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Regional Variations in Child Malnutrition in Uttar Pradesh

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Abstract

Malnutrition is a major health concern in most developing countries in children aged less than 5 years. Child malnutrition is generally considered as a condition of child being undernourished or underweight or overweight. As Uttar Pradesh (UP) has the largest proportion of the country's malnourished children, the study of child nutrition is relevant. Very few studies have been done to look into the spatial pattern of child malnutrition in India and none has been done in UP. In this study, we analyse the regional variation in Uttar Pradesh with respect to child malnutrition and examine the determinants of child malnutrition. Economic inequality (wealth index, place of residence and maternal education), social structure of the society (social groups, religion and sex of child), source of drinking water and toilet facility are directly connected with the health of children. Using Multivariate Logistic Regression analysis on the data of NFHS-4, this paper examines the regional variation of child malnutrition in Uttar Pradesh. The overall picture is that the intra-state regional variation of child malnutrition is present in Uttar Pradesh. The problem of wasting and being underweight is very high in the southern region. The eastern region is the second most concerned area for child health. Maternal education has been found to be negatively associated with child malnutrition. Thus, there is a need to implement health programmes region-wise to eliminate malnutrition. Also, there is a need to put a greater focus on female literacy which is low in Uttar Pradesh.

Keywords: Child malnutrition, regional variation, climate, health, Uttar Pradesh, NFHS-4

I. Introduction

Good health and well-being is the third and foremost goal of the 17 global Sustainable Development Goals (SDGs) set by the United Nations Development Programme (UNDP). Covid pandemic has shown the world again that health issues are still the main hurdle before the world for attaining SGDs by 2030. The SDGs recognize that health and development are intimately connected (UNDP, 2017). Malnutrition is a major health concern in most of the developing countries in children aged less than five years. According to the World Health Organization (WHO), malnutrition is responsible for more than half of child deaths globally. The burden of malnourished children in India is amongst the highest in the world: nearly 60 million Indian children are estimated to be underweight, more than 50 per cent suffer from anaemia and a similar proportion lacks full immunization (Deaton & Dreze, 2009). India accounts for approximately one-third of the world's total population of stunted children under the age of 0-5 years (Global Nutrition Report, 2018). India comprises of almost 13 per cent of the child population aged 0-6 years (Census, 2011) and 38 per cent of children suffer from chronic under-nutrition (NFHS, 2017). As Uttar Pradesh (UP) has the largest proportion of the country's child malnutrition, the study is relevant.

The term malnutrition covers two broad groups of conditions. The first one is 'undernutrition' while the other is 'over-weight' or 'over-nutrition'. Undernutrition includes stunting (low height-for-age), wasting (low weight-for-height), underweight (low weight-for-age) and micronutrient

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deficiencies or insufficiencies (a lack of important vitamins and minerals) (WHO, 2013). Malnutrition is one of the best measures of children's health and wellbeing and a sound cogitation of social inequalities and there are many studies to understand the reasons behind it. Some studies reveal that child nutrition is affected by physical and cultural context (Cleland, 1990; Borooah, 2005; Smith et al., 2005). Most of the literature on child malnutrition focused on household-level determinants such as household wealth, residence, caste and religion (Coffey et al., 2019).

Entwisle (2007) found that place played an important role in health issues. Webb et al. (1998) found that stunting of child is significantly correlated with variegated topography and dry marginal lands of Africa. Smith et al. (2005) conceded that food availability is not a significant determinant but household poverty is. Sen (1998) found that in times of famine or drought, poorest could not afford to buy food. Almasi et al. (2019) studied the spatial pattern of malnutrition in the countries. They found that stunted and wasted children under five years were clustered in some countries and child illness, food diversification and food security have not been effective in the cluster formations of stunted and wasted children but the geographic location has affected in this area. Menon et al. (2018) predicted spatial patterns in stunting and differences between very high-burden and low-burden districts in India. Cesare et al. (2015) explored geographical and socio-economic inequalities with reference to child and maternal under nutrition in Pakistan and there was not much improvement in the nutritional status of children in agrarian irrigated districts which are more water secure than others. Hathi et al. (2014) found that rural children are exposed to more open defecation, on an average, than urban ones, and, therefore, in urban areas infant mortality is less likely to occur than rural areas. However, they found that urban survival advantage is less pronounced where open defecation is high and higher average population density has reduced the effect of sanitation on infant mortality and stunting in urban areas. Some evidence shows that urban children generally have a better nutritional status than their rural counterpart.

Smith et al. (2005) explored rural-urban differences in child malnutrition. Immunization and health care services for children are better in urban areas than in rural areas. Several studies have established that open defecation is an important cause of infant mortality and child stunting in both rural and urban areas of developing countries (Spears, 2013). Spears (2018) used 'Asian enigma' for the paradox of an odd situation in which people in India are shorter on an average than people in Sub-Saharan Africa despite the fact that Indians are also richer on an average. According to the author, sanitation could explain international variation in child height that income and other dimensions of development couldn't. He found that on an average, Indian children are as tall as African children.

Several social-economic factors like caste, religion, literacy, sex of children and economic status of family are equally significant in the study of nutrition among children. The malnutrition rate remained high in India while the country achieved high growth of Gross Domestic Product (GDP) (Tarozzi & Mahajan, 2007). Socio-economic condition is one of the most important factors which affects infant and child mortality in India and so socio-economic inequality requires attention for the study of infant and child mortality. The evidence is that infant mortality rate in the poorest population is higher than the richest population and so these kinds of inequalities are important research topics among researchers and policymakers (Pathak & Singh, 2011).

