnderWeight	Aggregated_Rank	Footrule_Distance
Pashchimi Singhbhum	Jharkhand	1	32	1	11.33	62
Panch Mahals	Gujarat	44	8	9	20.33	72
Dohad	Gujarat	4	63	4	23.67	118
Arwal	Bihar	63	5	5	24.33	116
Nandurbar	Maharastra	58	27	2	29	112
Chhota Udaipur	Gujarat	30	54	18	34	72
Adilabad	Telangana	61	40	8	36.33	106
Aravali	Gujarat	45	46	21	37.33	50
Buldana	Maharastra	73	22	23	39.33	102
Banda	Uttar Pradesh	14	99	13	42	172
Tapi	Gujarat	132	6	10	49.33	252
Jehanabad	Bihar	134	7	11	50.67	254
Banka	Bihar	49	77	39	55	76
Aurangabad	Bihar	135	16	16	55.67	238
Pakur	Jharkhand	12	151	12	58.33	278
Kaimur (Bhabua)	Bihar	85	70	22	59	126
Araria	Bihar	18	144	20	60.67	252
Saraikela-Kharsawan	Jharkhand	161	15	15	63.67	292
Mahisagar	Gujarat	97	87	14	66	166
Rohtas	Bihar	162	20	17	66.33	290
Nalanda	Bihar	115	60	26	67	178
Purnia	Bihar	95	96	25	72	142
Zunheboto	Nagaland	87	78	52	72.33	70
Narmada	Gujarat	43	170	7	73.33	326
Nabarangapur	Odisha	84	110	29	74.33	162
Bhojpur	Bihar	146	25	54	75	242
Buxar	Bihar	171	13	41	75	316
The Dangs	Gujarat	223	2	3	76	442
Koppal	Karnataka	26	168	38	77.33	284
Gaya	Bihar	42	137	61	80	190
Nashik	Maharastra	124	72	50	82	148
Chitrakoot	Uttar Pradesh	41	130	79	83.33	178
Lakhisarai	Bihar	111	101	44	85.33	134
Supaul	Bihar	119	97	45	87	148
Dhule	Maharastra	225	3	35	87.67	444
Chandrapur	Maharastra	234	4	27	88.33	460
Katihar	Bihar	90	156	19	88.33	274
Saran	Bihar	170	49	46	88.33	248
Biswanath	Assam	108	74	89	90.33	68
Katni	Madhya Pradesh	21	195	57	91	348
Khunti	Jharkhand	202	19	55	92	366

District Names	State/UT	Rank_Stunted	Rank _Wasted	Rank_UnderWeight	Aggregated_Rank	Footrule_Distance
Burhanpur	Madhya Pradesh	197	59	24	93.33	346
Anand	Gujarat	205	51	28	94.67	354
Lohardaga	Jharkhand	144	82	62	96	164
Gandhinagar	Gujarat	211	29	51	97	364
Bijapur	Chhattisgarh	6	265	34	101.67	518
Komaram Bheem Asifabad	Telangana	212	9	87	102.67	406
Bharuch	Gujarat	139	136	40	105	198
Dumka	Jharkhand	210	61	47	106	326
Puruliya	West Bengal	245	42	31	106	428

4. Discussion

This study used NFHS-5 data to identify high-priority districts for child malnutrition in India employing the Spearman Footrule aggregation method. States such as Bihar, Jharkhand, Madhya Pradesh, Gujarat, and Uttar Pradesh exhibited the highest malnutrition burden, whereas southern and western states had comparatively lower prevalence, highlighting persistent regional disparities consistent with previous national surveys.

Overall, the prevalence of stunting among children under five was 35.7%, wasting 19.5%, and underweight 33.8%, indicating moderate improvement from NFHS-4 but still a substantial burden. These figures were slightly higher than Singh and Gupta (2022), who reported 33.2% stunting and 19.3% wasting [19], and aligned closely with UNICEF (2022) estimates of 35.5% stunting and 19.3% wasting [4].

