Determinants of Stunting, Wasting, and Underweight in Five High-Burden Pockets of Four Indian States

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Abstract

Objectives: Prevalence of under-nutrition is very high in India. Under-nutrition is a result of interplay between different immediate, underlying, and basic causes. The study was conducted with the objective to identify significant predictors of stunting, wasting, and underweight.

Methods: Cross-sectional studies with 2299 children from five high-burden pockets of four Indian states were conducted. Primary data on their anthropometric measurements along with their households’ demographic and socioeconomic characteristics were collected. Binary logistic regression analyses were performed to examine the predictors of stunting, wasting, and underweight.

Results: Results show very high prevalence of stunting, wasting, and underweight in all five regions covered in the study. Multivariate analyses show that food security, use of toilets, and low body mass index status of mothers were the major predictors of stunting and underweight among children. Acute respiratory infection disease was the major predictor of underweight and diarrhea was the major predictor of stunting. Younger children (<24 months) had lower odds of underweight and stunting compared to older children (24–59 months). The analyses showed higher odds of wasting among male children. Regional variations were also seen in the study with higher odds of underweight and wasting in Khuntpani block and higher odds of stunting in Naraini block.

Conclusion: The above findings indicate that for comprehensively addressing child under-nutrition, it is very important to address maternal nutrition, improve food security, and reduce poverty status, provide better water and sanitation facility to the community, control infections, and address regional disparity.

Keywords: Determinants, predictors, stunting, underweight, wasting

Introduction

The reduction in child under-nutrition is very important for economic and social development of a country. Child under-nutrition is associated with higher mortality and morbidity, and hence, it should be one of the priority areas for the policy-makers for taking urgent and appropriate actions, especially where the burden is high. Nutritional deficits also hinder children’s long-term physical, mental, and emotional development and restrict countries’ economic and social growth and prosperity. Under-nutrition results from different causes—immediate, underlying, and basic. Immediate causes include inadequate intake of diet and repeated illnesses, whereas underlying causes include inadequate care of mothers, lack of access to health facilities, poverty, and food insecurity. Stunting, wasting, and underweight are the important nutritional status indicators for children. While stunting is caused by long-term insufficient nutrient intake and repeated infections, wasting is a result of acute food shortage and illness. Effects of stunting are delayed motor development and impaired cognitive development and are largely irreversible. Wasting, on the other hand, is a strong predictor of mortality and requires urgent response. Underweight combines information about linear growth obstruction and weight for length/height.

India’s recent National Family Health Survey (NFHS-4), conducted during 2015–2016, shows a very high prevalence of stunting, wasting, and underweight in all five regions covered in the study. Multivariate analyses show that food security, use of toilets, and low body mass index status of mothers were the major predictors of stunting and underweight among children. Acute respiratory infection disease was the major predictor of underweight and diarrhea was the major predictor of stunting. Younger children (<24 months) had lower odds of underweight and stunting compared to older children (24–59 months). The analyses showed higher odds of wasting among male children. Regional variations were also seen in the study with higher odds of underweight and wasting in Khuntpani block and higher odds of stunting in Naraini block.
of stunting, wasting, and underweight among children <5 years of age.[7] Their prevalence is 38.4%, 21%, and 35.7%, respectively. This is certainly less than the previous NFHS survey (NFHS-3), conducted during 2005–2006, so far as stunting and underweight are concerned.[7] However, there is an increase in the prevalence of wasting from the last survey which is a matter of concern because wasting is one of the underlying causes of child mortality.[8] Furthermore, the recently released Global Hunger Index 2017 report by the International Food Policy Research Institute, in which India is ranked 100th out of 119 nations, shows a very sorry state of hunger in the country.[9] Lack of consensus and less priority have led to very poor formulation of nutritional policies and program globally,[10,11] and this is also true for India. The Government of India’s Integrated Child Development Services and National Health Mission seek to improve the nutritional status of children through growth promotion activities, especially implementing interventions to promote growth in the first 1000 days of life but face substantial barriers.[12]

To combat child under-nutrition with right set of interventions, policy-makers need to have better understanding of its economic, social, and policy determinants.[13-15] The specific objective of this paper is to identify the social determinants of stunting, wasting, and underweight among children in five high-burden pockets of the four Indian states and also to examine the general question that whether there are different predictors of stunting, wasting, and underweight or whether they share common predictors. The analysis was done primarily to help policymakers for designing a comprehensive nutrition promotion program by addressing all three nutritional problems.