Coffey et al. (2019) found that rural Scheduled Castes (SCs) and Scheduled Tribes (STs) children are shorter than rural general castes children. Mishra (2017) studied the determinants of child malnutrition in three tribal districts- Alirajpur, Barwani and Khandwa of Madhya Pradesh. He found that the awareness about child malnutrition among mothers lacked and poor nutrition and health conditions of tribal women had a strong association with nutrition and health status of children.

Gender bias is also present in Indian society and affects social, cultural and economic structure of India (Mishra et al., 2004). Many social aspects of Indian society such as dowry are considered as the main cause of this bias (Dreze & Sen, 2003). Sex ratio at birth is an important sign of gender bias which shows no improvement (Census of India, 2001; Census of India, 2011). Sex ratio among

children aged 0-6 years has decreased constantly over more than two decades. 2011 census shows a ratio of 919 girls per every 1000 boys. In Uttar Pradesh child sex ratio is registered 902 among children aged of 0-6 years. While in 1991 it was 927, in 2001 it was 916 (Census of India, 2011). There is mixed or no evidence of gender bias in nutritional status and in nutrient intakes despite evidence of gender discrimination (Tarozzi, 2012).

Literacy level is the indicator of social and political situation of any society (Gokhale et al., 2002). Women's education is positively associated with nutrition. This is because educated mothers are generally better informed about right breastfeeding practices and of nutritional value of foods, making better choices for the children (Cleland, 1990). Smith et al. (2003) found that illiterate women ignore the importance of preventive childcare services such as vaccination and the effect of female literacy on infant mortality is negative in rural areas.

The above review suggests that child malnutrition is affected by various socio-economic, geographical and environmental factors. Nonetheless, geographical aspects of malnutrition have not been explored much for Uttar Pradesh. In this study, we analyse the regional variations in Uttar Pradesh with respect to child malnutrition and examine its determinants.

II. Data and methods

Data

The present study has used the data from National Family Health Survey, 2015-16 (NFHS-4) of India which was conducted by the Ministry of Health and Welfare and coordinated by International Institute for Population Sciences, Mumbai. NFHS is an Indian form of Demographic and Health Survey which provides important data on health issues and family welfare in India since 1992-93. NFHS-4 collected data in each of India's states and union territories as well as district level data for all 640 districts of the country. This had not been collected before. NFHS-4 applied two-stage random sampling to make a representative sample of the rural and urban population. The 2011 census served as the sampling frame for the selection of the Primary Sampling Units (PSUs) which were villages in rural areas and Census Enumeration Blocks (CEBs) in urban areas. The NFHS-4 collected data on nutrition, health and domestic violence as well. Generally, these data provide information about health status of the people. Women in the age group of 15-49 years and men in the age group of 15-54 years were interviewed. Survey also collected information about their background, reproduction, marriage, pregnancy, delivery, children's nutrition, child immunization and health, utilization of ICDS services and other health issues. It collected data for children's height, weight and haemoglobin level by biomarker questionnaire. Data related to the biomarkers were initially recorded on the Biomarker Questionnaire and subsequently entered into the interviewers' mini-computers. It has been designed to collect data on three components– clinical, anthropometric and biochemical (CAB) to estimate the prevalence of malnutrition, anaemia, hypertension, human immunodeficiency virus (HIV) and high blood glucose levels through a series of biomarker tests and measurements (IIPS & ICF, 2017).

Measures

NFHS-4 measured the weight and height of children under the age of five years regardless of whether their mothers were interviewed in the survey or not. Height of the children was measured with a Seca-213 Infantometer. Older children's height was measured by standing but height of children younger than 24 months was measured lying them down (recumbent length using a Seca-417 Infantometer). Weight of children was measured by an electronic Seca-874 flat scale. For the weighing of very young children, firstly, the mother or caretaker was weighed and after this mother or caretaker was weighed holding the child (baby's weight was measured after deduction of mother's weight).

NFHS-4 calculated HAZ using the WHO 2006 child growth standards. A height-for-age Z score scales a child's height relative to a healthy population of that child's age and sex. Child growth standards were developed by studying a large group of healthy children living in south Delhi (Khadilkar et al., 2010). Experts of many disciplines agreed that these standards apply to all Indian children whose height-for-age Z-score is below minus two standard deviations (-2 SD) from the median of the reference population. Children who are below minus three standard deviations (-3 SD) are considered severely stunted. Stunting, or low height-for-age, is a sign of chronic under-nutrition that reflects failure to receive adequate nutrition over a long period. Five-year birth history file has been used for this estimate (IIPS & ICF, 2017). A total 41,751 children from 76,233 households in Uttar Pradesh were visited to seek the information on various health-related aspects. Out of them, 36,465 children's nutritional related information is available. A total 52,82 children's nutrition related information in not available (are flagged cases, don't know and missing) in Uttar Pradesh. So the ultimate sample for the present study is 36,465 children from kids file of NFHS-4. This study used state sampling weights provided by the NFHS-4 in the data file.

Dependent variables

Three variables, stunting, wasting and underweight, were taken as dependent variables for this study.

