

Prevalence of undernutrition and change detection among under-five children of EAG states in India: scrutinizing from NFHS-4 and NFHS-5

Dr. Arabinda Roy (✉ arabindaroy3006@mail.com)

Dr. Meghnad Saha College

Mostafijur Rahaman

University of Gour Banga

Research Article

Keywords: Undernutrition, Under-five children, EAG states, NFHS

Posted Date: January 11th, 2023

DOI: <https://doi.org/10.21203/rs.3.rs-2431057/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

Background:

Nowadays undernutrition among the under five children is a serious public health problem in the developing countries like India. There are EAG states in India which are socio-economically backward in term of demographic and epidemiological transition, characterized by high population growth rate, high infant child mortality and high fertility. The current study was conducted to assess the changes of the indicator of undernutrition with the help of anthropometric measurement of under five children and represent the current (NFHS-5, 2019-21) prevalence of child undernutrition among the EAG states of India.

Methods

The state level data of undernutrition were extracted from state fact sheet of India, published by NFHS, India. The study is based on two time series of NFHS (NFHS-4 & NFHS-5). The changes of undernutrition indices in the EAG states were estimated by differentiate the last series prevalence from the previous series prevalence. Also thematic map were used to show spatial distribution of undernutrition indices of the latest NFHS series (NFHS-5).

Result

From the result it is found that the prevalence of stunting and underweight are decreased in all the EAG states and the decreasing pattern is more than the national level but the prevalence of wasting is only increased in Bihar. The NFHS-5 report shows that the prevalence of stunting and underweight in most of the EAG states has still more than 30%.

Conclusions

To reduce undernutrition among under-5 children there is need some target oriented policies which will help in improving the socio economic status of the children's family as well as maternal and child health. Enhance the level of education of mothers, awareness and raising the economic as well as socio-political empowerment of mothers is essential to reduce the undernutrition status. This study will be beneficial for the health workers and policy makers to understand the prevalence and changing pattern of undernutrition among the children of EAG states.

1. Introduction

The United Nations Children's Fund (UNCF) has described malnutrition as the "silent emergency" since it causes undernutrition, which includes underweight, stunting, and wasting [1, 2, 3]. Malnutrition are classified in to undernutrition (stunting, wasting and underweight) and over nutrition (overweight and obesity) condition of human being while childhood morbidities are the outcome of undernutrition among the under-5 children [4]. Malnutrition among the under-five children's is the major underlying cause of child morbidity and child mortality in many developing countries like India [5]. Malnutrition in under-five aged children increase the risk of infections, child morbidity and mortality and also reduce the mental development and nutritional status which is the best global indicator of wellbeing in children [6, 7, 8].

In India, undernutrition in children under the age of five is a serious public health issue [9] and the prevalence of it is highest in the globe and roughly twice as common in Sub-Saharan Africa [10, 11]. Almost 60 million children in India are underweight [12]. It has both long and short term irreversible negative health outcomes [13]. The short-term consequences of undernutrition are morbidity, mortality, and disability [14] and long term consequences of undernutrition largely affected brain structure and function along with reduced mental ability and learning capacity, poor school performance, and lower earnings [15]. Young children's physical and cognitive development is adversely affected by long-term undernutrition [16]. Nutritional status of children can be assessed in term of physical, biological, mental characteristics and stunting, wasting, underweight is the important indicator of undernutrition that affects the development and improvement of under-five children's which indirectly

influence the economy of the country [17, 18]. This is not a simple problem with single solution, it is the result of multiple and hierarchical interrelated determinant [19].

The causes of childhood malnutrition are multiple phenomenons. It is mainly affected by several socio-economic (religion, caste, education, wealth, family income), demographic (age of mother, age at marriage), proximal (gestation age, birth interval, maternal BMI, birth interval) and environmental determinants [20–24]. Many of the previous studies identified that there are many factors effect on child growth failure, these are poor household, food insecurity, residence in rural areas, maternal depression and deficiency of infant feeding [25–32]. As per UNICEF report (2006), the main factor behind childhood malnutrition are insufficient diet, frequent infections, poor breastfeeding practices, delayed introduction of complementary foods and inadequate protein in the diet, health status, food taboos, growth and personal choice related to diet [33].

The UNICEF/WHO/WB Joint Child Malnutrition Estimates (JME) Group released new data for 2021 showing that in 2020, globally, 149.2 million children under the age of 5 were stunted, 45.4 million wasted and 38.9 million overweight [34]. According to World Health Statistics Report (WHSR, 2012), India ranked second worldwide for child malnutrition (43.1%) after Timor-Leste (43.7%) which is a significant barrier to succeed better health outcome of the children [35]. According to National Family Health Survey (NFHS 5), prevalence of undernutrition among under five children in India shows that 32.1% under five children were underweight, 35.5% were stunted and 19.3% were wasted and there also exists a huge difference of undernutrition between rural and urban areas. The prevalence of undernutrition has not decreased as intended from the National Family Health Survey 1 to the National Family Health Survey 5.

Ministry of health and family welfare, Government of India established 8 Empowered Action Group (EAG) states in 2001 for achieving national health goals by monitoring and facilitating the Millennium Development Goal, these are Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh and Uttarakhand [36]. The states are socio-economically backward in term of demographic and epidemiological transition, characterized by high population growth rate, high infant and child mortality, high fertility [37–39]. The EAG states are highly populous and constitute 45.9% share of India's population. It is notable that half of the population below the poverty line in India is lived in the EAG states. The latest round (NFHS-5, 2019-21) reported that 35.3% children aged under-5 years of EAG states were stunted that is too short for their age; 18.6% children were wasted and 31.9% children were underweight i.e. too thin to their age.

The achievement of 2030 Sustainable Development Goals (SDGs) as well national health goals is very essential in contemporary time for the development of a nation like India. The undernutrition scenario and nutrition related factors that enhance Sustainable Development Goals (SDGs) in India as well as EAGs are not in good conditions [40]. The nation won't achieve its SDGs of reducing child mortality if undernutrition is not successfully addressed [41]. Even though India's economy is expanding, both urban and rural areas still have significant rates of undernutrition-related child mortality [42].