**Study Design, Sampling, and Data Collection**

The study used data on child morbidity, anthropometry of children and mothers, households’ food security, water, sanitation and hygiene practices and other relevant information collected from the sampled households. Data were collected through cross-sectional nutritional surveys conducted in five high-burden pockets of five districts from four Indian states, Khuntpani (Jharkhand), Nabarangpur (Odisha), Koraput (Odisha), Naraini (Uttar Pradesh), and Kesla (Madhya Pradesh) between 2015 and 2017 by Kalawati Saran Children’s Hospital, New Delhi, in collaboration with the United Nations Children’s Fund (UNICEF), India. These high-burden pockets were identified by states for planning their community-based program for addressing under-nutrition among children.

Nutrition surveys in five districts used two-stage cluster sampling with the probability of being sampled proportional to the population. For survey in Jharkhand, the sample size was calculated taking prevalence of wasting as per the Rapid Survey of Children 2013–2014. For survey in other states, respective sample sizes were calculated taking the prevalence of wasting as per the NFHS-4 2015–2016 data. In each survey, a precision of ±5% was taken for calculating the sample size. Table 1 provides the details of states, districts, and blocks covered under the survey with timeline and total children covered under each district.

In all five surveys, equipment of global standards was used for taking anthropometry. Height, weight, and mid-upper arm circumference (MUAC) were measured using wooden infanto-cum-stadiometer, SECA 874 digital weighing scales, and tri-color MUAC tapes, respectively. Standard methods were followed to take weight, height/length, and MUAC as recommended by the World Health Organization (WHO). Anthropometric indices based on the WHO 2006 standards were calculated using ENA software (July 2015 version Manufactured by Action Against Hunger Canada).

**Statistical methods**

All analyses were performed in SPSS 20 software (IBM Corporation). Binary logistic regression analyses were performed to identify significant social determinants of under-nutrition separately for stunting, wasting, and underweight among children <5 years of age. Independent variables taken in the analyses were age groups of children, gender, maternal under-nutrition (low body mass index [BMI], low height, low MUAC), child care and childhood illness (ration received for children from anganwadi centers [AWC], diarrhea, and acute respiratory infections [ARIs]), hygiene and sanitation (usage of toilet facility, access to safe drinking water, treatment of water, hand washed before feeding, before cooking food, after defecation, stagnant or sewage water, and solid waste near the house), underlying determinants such as household received public distribution system (PDS) ration last month, and household food security/insecurity status and regions covered in the study to understand geographical variations.

Stunting, wasting, and underweight were taken separately as dependent variables with binary categories. Stunting is defined as the children with height-for-age Z-score (HAZ) <-2SD and severe stunting is defined as the children with HAZ <-3SD. Global acute malnutrition (GAM) or wasting is defined as the children with weight-for-height Z-score (WHZ) <-2SD.

| State      | Survey area                          | Survey month/year | Total children |
|------------|--------------------------------------|-------------------|----------------|
| Jharkhand  | Khuntpani block of West Singhbhum    | October 2016      | 224            |
|            | district                             |                   |                |
| Odisha     | Nabarangpur district                 | May-June 2017     | 581            |
|            | Koraput district                     | May-June 2017     | 502            |
| Uttar      | Naraini block of Banda district       | June-July 2017    | 450            |
| Pradesh    |                                      |                   |                |
| Madhya     | Kesla block of Hosangabad district    | August 2017       | 542            |
| Pradesh    |                                      |                   |                |
| Total number of children covered in all the five surveys |                     | 2299            |
and/or MUAC <125 mm and/or presence of bilateral pitting edema. Similarly, severe acute malnutrition (SAM) or severe wasting is defined as the children with WHZ <-3SD and/or MUAC <115 mm and/or presence of bilateral pitting edema. Underweight is defined as the children with weight-for-age Z-score (WAZ) <-2SD and severe underweight is defined as the children with WAZ <-3SD.

All independent variables were also categorical and binary categories were created with codes 1 and 0 for including them in the regression models.

The HFIAS indicators were categorized into two levels of household food insecurity (access): food secure and food insecure using USAID guideline of HFIAS for the measurement of food access. They were coded 1 and 0, respectively. A food secure household experienced none of the food insecurity (access) conditions, or just experienced worry, but rarely. All other households who worried about not having enough food, were unable to eat preferred foods, and/or ate a more monotonous diet than desired and/or some foods considered undesirable, sacrificed quality of food, were cut back on meal size or number of meals in the last 4 weeks (30 days) were considered food insecure.[16]

Children were also divided into two age groups (0–24 and 24–59 months) to understand whether stunting, wasting, and underweight are significantly different in early age-group of children compared to the older children, keeping other variables constant.