Stunting: Stunting, or low height-for-age, is a measure of linear growth retardation and cumulative growth deficits. Children whose height-for-age Z-score is below minus two standard deviations (-2 SD) from the median of the reference population are considered short for their age (stunted), or chronically undernourished (IIPS & ICF, 2017).

Wasting: Wasting, or low weight-for-height measures body mass in relation to body height or length and describes current nutritional status. Children whose Z-score is below minus two standard deviations (-2 SD) from the median of the reference population are considered thin (wasted) or acutely undernourished (IIPS & ICF, 2017).

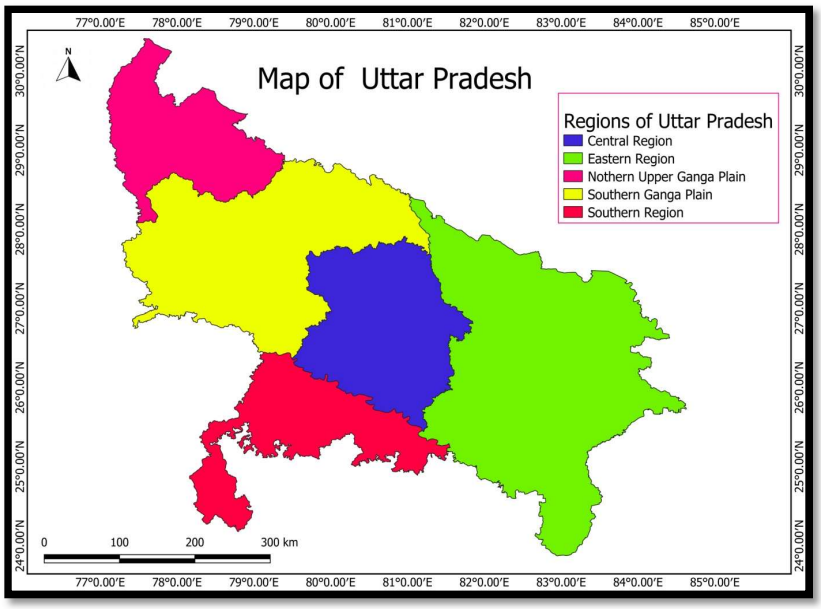
Underweight: Underweight or weight-for-age is a composite index of height-for-age and weight-for-height. Children whose weight-for-age Z-score is below minus two standard deviations (-2 SD) from the median of the reference population are classified as underweight (IIPS & ICF, 2017).

Independent variables

This study tried to analyse socio-economic factors as well as geographical factors to understand the reason behind child malnutrition prevalence. Place of residence (rural, urban), sex of child (male, female), wealth index (poorest, poorer, middle, richer, richest), caste (SCs/STs, OBCs, others), maternal education (illiterate, up to secondary, higher), religion (Hindu, non-Hindu), source of drinking water (surface water, tube well/protected well, piped water/bottled water), toilet facility type (open defecation, toilet facility available) and geographical region [Northern Upper Ganga Plain (NUGP), Southern Ganga Plain (SGP), Central, Eastern, and Southern] were used as independent variables. To study the regional pattern of child malnutrition in UP, NSS regions were followed as geographical region. This regional classification was followed because the NSS region, essentially an intermediate unit between the district and the state, typically consists of several districts within a state with similar agro-climatic conditions and socio-economic features (Keshri, 2019).

UP has five NSS regions: NUGP, SGP, Central, Eastern and Southern.

Figure 1: Regional divisions of Uttar Pradesh as per National Sample Survey's regional classification



Source: Prepared by the authors following census administrative map of U*ttar Pradesh*, 2011 and NSS, 2007-08.

Statistical analysis

In the first step, malnutrition percentage was tabulated by the districts and region to find the pattern of malnutrition in Uttar Pradesh. Further logistic regression models were used in this study to assess the adjusted effects of socio-economic and geographical factors on the dependent variables.

Logistic regression is a statistical model that is used to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables (Retherford and Choe, 1993). Logistic regression works with binary data, where the either event happens (1) or the event does not happen (0).

The outcome variable of stunting was coded in a binary form, that is, "1" if a child was stunted and "0" if the child was normal. To analyse geographical disparities, the prevalence of stunting has been estimated for all regions of Uttar Pradesh and according to different independent variables. Further, logistic regression models were fitted to examine the overall effect of all socio-economic and geographical determinants on stunting.

Three logistic regression models were applied to examine the associated factors of stunting, wasting, and underweight. In model I, regression was run for Stunting with the NSS region. In model II, along with the NSS region, the place of residence was added as a control variable. In model III, the sex of the child, social groups, religion, toilet facility type, sources of drinking water and region were added as control variables. The same method was applied to assess the regional variation of wasting and underweight. Based on the results, conclusions have been drawn.