State-wise, Bihar (42.9%), Jharkhand (39.6%), and Gujarat (39.0%) had higher stunting than the national average, corroborating Kumar et al. (2022) [25], while Kerala (23.4%) and Puducherry (20.0%) showed the lowest prevalence, in line with Sharma and Singh (2022) [27]. Wasting remained high in Maharashtra (26%) and Gujarat (25%), consistent with Sethi et al. (2023) [20] and Bhattacharya and Chattopadhyay (2021) [21].

Socio-economic analysis revealed stunting was more prevalent among children of mothers with no schooling (46.3%) and in the lowest wealth quintile (46.1%), supporting findings by Dutta and Bhattacharyya (2022) [22], Srivastava and Chauhan (2020) [23], and Mondal et al. (2023) [24].

At the district level, Pashchimi Singhbhum (Jharkhand) and Arwal (Bihar) ranked highest in aggregated malnutrition burden, matching spatial clusters identified by Sahoo et al. (2023) [26]. These high-burden districts were also linked to marginalized caste and tribal populations, as reported by Sharma and Singh (2022) [27].

Despite modest improvements, malnutrition remains significant, reflecting gaps in program implementation. Evaluations of POSHAN Abhiyaan by Gupta et al. (2023) and Chatterjee et al. (2023) highlighted limited success due to uneven coverage and inadequate monitoring [33, 34]. Compared with global estimates (22% stunting and 7% wasting) [35, 36], India's progress remains slower, emphasizing the need for targeted, multisectoral interventions to address persistent regional and socio-economic inequalities.

5. Conclusion

The NFHS-5 analysis reveals that child malnutrition remains a major public health concern in India, with high levels of stunting, wasting, and underweight across several states and districts. Malnutrition was found to be more prevalent among children from poor, rural, and less-educated families, and among those born to undernourished mothers. Using rank aggregation methods, states such as Bihar, Jharkhand, and Gujarat and districts like Pashchimi Singhbhum and Arwal were identified as high-priority areas. The findings emphasize the need for targeted, region-specific nutrition programs focusing on maternal health, education, and poverty reduction. The rank-based approach provides a useful framework for policymakers to prioritize interventions and monitor progress toward national nutrition goals.

Abbreviations

BMI
Body Mass Index
COVID-19
Coronavirus Disease 2019
HAZ
Height-for-Age Z-score
IIPS
International Institute for Population Sciences
NFHS
National Family Health Survey
POSHAN

Prime Minister’s Overarching Scheme for Holistic Nourishment
SD
Standard Deviation
UNICEF
United Nations Children’s Fund
WAZ
Weight-for-Age Z-score
WHO
World Health Organization
WHZ
Weight-for-Height Z-score

Declarations

7. Data availability

The data that support the findings of this study are publicly available from the Demographic and Health Surveys (DHS) Program repository. The study utilized data from the National Family Health Survey (NFHS-5), India (2019–2021). These data are available upon reasonable request and registration through the DHS Program website:

https://dhsprogram.com/data/

The datasets analyzed during the current study are not publicly redistributed by the authors but can be accessed directly from the data provider following approval of a data request.

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10. Author’s Contributions Statement

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10.2 Contributions

Dr. Shubham Pandey: Conceptualization, Methodology, Visualization, Software, Writing - Original Draft, Formal Analysis. **Dr. Ankit Singh:** Conceptualization, Writing - Review & Editing. **Dr. Arunesh Kumar:** Conceptualization, Writing - Review & Editing

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11. Ethics declarations

11.1 Ethics approval and consent to participate

This study was based on secondary analysis of publicly available, anonymized data from the National Family Health Survey (NFHS-5). Prior permission to access and use the dataset was obtained from the Demographic and Health Surveys (DHS) Program under the authorization of the International Institute for Population Sciences (IIPS), Mumbai. Ethical approval for NFHS-5 was originally obtained by IIPS in collaboration with the Ministry of Health and Family Welfare, Government of India, before data collection. The survey protocols were reviewed and approved by the relevant national ethics review boards, and

informed consent was obtained from all participants during the original survey. As the present study involved analysis of de-identified secondary data with no direct participant involvement, additional ethical approval was not required in accordance with institutional and national research guidelines.