Most of previous studies on malnutrition as well as undernutrition were carried out in rural and urban areas of India that basically focus on prevalence and determinants of undernutrition. A very few number of study of under five children have been conducted at community level and or district level in EAGs states (Table 1). Still no such study was conducted to analyse the current prevalence and change detection of undernutrition of under five children in the EAGs states in India in a comparative way. To bridge this gap, the current study was conducted to assess the changes of the indicator of undernutrition with the help of anthropometric measurement of under five children in the EAG states and represent the current (NFHS-5, 2019-21) prevalence of child undernutrition indices (stunting, wasting and underweight) among the EAG states of India. The study is helpful for policy making and creates public awareness about the child malnutrition in the EAG states by understanding the prevalence and changing pattern of malnutrition among the most focused states of India.

2. Materials & Methods

2.1. Data Source

The data used in the present study was carried out using the National Family Health Survey factsheets (NFHS-4, 2015-16 & NFHS-5, 2019-21) from eight EAG states of India - Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan, Uttar

Pradesh and Uttarakhand which can access easily and is available on the website <http://rchiips.org/nfhs/>. All the surveys were conducted by the International Institute for Population Science (IIPS), Mumbai, under the stewardship of the Ministry of Health and Family Welfare (MoHFW), Government of India. NFSH survey includes data on a number of demographic factors, maternal and child health outcomes, and health services at the national and sub-national levels. Data related to stunting, wasting, underweight and other anthropometric measurements have been collected from ever-married women aged 15–49 years and children born to those women in the 5 years preceding the survey.

Table 1
A general search of literature on undernutrition among under-five children in EAG states of India

Location	Published Year	Age group	Sample size	Prevalence (%)	Reference number
Bihar, Samastipur district	2005	0–5 years	191	All children under-weight	43
North Bihar, Darbhanga district	2011	6–59 months	1405	Acute malnutrition, 15.4 (NCHS), 19.4 (2006 WHO references)	44
Chhattisgarh, Baster district	2019	0–5 years	140	40.7% children were found to be stunted 29.3% found to have wasting and around 44.3% were found underweight.	45
Chhattisgarh, Raipur district	2004	2–3 years	311	Multiple form of prevalence of malnutrition among the children of Brahmin, Rawat and Teli	46
Jharkhand, India	2019	0–5 years	45	Stunting 45.3% (higher than the national average of 38.4%), wasting 29% and underweight 47.8%.	47
Odisha, urban slums of Berhampur district	2017	6–59 months	300	Underweight (55.3%), wasting (75%) and stunting (42%)	48
Orissa, Joda block, Keonjhar district	2009	0–5 years	600	The prevalence of stunting, underweight and wasting was 71%, 68% and 40% respectively	49
Madhyapradesh, Jabalpur district	2005	0–5 years	1022	Stunting: 51.6, under-weight: 61.6 and wasting: 32.9 (WHO criteria)	50
Rajasthan, Jodhpur district	2006	0–5 years	914	Stunting: 53, under-weight: 60 and wasting: 28 children	51
Uttar Pradesh, Bareilly district, urban slum	2012	0–5 years	110	Under-weight: 66.3 (IAP criteria)	52
Uttarakhand, Dehradun district	2022	0–5 years	70	Out of 70 children 17.14% showed mild wasting, 18.57% showed moderate wasting and (21.43%) showed severe wasting. 11.43% children showed mild stunting, moderate stunting was present in 15.71% children and severe stunting was present in 27.14% children. 31.43% children were moderately underweight and 30% were severely underweight.	53
Uttarakhand, Rishikesh district	2020	0–5 years	400	Urban vs rural areas: Underweight (40.5% vs 35.0%) and 46.5% vs 40.0%, respectively. Wasting more in urban (27% V/s 22.0%) than rural areas	54
NFHS: National Family Health Survey, IAP: Indian Academy of Pediatrics, NCHS: National Center for Health Statistics					

Source

Completed by authors.

2.2. Indicators of undernutrition used in the study

The assessment of undernutrition and its prevalence were the main outcome of the present study. The main indicators used in the present study are stunting, wasting and underweight which is presented in Table 2.

Table 2
Indicators of undernutrition

Anthropometric measure	Indicators	Explanations	What it measures	Contexts
z-score of height-for-age (HAZ)	Stunting	Those children have HAZ below - 2SD from the median of the WHO reference population is consideration as stunted	Chronic malnutrition	CHRONIC MALNUTRITION
z-score of weight-for-height (WHZ)	Wasting	Those children have WHZ below - 2SD from the median of the WHO reference population is consideration as wasted	Acute malnutrition	EMERGENCIES
-score of weight-for-age (WAZ)	Underweight	WAZ below - 2SD from the median of the WHO reference population is consideration as underweight. WAZ (weight-for-age) is a composite index of stunting and wasting.	Chronic or acute malnutrition or both	STABLE SITUATIONS

Source

Prepared by the authors based on WHO, 2018

2.3. Data Analysis

In the present study, the child growth failure indicators i.e., stunting, wasting and underweight were calculated using data from NFHS- 4(2015-16) and NFHS-5 (2019-21) factsheets of EAG states of India. To get a clear cut idea of nutritional status of under-five children in the EAG states of India, a comparative analysis have been performed. The change of undernutrition among under-5 children of EAG states were estimated by differentiating the prevalence of child growth failure of NFHS-4 from NFHS-5. Thematic mapping technique is used to show the child undernutrition status of the EAG states.

2.4. Software

The statistical analysis and diagrams had been operated with MS Excel v2007 (Microsoft Corporation). Thematic maps are prepared in QGIS v3.4 software platform.

3. Results

3.1. Trends and change detection of undernutrition among under 5 children in EAG states

The trend and change detection (Table 3, 4, 5 and Fig. 1) shows that over the years the prevalence of undernutrition in the form of stunting, wasting and underweight) in EAG states of India has reduced. However, underweight forms of undernutrition of under five children across the EAG states has reduced comparatively more (-6.79%) than the stunting (-5.5) and wasting (-3.9%) across NFHS-4 & NFHS-5 round.