III. Results

Regional differentials in child malnutrition level in Uttar Pradesh

Stunting

Stunting is the most prevalent form of child malnutrition and also a significant indicator of children's well-being (WHO, 2013). According to the NFHS-4 data, height-for-age (percentage

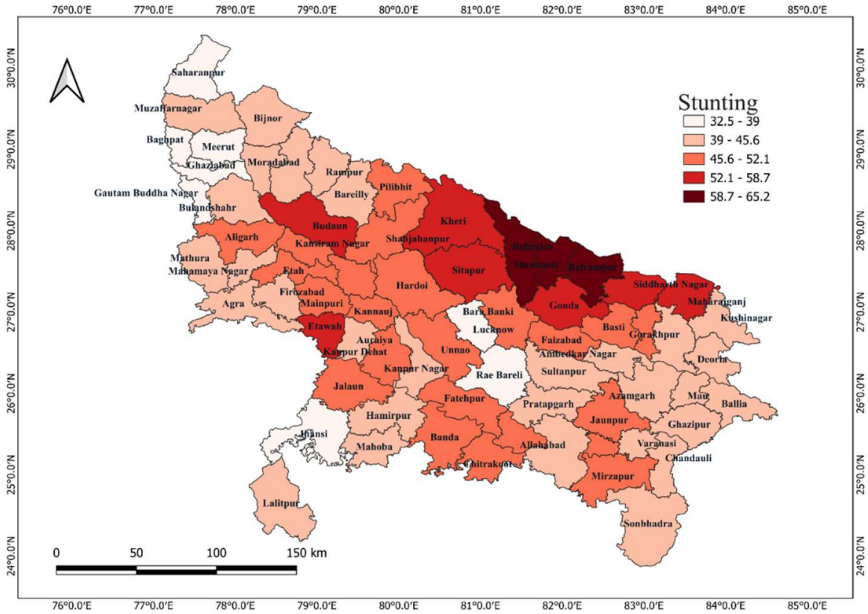
below-2SD) is 46.2 per cent in Uttar Pradesh. Table 1 presents the total percentage of stunted children according to regions of Uttar Pradesh and Figure 1 provides the geographical disparity between its districts. Stunting (percentage below -2SD) is higher in the SGP Region (48.14%) (e.g., Badaun and Itawah) and the eastern region (48.13%) (e.g., Shrawasti and Balrampur) and it is the lowest in the NUGP region (39.27%) (e.g., Ghaziabad and Meerut).

Table 1: Percentage distribution of stunting, wasting and underweight by region in Uttar Pradesh, 2015-16

Region	Stunting	Wasting	Underweight
Northern Upper Ganga Plain	39.3	18.3	37.1
Southern Ganga Plain	49.6	17.7	43.3
Central	47.0	16.3	37.4
Eastern	48.1	17.8	39.9
Southern	43.0	29.5	45.4
Total	46.3	17.9	39.5

Source: Prepared by the authors using the unit-level data of the NFHS, 2015-16, India and NSS, 2007-08.

Figure 2: Geographical distribution of stunted children in districts of Uttar Pradesh, 2015-16



Source: Prepared by the authors using the unit-level data of the NFHS, 2015-16, India.

Wasting

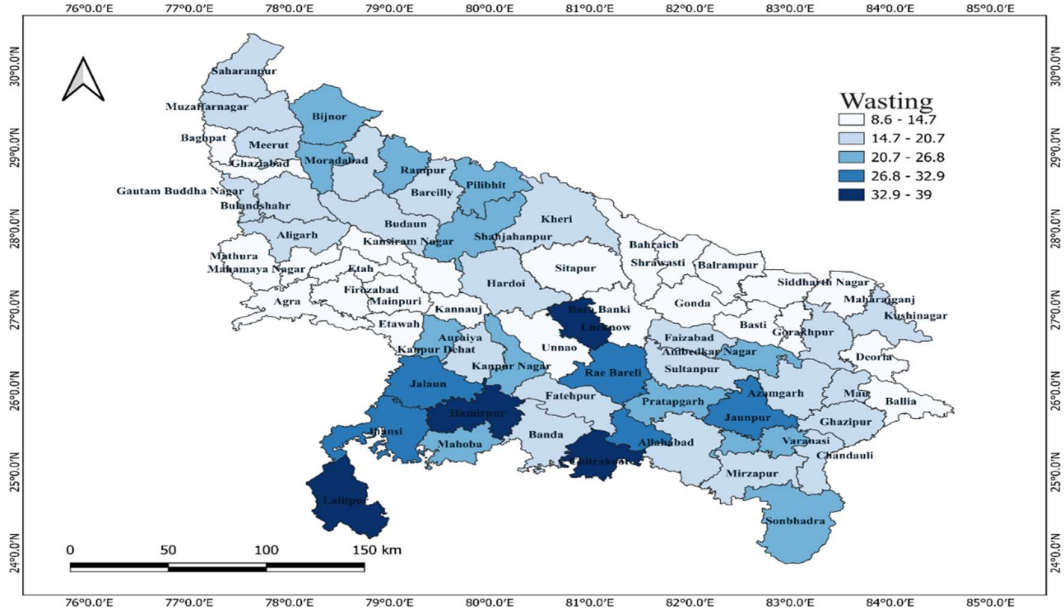
Wasting, or low weight-for-height, is considered as a predictor of under-five mortality in any place (WHO, 2013). It is usually the result of acute nutrients shortage and/or disease. Table 1 presents the total percentage of wasted children according to regions of Uttar Pradesh and Figure 3 provides the geographical disparity among its districts. The overall prevalence of wasting in Uttar Pradesh is 17.93 per cent which is the highest in the Southern Region (29.5%) (e.g., Lalitpur and Chitrakoot) and comparatively low in the SGP Region (16%) (e.g., Agra and Etawah).