Different blocks/regions covered under the study were also taken as predictors to understand geographical variations in under-nutrition among children.

### Sample characteristics

The study sample for this study consists of children below 5 years of age whose mothers were interviewed and whose anthropometric information were collected. The total sample size was 2,299. The sample had an equal distribution of male (49.9%) and female (50.1%) children. 7.7% children were aged below 6 months, 31.5% children were between 6 and 24 months, 23% children were between 24 and 36 months, and 37.7% were aged 3–5 years. Table 2 shows age-wise gender distribution of children covered in the study. The Chi-square test confirms that there is no significant difference in gender distribution across all age groups of children covered in the study.

Mothers of 38% children were underweight (BMI <18.5 kg/m²), 41.83% were wasted (MUAC <230 mm), and 12% mothers were stunted (height <145 cm). 71% of the children belonged to households with no toilet facility, and only 33% of the children belonged to households where water was treated before being used for drinking purpose. 74% households were linked with the PDS scheme of the government of which 81% had received PDS ration in the last month. 76% children received take-home rations (THR) in the last month.

### Table 2: Age-wise gender distribution of children covered in the study

| Age group (months) | Female | Male | Total |
|-------------------|--------|------|-------|
| <6                | 92     | 85   | 177   |
| 6-12              | 116    | 117  | 233   |
| 12-18             | 109    | 125  | 234   |
| 18-24             | 124    | 134  | 258   |
| 2-3               | 278    | 251  | 529   |
| 3-4               | 231    | 236  | 467   |
| 4-5               | 202    | 199  | 401   |
| Total             | 1152   | 1147 | 2299  |

Table 3 shows area-wise prevalence of malnutrition in different categories. Prevalence of GAM was highest in Nabrangpur (39.8%) and lowest in Kesla (26.4%). Prevalence of SAM was highest in Khuntapani (8.1%) and lowest in Kesla (3.8%). Prevalence of stunting and severe stunting was highest in Khuntapani (70.7% and 36.2%) and lowest in Kesla (37.9% and 9.6%). Similarly, prevalence of underweight and severe underweight was highest in Khuntapani (72.5% and 36.1%) and lowest in Kesla (46.5% and 11.1%). This shows huge geographical variations in under-nutrition among children.

### RESULTS

**Determinants of stunting, wasting, and underweight**

Binary logistic regression estimates show that children with ARI had higher odds of underweight and children with diarrhea had higher odds of stunting. Children of mothers with low BMI had higher odds of both underweight and stunting. Children living in food secure households and households, where toilets were being used, had lower odds of underweight and stunting. Odds of underweight and stunting were significantly lower among younger children compared to older children. Odds of underweight and wasting were significantly lower in Kesla block compared to Khuntapani block (reference block). Odds of wasting were significantly lower in Naraini and Koraput regions, and odds of stunting were significantly higher in Naraini block compared to Khuntapani block. Odds of underweight and stunting were significantly higher among those households who received THR for their children from the AWC which indicates low economic status of such households. Similarly, odds of stunting were significantly higher among those households who received PDS ration. Odds of wasting among male children were significantly higher compared to female children [Table 4].

### CONCLUSION

The study explored the effects of child’s characteristics, mother’s nutritional characteristics, and household’s characteristics on child nutritional status using multivariate analysis.
Results reveal that food availability and clean WASH practices are important factors of better nutritional outcomes among children. Results also show that episodes of illnesses bring down the nutritional status of children. Results prove that mother’s nutritional status has significant bearing on child nutritional status. Wasting was found to be high among male children, and underweight and stunting were significantly lower among younger children. The analysis also showed some regional variations in stunting, wasting, and underweight.

The analysis also tried to address the question that whether stunting, wasting, and underweight share common predictors. It was found that some predictors such as food security status, usage of toilet facility, mothers BMI status, and age group of children were common for underweight and stunting. Wasting did not share any common predictor with stunting or underweight.

**Discussion**

Food security status and usage of toilet facility emerged as major predictors of childhood stunting and underweight, thus underpinning the importance of addressing poverty and providing sanitation facilities to rural households. Low BMI status of mothers also emerged as a major predictor of childhood stunting and underweight which shows that both maternal and child under-nutrition are interrelated. Policy-makers and program implementers should plan new approaches to take these interrelations into account while designing child nutrition program including their life-cycle and intergenerational effects. Infection control would help children’s body to absorb and retain vitamins and minerals and thus improving their immunity.