3.2. Changing pattern of stunted children among the EAG states

Data of Table 3 shows that prevalence of stunting among under-5 children in EAG states have decrease in NFHS-5 from NFHS-4. The decreasing trend in EAG states (-5.5%) in more than the national average (-2.9). Highest decline of stunting is found in Rajasthan (-7.3%). There are also 4 states, Uttar Pradesh (-6.6%), Uttarakhand (-6.5%) and Madhya Pradesh (-6.3%) who perform their best to declining the prevalence of stunting in NFHS-5. Chhattisgarh and Orissa are comparative worst performing state to

decline the prevalence of stunting (almost – 3%) between 4th and 5th round of NFHS. This is the sign of chronic under nutrition. Bihar (-5.4%) and Jharkhand (-5.7%) performed moderately in declination of stunting.

Table 3
Changing pattern of stunted children between NFHS-4 & NFHS-5 in EAG states of India

Changing pattern of stunted (%)									
India/States	NFHS-4			NFHS-5			Changes in % (Difference between NFHS-5 & NFHS-4)		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
India	38.4	41.2	31	35.5	37.3	30.1	-2.9	-3.9	-0.9
EAG states	40.8	42.3	34.2	35.3	36.7	29.3	-5.5	-5.7	-4.9
Bihar	48.3	49.3	39.8	42.9	43.9	36.8	-5.4	-5.4	-3
Chhattisgarh	37.6	39.2	31.6	34.6	35.7	30	-3	-3.5	-1.6
Jharkhand	45.3	48	33.7	39.6	42.3	26.8	-5.7	-5.7	-6.9
Madhya Pradesh	42	43.6	37.5	35.7	37.3	30.1	-6.3	-6.3	-7.4
Orissa	34.1	35.3	27.2	31	32	24.9	-3.1	-3.3	-2.3
Rajasthan	39.1	40.8	33	31.8	32.6	28.3	-7.3	-8.2	-4.7
Uttar Pradesh	46.3	48.5	37.9	39.7	41.3	33	-6.6	-7.2	-4.9
Uttarakhand	33.5	34	32.5	27	28.2	24.3	-6.5	-5.8	-8.2

Source

Author's own calculation based on NFHS-4 (2015-16) and NFHS-5 (2019-20) factsheet for EAGs states of India

The changing pattern of stunted of under five children in rural and urban areas of EAG states in India is also presented in Table 3. Rajasthan has the highest decreasing trend (-8.2) of stunting while Orissa (-3.3%) had the least stunting in rural areas of EAG states and in urban areas of EAG states, highest decreasing trend of stunting (-8.2%) was observed in Uttarakhand and lowest was found in Jharkhand (-1.6%). The decreasing trend of stunted in rural areas of Rajasthan (-8.2), Uttar Pradesh (-7.2), Orissa (-3.3), Chhattisgarh (-3.5), Bihar (-5.4) is higher comparing to the urban areas.

3.3. Changing pattern of wasted children among the EAG states

Table 4 gives details of the changing pattern of prevalence of wasting between NFHS-4, 2015-16 & NFHS-5, 2019-21 among under-5 children in the EAG states of India. The table indicates that the proportion of wasted children decreased in EAG states is (-3.8) which is double than the national average (-1.7%). It is surprisingly observe that Bihar (2.1) is the worst performing state for increasing wasted children over the same period of time, which is a sign of under nutrition. The prevalence of wasting among under-5 children has decreased highest in Madhya Pradesh (-6.8%). Also there are three states Jharkhand (-6.6), Rajasthan (-6.2%) and Uttarakhand (-6.3%) doing their best to reduce prevalence of wasting, Chhattisgarh (-4.2%) moderately decrease the stunting rate between the mentioned duration. Although Uttar Pradesh (-0.6) has the lowest decreasing trend of thinness or wasting followed by Orissa (-2.3%). Highest decreasing trend of wasting (-8.6%) was observed in rural areas of Uttarakhand and lowest was found in Uttar Pradesh (-0.9%). Undernutrition in the form of wasting is more prevalent in the rural areas than the urban areas of EAG states.

Table 4
Changing pattern of wasted children between NFHS-4 & NFHS-5 in EAG states of India.

Changing pattern of wasted (%)									
India/States	NFHS-4			NFHS-5			Changes in % (Difference between NFHS-5 & NFHS-4)		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
India	21	21.5	20	19.3	19.5	18.5	-1.7	-2	-1.5
EAG states	22.4	22.9	20.7	18.6	18.3	19.1	-3.9	-4.6	-1.7
Bihar	20.8	20.8	21.3	22.9	23.1	21.6	2.1	2.3	0.3
Chhattisgarh	23.1	23.7	20.6	18.9	18.9	18.9	-4.2	-4.8	-1.7
Jharkhand	29	29.5	26.8	22.4	22.3	23	-6.6	-7.2	-3.8
Madhya Pradesh	25.8	27.1	22	19	18.7	19.9	-6.8	-8.4	-2.1
Orissa	20.4	20.9	17	18.1	18.6	14.9	-2.3	-2.3	-2.1
Rajasthan	23	23.4	21.6	16.8	16.4	18.3	-6.2	-7	-3.3
Uttar Pradesh	17.9	17.9	18	17.3	17	18.7	-0.6	-0.9	0.7
Uttarakhand	19.5	19.9	18.6	13.2	11.3	17.4	-6.3	-8.6	-1.2

Source

Author's own calculation based on NFHS-4 (2015-16) and NFHS-5 (2019-20) factsheet for EAGs states of India

3.4. Changing pattern of underweight children among the EAG states

Table 5 delineates the changes of prevalence of underweight between NFHS-4 and NFHS-5 among the EAG states of India. The decreasing proportion in the EAG states (-6.8%) is slightly higher than the national level (-3.7%). Most of the states are able to decline the proportion of underweight children (more than 5%). Madhya Pradesh (-9.8%) is the best performing state to decreasing underweight of the under-5 children between NFHS-4 and NFHS-5. Also Rajasthan (-9.1%), Jharkhand (-8.4%), Uttar Pradesh (-7.4%), Chhattisgarh (-6.4%), Uttarakhand (-5.6%) and Orissa (-4.7%) reduce the prevalence of underweight. Interestingly Bihar (-2.9%) has the lower decreasing proportion of underweight children than the national level (-3.7%), also lowest among the EAG states. Out of the three childhood morbidity indices, the declining trend of prevalence of underweight among under-5 children is slightly high in the EAG states that were performing their best in NFHS-5 series to reduce childhood morbidities. The declining pattern of underweight as a form of undernutrition of under five children is higher in rural areas comparing to urban areas of EAG states. Madhya Pradesh (-10.8) has the highest decreasing trend of underweight while Bihar (-2.8%) had the least underweight in rural areas of EAG states and in urban areas of EAG states, highest decreasing trend of underweight (-9.3%) was observed in Jharkhand and lowest was found in Bihar (-1.7%).