Underweight

Underweight measures protein-energy malnutrition (Hudson et al., 2007). According to NFHS-4 data, the underweight children were 39.49 per cent in Uttar Pradesh. Table 1 presents the total percentage of underweight children according to regions of Uttar Pradesh, and Figure 4 shows the geographical disparity among its districts. Child underweight is high compared with other regions in

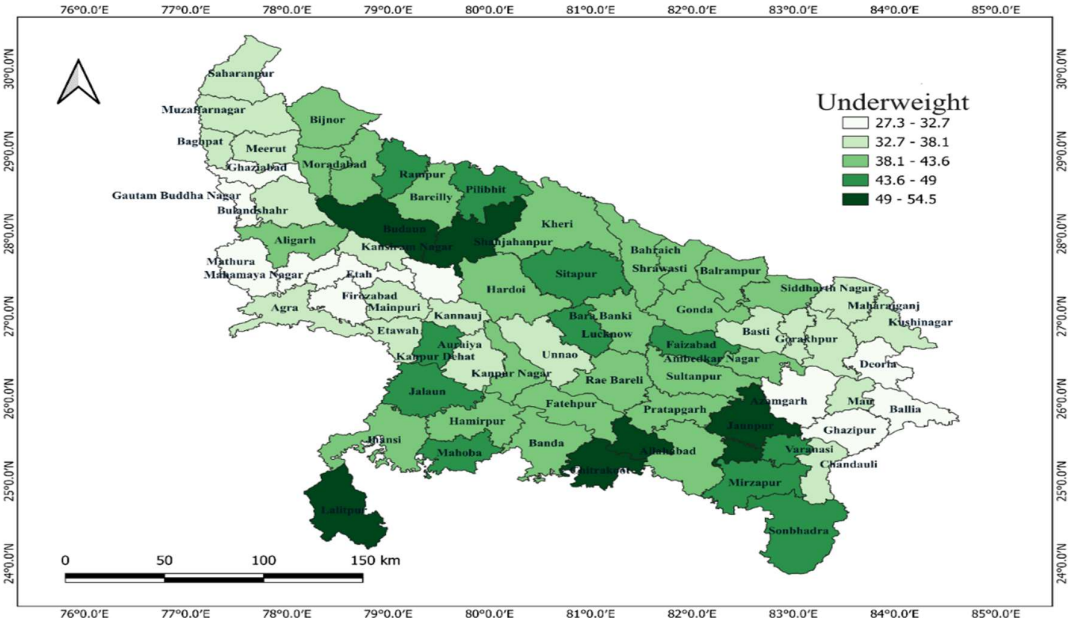
the Southern Region (45.44%) (e.g., Lalitpur and Chitrakoot) and lower than other regions in the NUGP Region (37.14%) (e.g., Ghaziabad and Gautam Buddha Nagar).

Figure 3: Geographical distribution of wasted children in districts of Uttar Pradesh, 2015-16



Source: Prepared by the authors using the unit-level data of the NFHS, 2015-16, India.

Figure 4: Geographical Distribution of Underweight Children in Districts of Uttar Pradesh, 2015-16



Source: Prepared by the authors using the unit-level data of the NFHS, 2015-16, India.

Sample distribution by socio-economic and demographic characteristics

Table 2 provides the sample distribution of all the covariates from a sample of 41,751 individuals and their weighted percentage, focusing on various categories such as region, place of residence, wealth index, maternal education, sex of child, social groups, religion, source of drinking water and toilet facility.The eastern region has the highest representation, with 39.9 per cent, while a majority of respondents (79.4%) are from rural areas. Economic disparities are evident, as 32.9 per cent belong

to the poorest wealth quartile. A significant portion (43.4%) of maternal education level is illiterate. The social group background shows a predominant percentage of OBCs (54.9%). Additionally, a large majority (90.3%) have access to improved sources of drinking water, but open defecation remains a critical issue with 62.4 per cent not having access to toilet facilities.

Table 2: Sample distribution by socio-economic and demographic characteristics, Uttar Pradesh, 2015-16

Variables	Percentage	N
Region		
Southern Ganga Plain	17.2	4,250
Northern Upper Ganga Plain	14.7	8,132
Central	24.5	11,404
Eastern	39.9	15,204
Southern	3.8	2,761
Place of residence		
Rural	79.4	32,597
Urban	20.6	9,154
Wealth Index		
Poorest	32.9	12,937
Poorer	24.2	10,151
Middle	17.6	7,534
Richer	13.6	5,970
Richest	11.7	5,159
Maternal education		
Illiterate	43.4	17,811
Up to secondary	35.6	15,256
Higher	21.0	8,684
Sex of child		
Male	52.5	21,932
Female	47.5	19,819
Social groups		
SCs/STs	26.8	10,997
OBCs	54.9	23,114
Others	18.2	7,640
Religion		
Hindu	79.1	32,614
Non-Hindu	20.9	9,137
Source of drinking water		
Improved	90.3	37,586
Unimproved	9.7	4,165
Toilet facility		
Toilet facility available	37.7	16,419
Open defecation	62.4	25,332
Total	100.0	41,751

Note: Cases may not be equal due to missing values. Percentages are weighted while numbers are unweighted.