### Table 3: Area-wise prevalence of malnutrition in different categories (%)

| Area            | GAM (%) | SAM (%) | Stunting (%) | Severe stunting (%) | Underweight (%) | Severe underweight (%) |
|-----------------|---------|---------|--------------|--------------------|-----------------|-----------------------|
| Khuntpani (JH)  | 34.80   | 8.10    | 70.70        | 36.20              | 72.50           | 36.10                 |
| Nabarangpur (OD)| 39.80   | 7.30    | 47.80        | 15.90              | 62.30           | 23.50                 |
| Koraput (OD)    | 29.90   | 4.10    | 50.10        | 16                 | 55.80           | 18.20                 |
| Naraini (UP)    | 32.90   | 6.30    | 58.90        | 23.40              | 59.70           | 21.50                 |
| Kesla (MP)      | 26.40   | 3.80    | 37.90        | 9.60               | 46.50           | 11.10                 |

SAM: Severe acute malnutrition, GAM: Global acute malnutrition

### Table 4: Determinants of underweight, stunting, and wasting of children <5 years

| Predictors                                                                 | Underweight | Stunting | Wasting |
|---------------------------------------------------------------------------|-------------|----------|---------|
| Age group (0-24 months=1 and >24 months=0)                                 | 0.786**     | 0.625*** | 1.165   |
| Gender                                                                    | 0.991       | 1.176    | 1.270** |
| Child suffered from ARI diseases in the last 15 days                       | 1.256*      | 1.025    | 1.229   |
| Child suffered from diarrhea in the last 15 days                           | 1.133       | 1.364**  | 1.097   |
| Mothers with low BMI (BMI <18.5 kg/m²)                                     | 1.502***    | 1.272*   | 1.204   |
| Mothers with low MUAC (MUAC <230 mm)                                      | 0.939       | 1.012    | 1.156   |
| Mothers with low height (height <145 cm)                                  | 1.179       | 1.238    | 0.804   |
| Households food security status                                           | 0.728***    | 0.831*   | 0.968   |
| Households received PDS ration in the last 30 days                         | 1.081       | 1.306**  | 0.903   |
| Households received THR from AWC in the last 30 days                       | 1.463**     | 1.322*   | 1.096   |
| Households using safe drinking water source                                | 0.962       | 0.813    | 0.880   |
| Households treated water for drinking purpose                              | 0.899       | 0.843    | 0.947   |
| Households used toilet facility                                           | 0.704***    | 0.794*   | 0.879   |
| Households had stagnant or sewage water near their houses                  | 0.962       | 0.863    | 0.915   |
| Households with solid waste accumulated near their houses                  | 1.132       | 1.153    | 1.111   |
| Mothers washed their hands before mealtime                                 | 0.888       | 0.974    | 1.118   |
| Mothers washed their hands before cooking food                             | 0.917       | 0.902    | 0.927   |
| Mothers washed their hands after using toilet/defecation                   | 0.943       | 1.159    | 0.953   |
| Children from Kesla Block (MP)                                            | 0.880       | 0.857    | 0.594***|
| Children from Naraini Block (UP)                                          | 1.195       | 1.869*** | 0.666** |
| Children from Koraput district (Odisha)                                    | 0.744**     | 1.185    | 0.586***|
| Constant                                                                  | 1.302       | 0.630    | 0.506** |

***P<0.01, **P<0.05, *P<0.10. BMI: Body mass index, ARI: Acute respiratory infections, MUAC: Mid-upper arm circumference, PDS: Public distribution system, THR: Take-home rations, AWC: Anganwadi centers, OR: Odds ratio
which would be leading to reduction of malnutrition burden among children.

The study found significantly higher odds of wasting among male children. Several studies have shown that male children were more at risk of being malnourished than female children.\(^{[19-21]}\) Regional variations were also found in the study with higher odds of underweight and wasting in Khuntapani block which is an underserved tribal block in the state of Jharkhand and higher odds of stunting in Naraini block which is situated in Bundelkhand region of Uttar Pradesh and is one of the most backward regions with persistent drought in India.

Policy and program implications are very clear from the above analyses. To comprehensively address child under-nutrition, it is very important to address maternal nutrition, improve food security and economic status, provide better sanitation facility to the community, control infections, and address regional disparities by identifying high-burden pockets for implementing effective nutrition promotion programs. Commission on Social Determinants of Health has identified that apart from policy intervention and inter-sectoral convergence, social participation and empowerment are the key strategies for dealing with inequities. Women empowerment using adult learning methods such as participatory learning and action approach have shown evidence of improving child survival and growth along with addressing other social determinants in underserved and marginalized communities\(^{[12,22,23]}\) and could also be integrated into the intervention package.

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**Conflicts of interest**

There are no conflicts of interest.

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