Table 5
Changing pattern of underweight children between NFHS-4 & NFHS-5 in EAG states of India.

Changing pattern of underweight (%)									
India/States	NFHS-4			NFHS-5			Changes in % (Difference between NFHS-5 & NFHS-4)		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
India	35.8	38.3	29.1	32.1	33.8	27.3	-3.7	-4.5	-1.8
EAG states	38.7	40.2	32.5	31.9	32.9	27.0	-6.79	-7.23	-5.4
Bihar	43.9	44.6	37.5	41	41.8	35.8	-2.9	-2.8	-1.7
Chhattisgarh	37.7	39.6	30.2	31.3	32.7	25.8	-6.4	-6.9	-4.4
Jharkhand	47.8	49.8	39.3	39.4	41.4	30	-8.4	-8.4	-9.3
Madhya Pradesh	42.8	45	36.5	33	34.2	28.6	-9.8	-10.8	-7.9
Orissa	34.4	35.8	26.2	29.7	31	21.5	-4.7	-4.8	-4.7
Rajasthan	36.7	38.4	30.7	27.6	28.1	25.4	-9.1	-10.3	-5.3
Uttar Pradesh	39.5	41	33.7	32.1	33.1	28.2	-7.4	-7.9	-5.5
Uttarakhand	26.6	27.1	25.6	21	20.9	21	-5.6	-6.2	-4.6

Source

Author's own calculation based on NFHS-4 (2015-16) and NFHS-5 (2019-20) factsheet for EAGs states of India

3.5. Prevalence of stunting (NFHS-5, 2019-21) in the EAG states of India

The prevalence of wasting (acutely undernourished condition) in the EAG states has changed in NFHS-5 (2019-21) since NFHS-4 (2015-16). As per the report of NFHS-5 prevalence of stunted children in EAG states is decreased from 40.8–35.3% in between the two consecutive round of National Family Health Survey. Figure 2(A) shows state wise prevalence of stunting among under-5 children in the EAG states of India during the 5th round of NFHS. Among the EAG states Bihar (42.9%) has the highest prevalence of stunting followed by Uttar Pradesh (39.7%), Jharkhand (39.6%) and Madhya Pradesh (35.7%). The lowest prevalence observed in Uttarakhand (27%). Orissa (31%), Rajasthan (31.8%) and Chhattisgarh (34.6%) have comparatively moderate proportion of stunted children. With the pattern of the distribution the states with high proportion of stunted children are located clustering with each other in the central part of the EAG states.

3.6. Prevalence of wasting (NFHS-5, 2019-21) in the EAG states of India

Figure 2(B) shows prevalence of wasting or too thin for their height among the under-5 children of the 8 high focused states in India in NFHS-5, 2019-21. Though the weighted proportion of wasted children in India is not sharply change from NFHS-4 (21%) to NFHS-5 (19.3%) but the prevalence of wasted children in the EAG states is sharply decline from NFHS-4 (22.4%) to NFHS-5 (18.6%). Most of EAG states have lower prevalence of wasting than the national level. Among the EAG states there were 2 states reported with high proportion of wasted children (more than 20%), these are Bihar (22.9%) and Jharkhand (22.4%). There were 4 states (Rajasthan [16.8%], Uttar Pradesh [17.3%], Orissa [18.1%], Chhattisgarh [18.9%] and Madhya Pradesh [19%]) that were moderately suffering from thinness or wasting. Accordingly Uttarakhand has the lowest prevalence of wasting with the proportion of 13.2% which is very much lower than national level. It is interestingly found that out of the 8 EAG states only Bihar has increase the proportion of wasted children (from NFHS-4 [20.8%] to NFHS-5 [22.9%]).

3.7. Prevalence of underweight (NFHS-5, 2019-21) in the EAG states of India

Figure 2(C) displays the current prevalence of underweight of the under-5 children among the EAG states of India. As per the NFHS-5 (2019-21) report, the proportion of underweight children in EAG states (31.9%) and India (32.1%) nearly same. The proportion of underweight children in the EAG states varies from the highest in Bihar (41%) to lowest in Uttarakhand (21%). The top two states having high prevalence of underweight among the children are Bihar (41%) and Jharkhand (39.4%). The low prevalence of underweight is observed in Uttarakhand (21%) followed by Rajasthan (27.6%) and Orissa (29.7%). Rest of the EAG states of India comes under moderately prevalent states where the proportion of underweight children varies in between 30–35%. The clustering of underweight children was more in central part of the EAG states.