Differentials in child malnutrition in Uttar Pradesh by demographic and socio-economic characteristics

Table 3 provides a comprehensive overview of the weighted prevalence of stunting, wasting, and underweight conditions among children in different socio-economic and demographic sectors from 2015-16, with a total sample size of 36,465. Stunting rates are higher in rural areas (48.5%) compared with urban areas (37.9%) and decrease with increasing wealth, with the lowest incidence in the richest quintile (24.8%). Wasting is relatively consistent across groups, but again highest among the poorest quintile (19.6%). Underweight percentages follow a similar pattern, with the highest rates in

the poorest wealth quintile (49%) and among children from households engaging in open defecation (43.3%). The data also highlights the significant impact of maternal education levels on these health conditions, with the highest rates observed among children of illiterate mothers (stunting at 55.1% and underweight at 46.4%). Differences based on sex are minimal, while social groups such as SCs/STs Tribes show higher rates of all conditions compared with other groups.

Table 3: Prevalence of Stunting, wasting and underweight by socio-economic and demographic characteristics, Uttar Pradesh, 2015-16

Variables	Stunting	Wasting	Underweight	N
Place of residence				
Rural	48.5	17.9	41.0	28,325
Urban	37.9	18.1	33.8	8,140
Wealth Index				
Poorest	57.3	19.6	49.0	11,014
Poorer	50.5	17.1	42.0	8,896
Middle	42.8	17.5	35.5	6,566
Richer	36.3	16.5	32.2	5,346
Richest	24.8	7.6	23.5	1,163
Maternal education				
Illiterate	55.1	18.0	46.4	15,296
Up to secondary	41.2	17.8	35.5	13,530
Higher	36.9	18.1	32.3	7,639
Sex of child				
Male	46.3	19.1	39.5	19,147
Female	46.2	16.6	39.5	17,318
Social groups				
SCs/STs	52.3	18.9	44.7	9,559
OBCs	46.5	18.0	40.1	20,236
Others	36.8	16.3	29.9	6,670
Religion				
Hindu	46.3	18.1	39.5	25,508
Non-Hindu	46.3	17.2	39.3	7,957
Source of drinking water				
Improved	46.8	17.8	39.6	32,935
Unimproved	40.9	19.1	38.1	3,530
Toilet facility				
Toilet facility available	38.2	17.7	33.9	14,669
Open defecation	51.3	18.1	43.3	21,796
Total	46.2	17.9	39.5	36,465

Note: Cases may not be equal due to missing values. Percentage are weighted and numbers unweighted.

Factors affecting child malnutrition in Uttar Pradesh

Stunting

We used logistic regression models in Table 4 to examine the effect of socio-economic factors on child stunting while, along with other variables, the variable of geographical region is also controlled. Model I observed a statistically significant relationship between the NSS region and stunting, implying that children from NUGP were less likely to be stunted than in other regions. In Model II, after controlling the place of residence, it's similar but slightly reduced. However, in Model III, after controlling other variables, the result changed and the southern region seems to be the less stunted region, while other regions are also in a better position. Children from urban areas are 13 per cent (OR=0.87) less likely to be stunted than children from rural areas.

Table 4: Results of Logistic Regression Analysis for determinants of child stunting (age-group 0-5 years), 2015-16

Variables	Model I (N=36,465)	Model II (N=36,465)	Model III (N= 36,465)
Region			
Northern Upper Ganga Plain®			
Southern Ganga Plain	1.55 ***	1.46***	1.14***
Central	1.42 ***	1.37***	1.17***
Eastern	1.54 ***	1.42***	1.15***
Southern	1.21 ***	1.15**	0.96
Place of residence			
Rural®			
Urban		1.35***	0.87***
Wealth Index			
Poorest®			
Poorer			0.83***
Middle			0.65***
Richer			0.50***
Richest			0.32***
Maternal education			
Illiterate®			
Up to secondary			0.78***
Higher			0.70***
Sex of child			
Male®			
Female			0.97
Social groups			
SCs/STs®			
OBCs			0.89***
Others			0.72***
Religion			
Hindu®			
Non-Hindu			1.19***
Source of drinking water			
Improved®			
Unimproved			0.82***
Toilet facility			
Toilet facility available®			
Open defecation			1.05

Notes: Level of significance: *p<0.10, **p< 0.05, ***p<0.001. ®: reference category.

The wealth index, which represents the economic status of the children, is significantly associated with stunting, as with increasing income the likelihood of stunting declines. For instance, the odds of stunting are 17 per cent lower (OR=0.83) in the poorer compared with the poorest, and the odds of stunting are 68 per cent lower (OR=0.32) in the richest compared with the poorest. Maternal education is an important indicator of the socioeconomic status of any country (Imai et al., 2014). A negative association exists between a mother's education and stunting. With higher maternal education, the likelihood of stunting declines. Children with mothers who completed higher education are 30 per cent (OR=0.70) less likely to be stunted compared with those children whose mothers are illiterate. The sex of the child is not significantly associated with stunting. Female children are 3 per cent (OR=0.97) less likely to be stunted compared with male children.

The variable of social groups (castes) is significantly associated with the prevalence of stunting. Stunting gradually declines from the SCs/STs category to OBCs and other categories that are in a socially advantageous position on the caste ladder. Children from other caste categories are

28 per cent (OR=0.72) less likely to be stunted than children from the SCs/STs category. Religion is another important social determinant of stunting. Children of non-Hindu communities are 19 per cent (OR=1.19) more likely to be stunted than children of Hindu communities. Sanitation is statistically insignificant and associated with stunting. Children from households without access to toilet facilities are 5 per cent (OR=1.05) more likely to be stunted than children from households with access to toilet facilities. Children from households with access to unimproved water facilities are 18 per cent (OR=0.82) less likely to be stunted than children from households with access to improved water facilities.