11.2 Clinical trial registration

Not applicable. This study is an observational secondary data analysis using nationally representative survey data and does not involve a clinical trial or prospective intervention; therefore, clinical trial registration was not required.

11.3 Consent for publication

Not applicable. This study used anonymized secondary data and does not contain any individual person's identifiable information.

11.4 Competing interests

The authors declare that they have no competing interests.

References

1. World Health Organization. Levels and trends in child malnutrition: key findings of the 2020 edition. Geneva: WHO; 2020.
2. Black RE, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet Glob Health. 2020;8(10):e1262–74.
3. Government of India. *POSHAN Abhiyaan annual report 2020–21*. New Delhi: Ministry of Women and Child Development; 2021.
4. UNICEF India. Situation of children in India: nutrition and health challenges. New Delhi: UNICEF; 2022.
5. International Institute for Population Sciences (IIPS), ICF. National Family Health Survey (NFHS-5), 2019–21: India report. Mumbai: IIPS; 2021.
6. World Bank. Repositioning nutrition as central to development. Washington (DC): World Bank; 2021.
7. Singh R, Kumar P. Co-occurrences of forms of child undernutrition in India: insights from NFHS-5. Nutrients. 2021;13(8):2723.
8. Srivastava S, et al. Contribution of low birth weight to childhood undernutrition in India: evidence from NFHS-5. BMC Public Health. 2023;23(1):456.
9. Pandey R, et al. Child food deficiency and regional patterns in India. Child Indic Res. 2024;18(3):678–92.
10. Jain M, Dandekar A. Socioeconomic inequalities in child malnutrition in India: evidence from NFHS-5. PLOS Glob Public Health. 2022;2(5):e0001534.
11. Bora JK, Saikia N. Inequality in childhood undernutrition in India: evidence from NFHS-5. BMC Nutr. 2022;8(1):112–25.
12. Rout A, et al. Multilevel analysis of geographic variation among correlates of child undernutrition in India. Matern Child Nutr. 2021;17(2):e13197.
13. Ghosh S, Pradhan J. Regional disparities in child nutrition outcomes in India. J Public Health Res. 2023;12(1):45–58.
14. Nair R, Gupta V. Women's empowerment and child nutrition in India: evidence from NFHS-5. BMC Public Health. 2023;23(4):872.
15. Verma S, Dubey A. Climate vulnerability, food inflation, and child nutrition outcomes in India. Glob Food Secur. 2024;41:100689.
16. Sharma T, Kundu S. Spatial clustering of undernutrition among Indian districts: an analysis of NFHS-5 data. Nutrients. 2025;17(6):977.
17. WHO Multicentre Growth Reference Study Group. Creation and evaluation of new growth charts with a gradual transition to the World Health Organization growth standards. Pediatrics. 2025;156(3):e2025070697.
18. Akbari S, Khoshgoftaar TM. Solving large-scale rank aggregation problems. Comput Oper Res. 2023;147:105832.
19. Singh A, Gupta S. Trends in childhood undernutrition in India, 2006–2021: evidence from NFHS-3 to NFHS-5. BMC Public Health. 2022;22(1):2314.
20. Sethi V, et al. Persistent wasting in Indian children: a multilevel analysis of NFHS-5 data. Int J Equity Health. 2023;22(1):45.
21. Bhattacharya H, Chattopadhyay S. Determinants of wasting among children under five in India. PLoS ONE. 2021;16(8):e0256195.
22. Dutta M, Bhattacharyya H. Maternal factors and child nutrition in India: evidence from NFHS-5. BMC Nutr. 2022;8(1):47.
23. Srivastava S, Chauhan S. Inequalities in child malnutrition across wealth and education strata. Public Health Nutr. 2020;23(10):1809–18.
24. Mondal N, et al. Decomposition analysis of socio-economic inequalities in stunting: NFHS-5 evidence. Int J Public Health. 2023;68:1605879.
25. Kumar A, et al. Regional disparities in child malnutrition in India: insights from NFHS-5. Indian J Community Med. 2022;47(4):563–9.
26. Sahoo A, et al. Spatial clustering of child undernutrition in India, 2019–21. Soc Sci Med. 2023;319:115626.
27. Sharma P, Singh R. Caste-tribe gaps in child nutrition outcomes: NFHS-5 analysis. J Popul Res. 2022;39(3):401–20.
28. Nanda P, et al. Impact of COVID-19 on child nutrition outcomes in India. BMJ Glob Health. 2022;7(9):e009822.
29. Menon P, et al. The nutrition effects of the COVID-19 pandemic in South Asia. World Dev. 2023;165:106141.
30. Patel K, et al. The double burden of malnutrition in India: emerging trends. Nutrients. 2021;13(9):2996.
31. Choudhary P, et al. Coexistence of undernutrition and obesity in Indian households. Front Public Health. 2023;11:1125468.
32. Roy S, et al. Household food insecurity and child nutrition: a NFHS-5 based analysis. Nutrients. 2023;15(2):385.
33. Gupta V, et al. Evaluating India's POSHAN Abhiyaan: progress and gaps. Indian J Public Health. 2023;67(2):128–34.
34. Chatterjee S, et al. Nutrition governance and programme implementation challenges in India. Health Policy Plan. 2023;38(5):681–93.
35. Mishra A, et al. Integrated determinants of child malnutrition in India: a systematic review. Public Health Rev. 2021;42:1604055.
36. World Bank Group. Joint child malnutrition estimates, 2023 edition. Geneva: WHO; 2023.