4. Discussion

In comparison to non-EAG states, the EAG states of India—Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh, Uttarakhand, Odisha, Jharkhand, and Chhattisgarh, including Assam—have a higher prevalence of undernutrition among children under the age of five [55]. The study was done to examine the change detection of the prevalence of childhood morbidities in under-5 children among the EAG states of India between NFHS-4 (2015-16) and NFHS-5 (2019-21). The study also provides the information about the status of childhood morbidities among the EAG states of India in NFHS-5. The study revealed that the decreasing rate of childhood morbidities among the EAG states is more than national level. But the status of childhood morbidities in most of the EAG states has very high than national level. There were 2 states (Bihar and Jharkhand) where the prevalence of stunting, wasting and underweight is very high. In case of wasting all the EAG the prevalence has declining but only in Bihar it increases. So, first of all we have to give special attention on Bihar and Jharkhand to reduce malnutrition of the under-5 children. Many previous studies show that low level of maternal education, employed parents, early marriage, poor household condition, bad sanitation, lack of maternal antenatal and postnatal care, under nutrition condition of mother, poor child and maternal dietary are positively and strongly associated with childhood morbidities [56–59]. A study observed that educated mothers are more aware about the children's nutritional requirement as a result they take care of their children more than uneducated mothers, who give birth of malnourished child [60]. In addition, a study remarked that in rural areas of Bihar and Chhattisgarh nearly 50% of females are still illiterate, it remains the causes of infant mortality [61]. Kumar et al. in their study mention the effect of gender disparity in literacy to utilize child health care [22]. A recent study examined that in the EAG states of India about 80% of inequality in stunting and underweight among under-5 children are determined by nutritional status of mother, mother's education, wealth index [62]. Some studies are shown that there is a significant association between malnutrition of the children and wealth status or family income [63, 64]. Some of these were the possible reasons that is why not all the EAG states are able to reduce individual malnutrition among the under-5 children. It is also acceptable that there is a direct correlation with poverty, unemployment, low health outcome, early marriage etc. and these are also the reasons of malnutrition and childhood morbidities in the EAG states. The NFHS (NFHS-5, 2019-21) shows only the indicators of childhood mortality in the EAG states but the data does not provide any causes behind the under nutrition condition of the children. So, to understand the causes of under nutrition we need micro level data of the states. To reduce malnutrition among under-5 children there is a need for some target oriented policies which will help in improving the socio economic status of the children's family as well as maternal and child health. We also need to focus on the district level of the EAG states for grass root improvement of the basic amenities like drinking water, good dietary and sanitation facility. Also by ensuring literacy and employment of the female can encourage women empowerment.

5. Conclusion And Recommendation

The study documents nutritional status among under-5 children and changes during NFHS-4 (2015-16) and NFHS-5 (2019-21) in the EAG states of India. Results of the present study revealed that the prevalence of stunting, wasting and underweight is higher in the EAG states, although the decreasing rate of nutritional measurements in the EAG states is more than our national average. The study results therefore, call for an evaluation of current health programs in EAG states and adoption of different strategies addressing these risk factors. Additional efforts are needed for maternal and child healthcare programs to improve the health status of women and children. Also there is a need to assess burden, training need and quality of service delivery by health workers at grass root level considering the large number of intervention strategies expected to be implemented by them. In context of EAG states despite several policies and program provisioning, the accessibility, availability, affordability and community childcare practices and strengthened implementation remain a challenge to the Indian health care system. In order to strengthen

the health system and internal evaluation of the activities for their efficacy, the implementation research has to integrate as a part of policy and programme implementation.

There are some strategies that can help policy makers and local governments should take initiative for mitigating the childhood morbidities.

- As the prevalence of malnutrition is very high in the EAG states, the state governments should take initiative steps to improve child health at individual level by educating the mothers on the basis of proper nutrition and utilize available health services. At community level health care system such as maternal and child health care programs are need to be accessible in rural areas.
- Continuity of healthcare during pregnancy period, delivery and also during under-5 age of the children is necessary for reduction of under-5 mortality.
- Proper implementation of The Integrated Child Development Services (ICDS), Maternal and Child Health (MCH) Care, Reproductive Child Health (RCH) and Accredited Social Health Activist (ASHA) is very much urgent in the EAG states for reduction of childhood morbidities.
- Make availability of infrastructure and adequate functioning machine of testing at District Hospitals, Primary Health Centre etc. for the improvement of public health facilities and institutional deliveries.
- Improving the overall household environment by increasing access to improved toilets and fuel can also contribute to further reductions in under-five mortality in EAG states of India.
- To improve the child undernutrition in EAG states, it is very essential to enhance the level of education of mothers, awareness and raising the economic as well as socio-political empowerment of mothers.

Declarations

Ethics approval and consent to participate

There is not required any ethical approve and consent of participate.

Consent to publication

'Not applicable'

Data Availability statement

The study is based on secondary data sets which are available in public domain. The data can access freely from the National Family Health Survey (NFHS) website at <http://rchiips.org/nfhs/>

Conflict of interest

The authors hereby declare that he has no conflict of interest.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgment

'Not applicable'

Authors' contributions

AR and MR contributed in the framing of design of the study; MR collected the data and analyzed. AR drafted the manuscript and its final shape. All authors have reviewed and approved the manuscript.