Wasting

In Table 5, logistic regression models are used to examine the effect of socio-economic factors on child wasting while controlling for the variable of geographical region. Model I observed that the central region is 15 per cent less likely to be stunted than the NUGP region and the southern region is 99 per cent more likely to be wasted than NUGP. It's similar when we control the place of residence. However, it is slightly reduced after controlling other socioeconomic factors.

A negative association between wealth index and wasting has been observed. Results suggest that children from the poorest quintile were more likely to be wasted than others. All categories of wealth are significantly clustered with a higher prevalence of wasting, with the increasing economic status likelihood of stunting declines. The odds of wasting are 18 per cent lower (OR=0.82) in poorer than in poorest categories. The sex of a child is significantly associated with wasting. Female children are 17 per cent (OR=0.83) less likely to be wasted than male children when other factors are controlled.

Wasting gradually declines from SCs/STs to the OBCs and other categories which are in a socially advantageous position in the caste ladder. Children from other caste categories are 13 per cent (OR=0.87) less likely to be wasted than children from SCs/STs. Children of non-Hindu communities are only 1 per cent (OR=1.01) more likely to be wasted than children of the Hindu community and also not significant. The source of drinking water is significantly associated with wasting. Children from households with access to unimproved water facilities are 9 per cent (OR=1.09) more likely to be wasted than those with access to safe water.

Underweight

In Table 6, logistic regression models are used to examine the effect of socio-economic factors on children's underweight while, along with other variables, the variable of the geographical region is also controlled. In model I, the southern region is 50 per cent more likely to be underweight than the NUGP region, and the central region is 1 per cent less likely to be underweight than NUGP. A similar result is coming after controlling the place of residence. However, it's reduced after controlling other socioeconomic variables. There is a negative association between the wealth quintile and underweight. It showed that the possibility of underweight declines from the poorer quintile to the richest quintile. The odds of being underweight are 63 per cent lower (OR=0.37) in the richest category compared with the poorest category.

Maternal education was used in model III which showed a negative association with underweight. Children with mothers who completed higher education are 26 per cent (OR=0.74) less likely to be underweight compared with those children whose mothers are illiterate. The sex of the child is used in model III to understand the prevalence of underweight. Female children are 2 per cent (OR=0.98) less likely to be underweight compared with male children.

Caste is used in model III, which is significantly associated with underweight. The prevalence of underweight is gradually decreasing from SCs/STs to the OBCs and other categories that are in socially advantageous positions in the caste ladder. Children from other castes are 30 per cent (OR=0.70) less likely to be underweight than children from SCs/STs. Religion is used in model III,

which is insignificantly associated with underweight. Children of non-Hindu communities are 11 per cent (OR=1.11) more likely to be underweight than children of the Hindu community.

Sanitation is statistically insignificantly associated with underweight. Children from households without access to toilet facilities are 2 per cent (OR=1.02) more likely to be underweight than children from households with access to toilet facilities. Children from households with access to unimproved water facilities are 2 per cent (OR=0.98) less likely to be underweight than those with improved water facilities.

Table 5: Results of Logistic Regression Analysis for determinants of child wasting (age-group 0-5 years), 2015-16

Variables	Model I (N=36,465)	Model II (N=36,465)	Model III (N=36,465)
Region			
Northern Upper Ganga Plain®			
Southern Ganga Plain	1.07	1.01	0.99
Central	0.85***	0.85***	0.82***
Eastern	1.01	1.01	0.96
Southern	1.99***	1.99***	1.87***
Place of residence			
Rural®			
Urban		1.01	0.92
Wealth Index			
Poorest®			
Poorer			0.82***
Middle			0.87***
Richer			0.77***
Richest			0.73***
Maternal education			
Illiterate®			
Up to secondary			1.02
Higher			1.03
Sex of child			
Male®			
Female			0.83***
Social groups			
SCs/STs®			
OBCs			0.95
Others			0.87***
Religion			
Hindu®			
Non-Hindu			1.01
Source of drinking water			
Improved®			
Unimproved			1.09*
Toilet facility			
Toilet facility available®			
Open defecation			0.95

Notes: Level of significance: *p<0.10, **p< 0.05, ***p<0.001. ®: reference category.

Table 6: Results of Logistic Regression Analysis for determinants of child underweight (age group 0-5 years), 2015-16

Variables	Model I (N=36,465)	Model II (N=36,465)	Model III (N=36,465)
Region			
Northern Upper Ganga Plain®			
Southern Ganga Plain	1.35***	1.28***	1.02
Central	0.99	0.97***	0.83***
Eastern	1.21***	1.13***	0.92**
Southern	1.50***	1.48***	1.21***
Place of residence			
Rural®			
Urban		1.27***	0.87***
Wealth Index			
Poorest®			
Poorer			0.81***
Middle			0.66***
Richer			0.54***
Richest			0.37***
Maternal education			
Illiterate®			
Up to secondary			0.81***
Higher			0.74***
Sex of child			
Male®			
Female			0.98
Social groups			
SCs/STs®			
OBCs			0.91***
Others			0.70***
Religion			
Hindu®			
Non-Hindu			1.11***
Source of drinking water			
Improved®			
Unimproved			0.98
Toilet facility			
Toilet facility available®			
Open defecation			1.02

Notes: Level of significance: *p<0.10, **p< 0.05, ***p<0.001. ®: reference category.