Figures

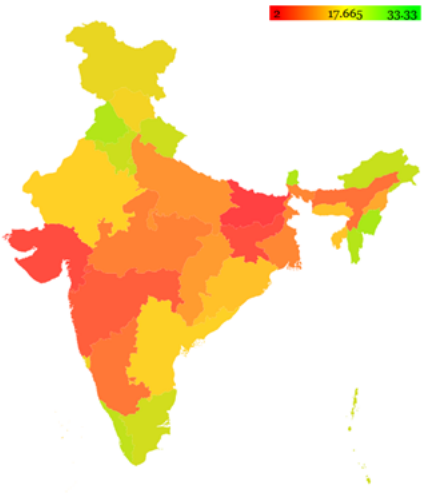


Figure 1

Aggregated Rank of malnutrition indicators across Indian states

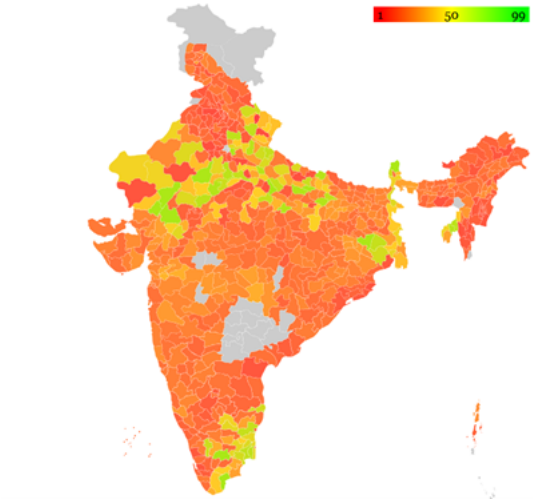


Figure 2

Aggregated Rank of malnutrition indicators across Indian districts