References

1. Priyanka R, Vincent V, et al. An assessment of the nutritional status of under-five children in rural area of Thrissur district, Kerala India. *Int J Community Med Public Health*. 2016;3(12):3479–86.
2. Yadav SS, Yadav ST, Mishra P, Mittal A, Kumar R, Singh J. An epidemiological study of malnutrition among under five children of rural and urban Haryana. *J Clin Diagn Res*. 2016 Feb;10(2):LC07.
3. Shukla N, Toppo NA, Thakur A, Kasar PK, Sharma B. A study of malnutrition and associated risk factors among children of age 06-59 months in rural area of Jabalpur district, Madhya Pradesh. *Indian J Community Health*. 2018; 30(1):24–9.
4. Aurangzeb, B., Whitten, K. E., Harrison, B., Mitchell, M., Kepreotes, H., Sidler, M., ... & Day, A. S. (2012). Prevalence of malnutrition and risk of under-nutrition in hospitalized children. *Clinical nutrition*, 31(1), 35-40.
5. Upadhyay, H. P., & Bhusal, M. K. (2017). Statistical analysis on nutritional status and its associated factors of under five years children in Nepal. *Advanced Journal Of Graduate Research*, 2(1), 12-24.
6. Demissie, S., & Worku, A. (2013). Magnitude and factors associated with malnutrition in children 6-59 months of age in pastoral community of Dollo Ado district, Somali region, Ethiopia. *Sci J Public Health*, 1(4), 175-83.
7. Rawe, K. (2012). *A life free from hunger: tackling child malnutrition*. Save the Children.
8. Rodríguez, L., Cervantes, E., & Ortiz, R. (2011). Malnutrition and gastrointestinal and respiratory infections in children: a public health problem. *International journal of environmental research and public health*, 8(4), 1174-1205.
9. Qadri, H. A., & Srivastav, S. K. (2015). Under-nutrition more in male children: a new study.
10. Sahu, S. K., Kumar, S. G., Bhat, B. V., Premarajan, K. C., Sarkar, S., Roy, G., & Joseph, N. (2015). Malnutrition among under-five children in India and strategies for control. *Journal of natural science, biology, and medicine*, 6(1), 18.
11. Sundari, S. (2017). A Study on the prevalence and pattern of malnutrition among children under five years in Chennai. *Int J Pharm Bio Sci*, 8(3), 135-9.
12. Bryce, J., Coitinho, D., Darnton-Hill, I., Pelletier, D., Pinstrup-Andersen, P., & Maternal and Child Undernutrition Study Group. (2008). Maternal and child undernutrition: effective action at national level. *The Lancet*, 371(9611), 510-526.
13. Akhade, K. S., Sankhe, L. R., & Akarte, S. V. (2019). Magnitude of malnutrition among under-five children in urban slums of commercial capital of India and its multifactorial causation: A community-based study. *Journal of family medicine and primary care*, 8(12), 3865.
14. Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M., Mathers, C., & Rivera, J. (2008). Maternal and child undernutrition: global and regional exposures and health consequences. *The Lancet*, 371(9608), 243–260. [https://doi.org/10.1016/S0140-6736\(07\)61690-0](https://doi.org/10.1016/S0140-6736(07)61690-0)
15. de Onis, M., & Branca, F. (2016). Childhood stunting: A global perspective. *Maternal and Child Nutrition*, 12, 12–26. <https://doi.org/10.1111/mcn.12231>
16. Dhone A, et al. Epidemiological study of under nutrition among under five years children in an urban slum. *Medical Journal of Dr. D.Y. Patil University*. 2012;5(2):110–3.
17. Silva, V. G. P., & Silva, S. G. P. (2015). Nutritional status of Anganwadi children under the Integrated Child Development Services scheme in a rural area in Goa. *International Journal of Scientific Study*, 3(7), 217-221.
18. Chase, H. P., & Martin, H. P. (1970). Undernutrition and child development. *New England Journal of Medicine*, 282(17), 933-939.
19. Bantamen, G., Belaynew, W., & Dube, J. (2014). Assessment of factors associated with malnutrition among under five years age children at Machakel Woreda, Northwest Ethiopia: a case control study. *Journal of Nutrition & Food Sciences*, 4(1), 1.
20. Houweling, T. A., Kunst, A. E., Looman, C. W., & Mackenbach, J. P. (2005). Determinants of under-5 mortality among the poor and the rich: a cross-national analysis of 43 developing countries. *International journal of epidemiology*, 34(6), 1257-1265.
21. Kayode, G. A., Adekanmbi, V. T., & Uthman, O. A. (2012). Risk factors and a predictive model for under-five mortality in Nigeria: evidence from Nigeria demographic and health survey. *BMC pregnancy and childbirth*, 12(1), 1-11.

22. Kumar, C., Singh, P. K., & Rai, R. K. (2012). Under-five mortality in high focus states in India: a district level geospatial analysis. *Plos one*, 7(5), e37515.
23. Sengupta, P., Giri, P. A., & Mohapatra, S. C. (2017). Under-Five Mortality in India: A Muddled Trip through Millennium Development Goal-4. *Archives of Community Medicine and Public Health*, 3(2), 048-053.
24. Van Malderen, C., Van Oyen, H., & Speybroeck, N. (2013). Contributing determinants of overall and wealth-related inequality in under-5 mortality in 13 African countries. *J Epidemiol Community Health*, 67(8), 667-676
25. Wachs, T. D. (2008). Multiple influences on children's nutritional deficiencies: a systems perspective. *Physiology & Behavior*, 94(1), 48-60.
26. Silva, P. (2005). Environmental factors and children's malnutrition in Ethiopia. Available at SSRN 648038.
27. Wachs, T. D., Creed-Kanashiro, H., Cueto, S., & Jacoby, E. (2005). Maternal education and intelligence predict offspring diet and nutritional status. *The Journal of nutrition*, 135(9), 2179-2186.
28. Kumar, D., Goel, N. K., Mittal, P. C., & Misra, P. (2006). Influence of infant-feeding practices on nutritional status of under-five children. *The Indian Journal of Pediatrics*, 73(5), 417-421.
29. Das, S., & Sahoo, H. (2011). An investigation into factors affecting child undernutrition in Madhya Pradesh. *The Anthropologist*, 13(3), 227-233.
30. Nandy, S., Irving, M., Gordon, D., Subramanian, S. V., & Smith, G. D. (2005). Poverty, child undernutrition and morbidity: new evidence from India. *Bulletin of the World Health Organization*, 83, 210-216.
31. Subramanyam, M. A., Kawachi, I., Berkman, L. F., & Subramanian, S. V. (2011). Is economic growth associated with reduction in child undernutrition in India?. *PLoS medicine*, 8(3), e1000424.
32. Das, P., Roy, R., Das, T., & Roy, T. B. (2021). Prevalence and change detection of child growth failure phenomena among under-5 children: A comparative scrutiny from NFHS-4 and NFHS-5 in West Bengal, India. *Clinical Epidemiology and Global Health*, 12, 100857.
33. Nayak, B. S., Unnikrishnan, B., George, A., Mundkur, S. C., & Guddattu, V. (2018). Risk factors for malnutrition among preschool children in rural Karnataka: a case-control study. *BMC Public Health*, 18(1), 1-8.
34. World Health Organization. (2021). Levels and trends in child malnutrition: UNICEF.
35. Bala, K., & Maheshwari, S. (2021). Field testing of flipbook on nutrition for children (0-3 years) for its comprehension by rural women.
36. Kumar, S., Sahu, D., & Chauhan, N. (2021). Factors Associated with Under-Five Mortality: A Comparison between Empowered Action Group (EAG) and Non-EAG States of India. *Health*, 13(11), 1190-1205.
37. Arokiasamy, P., & Gautam, A. (2008). Neonatal mortality in the empowered action group states of India: trends and determinants. *Journal of biosocial science*, 40(2), 183-201.
38. Arokiasamy, P., Jain, K., Goli, S., & Pradhan, J. (2013). Health inequalities among urban children in India: a comparative assessment of Empowered Action Group (EAG) and South Indian states. *Journal of biosocial science*, 45(2), 167-185.
39. Kumar, R., & Paswan, B. (2021). Changes in socio-economic inequality in nutritional status among children in EAG states, India. *Public Health Nutrition*, 24(6), 1304-1317.
40. Nations, U. (2016). Sustainable development knowledge platform. *New Orleans*.
<https://sustainabledevelopment.un.org/memberstates/india> .Accessed 20th Sept 2018.
41. Comprehensive National Nutrition survey report 2016–2018.<https://nhm.gov.in/index1.php?lang=1&level=2&sublinkid=1332&lid=713>. Accessed 15th Oct 2019.
42. Pal, A., Pari, A. K., Sinha, A., & Dhara, P. C. (2017). Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India. *International Journal of Pediatrics and Adolescent Medicine*, 4(1), 9-18.
43. Kumari, S. (2005). Nutritional status of scheduled caste pre-school children. *Indian journal of public health*, 49(4), 258-259.
44. Espie, E., Roure Pujol, C., Masferrer, M., Saint-Sauveur, J. F., Palma Urrutia, P. P., & Graiss, R. F. (2011). Acute malnutrition and under-5 mortality, northeastern part of India. *Journal of tropical pediatrics*, 57(5), 389-391.