IV. Discussion

Urban children are more likely to be malnourished than rural children but as soon as wealth index, which is proxy for income, was applied result changed. After adjusting wealth index, the likelihood of stunting among urban children was lower as compared with rural children. This result suggests that child health is better in urban area. This study found same result for wasting and underweight. Household poverty played an important role in child health. Children from the poorest and poorer households are more stunted than children from the middle, richer or richest households. A similar result was reported by Lone et al. (2018) and Coffey et al. (2019) regarding the nutritional status of children affected by lack of food security in poor families. Menon et al. (2014) pointed out that poor diets lead to a high incidence of infections, poor maternal nutritional status, female disempowerment, high socio-economic inequity, pervasive poverty and poor health services in Uttar Pradesh.

Maternal education is positively associated with stunting and underweight. Children of higher-educated mothers are less stunted than children of illiterate and less educated mothers, which is also supported by previous studies. Similar results were observed for underweight children. There is a positive association between child health and maternal education with a reduction of malnourishment. Maternal education is not significantly associated with wasting. For the prevention of stunting and being underweight, a mother's education could be helpful in adopting hygienic practices during childcare. Low socio-economic status of women is also a major factor of child malnutrition. Many Indian mothers have little control over decisions related to child health and utilisation of resources within households, which directly affects the nourishment of the child (Imai et al. 2014).

Male children had a slightly higher chance of being stunted than female children. Previous studies had same results and one plausible explanation for this could be that childhood morbidity is lower among female children than male children (Murthi et al. 1995). According to a previous study, female pre-term birth is lower than male pre-term birth which could also be a reason behind this result. This study found the same result for underweight and wasting. Mishra et al. (1999) reported that male and female children are more likely to be stunted and underweight but male children are more wasted than female children. Basu (1993) found that there is no evidence that girls are discriminated against in feeding but Mishra et al. (1999) found that discrimination in childhood feeding and immunization coverage is present.

This study found that stunting, wasting and underweight are higher in children of SCs/STs as compared with other groups. Caste is strongly associated with poverty, education of child's parents especially with maternal education, land ownership of family, consumption, use of health-services and maternal and child health (Deshpande, 2000). There is clear evidence mentioned about discrimination against some social groups.

Sanitation was another important predictor of malnutrition. This study suggests that sanitation and hygiene play an important role in child nutrition. Children from households with toilet facility are likely to be less stunted than children from households who do open defecation. Children from households with toilet facility are likely to be less stunted and underweight than children from households who do open defecation. Safe disposal of stools and proper hand-washing with an anti-bacterial soap after fecal contact could be strong barriers to fecal-oral transmission (Humphrey, 2009) and it may be effective for addressing the problem of child malnutrition in India. Safe drinking water has a positive impact on child health as children using safe water are less wasted.

This study found that the prevalence of stunting was above the average stunting (46.26%), underweight was above the average underweight (39.49%) and wasting was above the average wasting (17.93%) in three regions out of a total five regions of the state. The eastern region and the SGP region have higher prevalence of stunting. The southern region has lower prevalence of stunting. Prevalence of wasting and underweight is high in southern region. The SGP region has lower prevalence of wasting and underweight. This is an important finding of this study as most of the earlier studies ignored the intra-state variation of the child malnutrition as far as Uttar Pradesh is concerned. Southern region (generally known as Bundelkhand), which consists of hilly and forested areas and known for its backwardness, has been one of the lagging regions with respect to malnutrition of children, even after controlling socio-economic parameters.

Conclusion

Intra-state regional variation of child malnutrition is present in Uttar Pradesh. The problem of being underweight and wasting is serious in the southern region. The eastern region is the second area of concern for child health. The southern region contains the semi-arid geographical region of Uttar Pradesh (known as Bundelkhand), which could be explained by low food productivity. However, the eastern region is a part of the famous fertile Ganga-Yamuna Doab. Social and economic factors might be responsible for the poor nutritional status of children in the eastern region.

Household economic status is a significant determinant of child health. The study reveals that children from the poorest and poorer households face a higher risk of stunting compared with those from middle income and wealthier households, highlighting the impact of poverty on child nutrition and growth. There is also a strong link between maternal education and child health, with children of better educated mothers showing less incidence of stunting and underweight. This emphasizes the importance of maternal education in fostering healthier outcomes in children.

Policy implications

The results suggest that there is a need to implement health programmes region-wise to eliminate malnutrition. POSHAN Abhiyaan 2.0, ICDS, Pradhan Mantri Matru Vandana Yojana (PMMVY) and Mission Indradhanush are a few government schemes with the objective of eliminating malnutrition which should be implemented effectively. Maternal education is positively associated with child malnutrition. Thus, there is also a need to focus more on female literacy which is low in Uttar Pradesh. We recommend that government schemes like 'Beti Bachao Beti Padhao' and 'Kanya Vidya Dhan Yojana' should be implemented more effectively.

Limitations of the study

Maternal nutrition was not analysed in this study as it was not in its scope. Similarly, the role of male literacy has not been covered which could be helpful for further research. Due to a lack of regional economic data, regional disparities in terms of economic development couldn't be analysed in this study.

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