45. Sinha, T., Singh, G., & Nag, U. (2019). Nutritional status of children under 5 years in tribal villages of Bastar Chhattisgarh India. *J intern Med Prim Healthcare*, 3, 007.
46. Mitra, M., Tiwari, A., Ghosh, R., & Bharati, P. (2004). Dimensions and causes of child malnutrition: A study of preschool children of Raipur, Chhattisgarh, India. *The Anthropologist*, 6(4), 247-252.
47. Chaand, I. (2019). Continuity of information in nutrition interventions in India: Experiences from Jharkhand. *Field Exchange issue* 60, 26.
48. Sethy, S. G., Jena, D., Jena, P., Pradhan, S., & Biswas, T. (2017). Prevalence of malnutrition among under five children of urban slums of Berhampur, Odisha, India: A community a community based cross-sectional study. *International Journal of Contemporary Pediatrics*, 4(6), 2180-2186.
49. Jethy, D. (2009). Undernutrition among under-five tribal children of Joda block, Keonjhar district, Orissa, India, 2008.
50. Rao, V. G., Yadav, R., Dolla, C. K., & Kumar, S. (2005). Undernutrition & childhood morbidities among tribal preschool children. *Indian journal of Medical research*, 122(1), 43.
51. Singh, M. B., Fotedar, R., Lakshminarayana, J., & Anand, P. K. (2006). Studies on the nutritional status of children aged 0–5 years in a drought-affected desert area of western Rajasthan, India. *Public health nutrition*, 9(8), 961-967.
52. Anurag, S., Kumar, B., Esam, M. S., Ved Prakash, S., Payal, M. S., & Iram, S. (2012). Nutritional status of under five children in urban slums of Bareilly. *Indian J Matern Child Health*, 14, 1-7.
53. Nitanshu, N., Anjali, N., Priyanka, S., Sakshi, C., Manjeet, S., Ankit, R., ... & Naveen, S. (2022). Malnutrition among under Five Children in Uttarakhand. *International Journal of Trend in Scientific Research and Development*, 6(3), 1905-1909.
54. Rehan, A., Kishore, S., Singh, M., Jain, B., Reddy, N. K. K., Kumar, D., ... & Parveen, R. (2020). A study to assess undernutrition and its sociodemographic correlates in under-five children in urban and rural areas of Rishikesh, Uttarakhand. *Journal of Family Medicine and Primary Care*, 9(9), 4980.
55. Chowdhury, S., Kasemi, N., Singh, A., Chakrabarty, M., & Singh, S. (2022). Decomposing the gap in undernutrition among under-five children between EAG and non-EAG states of India. *Children and Youth Services Review*, 106796.
56. Hong, R., Banta, J. E., & Betancourt, J. A. (2006). Relationship between household wealth inequality and chronic childhood under-nutrition in Bangladesh. *International journal for equity in health*, 5(1), 1-10.
57. Parsons, C. E., Young, K. S., Rochat, T. J., Kringelbach, M. L., & Stein, A. (2012). Postnatal depression and its effects on child development: a review of evidence from low-and middle-income countries. *British medical bulletin*, 101(1), 57-79.
58. McDonald, C. M., McLean, J., Kroeun, H., Talukder, A., Lynd, L. D., & Green, T. J. (2015). Household food insecurity and dietary diversity as correlates of maternal and child undernutrition in rural Cambodia. *European Journal of Clinical Nutrition*, 69(2), 242-246.
59. Owoaje, E., Onifade, O., & Desmennu, A. (2014). Family and socioeconomic risk factors for undernutrition among children aged 6 to 23 Months in Ibadan, Nigeria. *The Pan African medical journal*, 17.
60. Mishra, S., Pandey, C. M., Chaubey, Y. P., & Singh, U. (2015). Determinants of child malnutrition in empowered action group (EAG) states of India. *Statistics and Applications*, 13(13), 2454-7395.
61. Roy, M. P. (2021). Infant mortality in Empowered Action Group states in India: An analysis of sociodemographic factors. *Journal of Dr. NTR University of Health Sciences*, 10(1), 21
62. Kumar, R., & Paswan, B. (2021). Changes in socio-economic inequality in nutritional status among children in EAG states, India. *Public Health Nutrition*, 24(6), 1304-1317.
63. Sarkar, S. (2016). Cross-sectional study of child malnutrition and associated risk factors among children aged under five in West Bengal, India. *International Journal of Population Studies*, 2(1), 89-102.
64. Achakzai, P., & Khan, R. (2016). Nutritional status and associated factors among children less than five years of age in tehsil Zarghoon town, District Quetta, Baluchistan. *Journal of Ayub Medical College Abbottabad*, 28(1), 146-151.

Figures

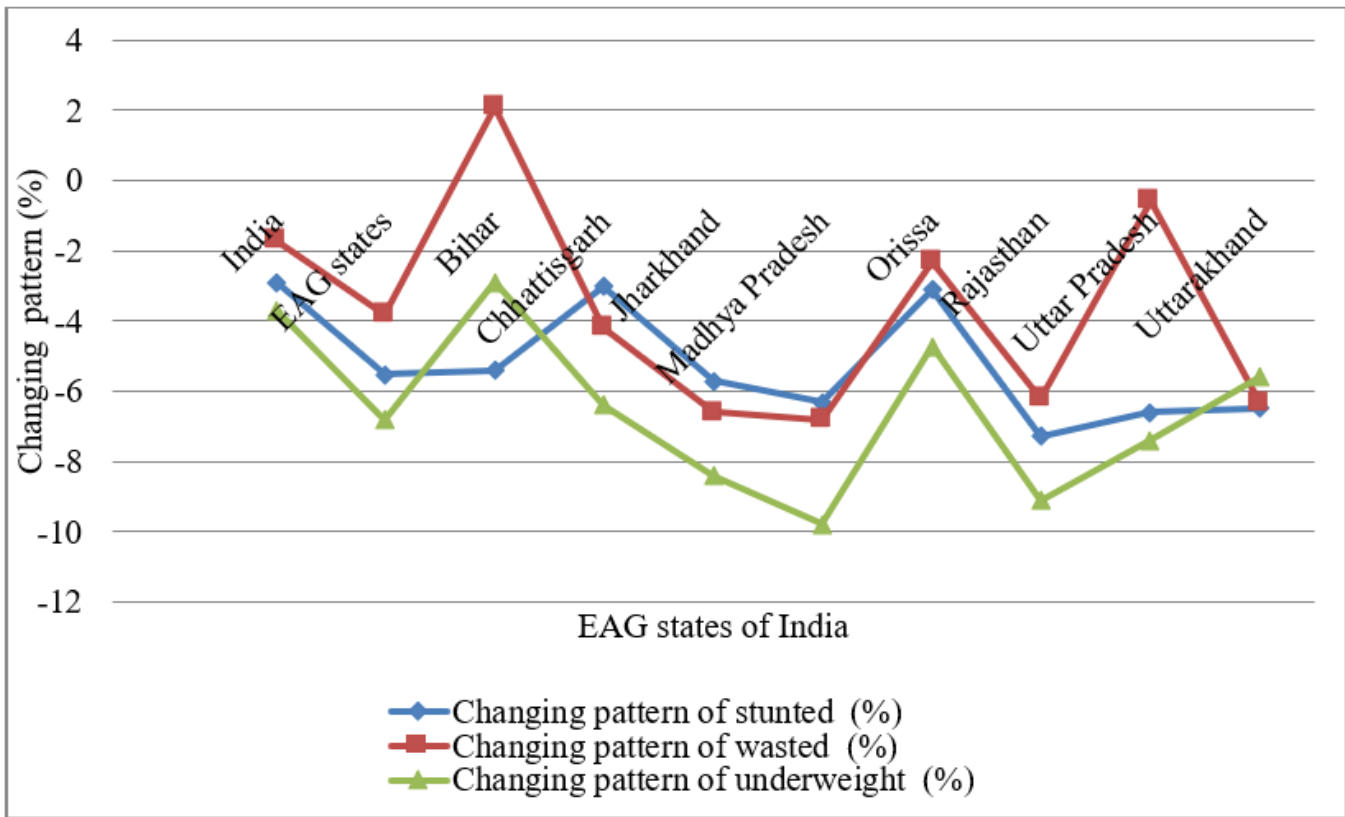


Figure 1

Trends and changing pattern of total stunted, wasted and underweight children between NFHS-4 & NFHS-5 in EAG states of India

Source: Author's own calculation based on NFHS-4 (2015-16) and NFHS-5 (2019-20) factsheet for EAGs states of India

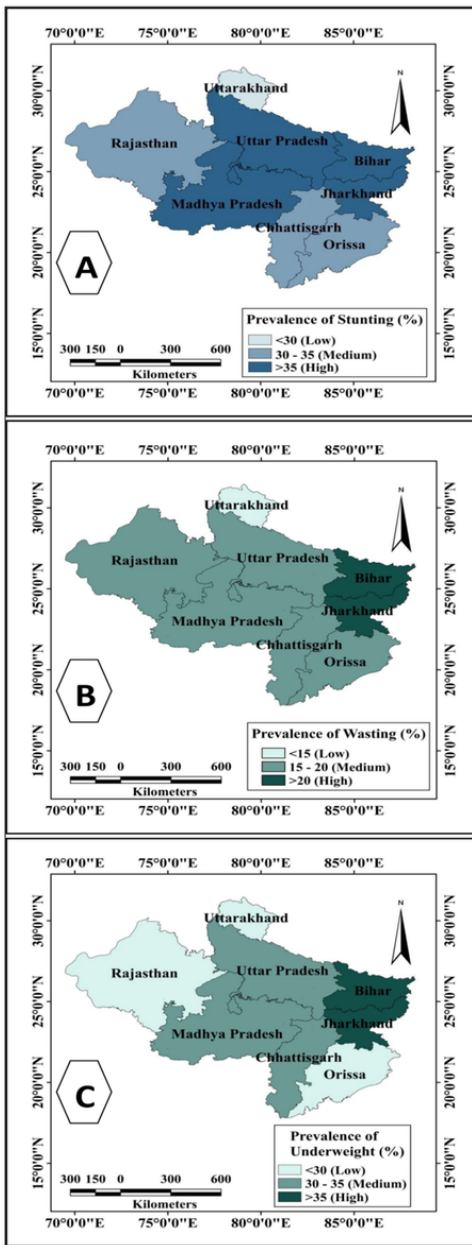


Figure 2

(A, B, C) Prevalence of stunting, wasting and underweight in EAG states of India (NFHS-5, 2019-21)

Source: The authors.