Contribution of Low Birth Weight to Childhood Malnutrition in India

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Research

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Abstract

Background

Although Low birth weight (LBW) is an independent predictor of malnutrition, it is still a negligible public health issue in the Indian context. Where, a large number of children died due to complications from maternal and child malnutrition. Furthermore, each year, India loses its GDP due to the cost of micronutrient malnutrition which is more that the public health budget.

Methods

To conduct the study, 4th round of the National Family Health Survey (NFHS-4), a large-scale survey was used. The study used the last birth information (190,898) due to the detailed availability of maternal care information. The univariate and bivariate analysis was done to find out the percentage distribution. Further, a logistic regression was applied to examine the association between LBW and malnutrition (stunting, wasting, and underweight). The study also employed the Fairlie decomposition technique to estimate the contribution of LBW to malnutrition among Indian children.

Results

The estimated result shows that childhood malnutrition was higher in most of the Empowered Action Group (EAG) states of India. Furthermore, the infant who was born with low birth weight was more likely to have stunted (OR=1.67; 95% CI: 1.60-1.75), wasting (OR=1.32; 95% CI: 1.26-1.39), and underweight (OR=1.44; 95% CI: 1.38-1.51) in their childhood as compared to infants with no low birth weight. The findings of the decomposition model explained 19 % of the difference in stunting, 12% in wasting, and 16% in underweight among the children born with low birth weight after controlling for background characteristics of the individuals. Other variables such as wealth status, mother's education, height, mother's age at birth, and sanitation facility were the significant contributors to childhood malnutrition in India.

Conclusions

Although many nutrient-centric programmes are going on to control the nutrition status of children, the Indian government should focus more on control LBW. As LBW has a significant contribution to malnutrition, the study recommends that government should take all the necessary steps to implement and monitor some special schemes like the Kangaroo Mother Care (KMC) at the ground level to reduce the burden of LBW.

Introduction

A general perception exists that malnutrition is a health condition that results from inadequate nutrient intake. But Low Birth Weight (LBW) is an independent factor contributing to malnutrition among children, primarily in Asian and African countries [1]. Stunting, wasting, and underweight are a combination of the anthropometric measurements of childhood malnutrition [2]. As per the Food and Agriculture Organization (FAO), worldwide, approximately 795 million populations suffered from undernutrition from 2014 through 2016 [3]. It has been proven that childhood malnutrition affects physical and mental health and is a significant impediment to the development of society by losing labour productivity and increasing the cost of healthcare [4–6]. Every year African and Asian countries lose 11% of gross domestic product (GDP) due to the burden of malnutrition, which cost more than the 2008-2010 financial crisis [7].

India is the home of the highest number of malnourished children. As per the latest Global Hunger Index (GHI), which is derived based on total undernutrition and infant mortality — India is ranked 94th out of 107 countries[8]. Previous studies revealed that malnutrition was much higher in children with LBW than normal children [9–11]. According to the World Health Organisation (WHO), low birth weight babies are those who are born with less than 2500g. [12]. According to global estimates, approximately 15 million premature babies [13] and more than 20 million LBW infants are born. An estimated 15% to 20% of all births worldwide are LBW, and it is highest in South Asian countries, 28% [12]. In India, the prevalence of LBW reduced to 3% (21% to 18%) in the last decade [14]. Thus, the higher prevalence of LBW remains a persistent concern among decision-makers and researchers.

The specific causes of LBW are not clearly understood. It manifests the complex interaction of several factors such as mother's malnutrition and health, poverty, previous caesarean delivery, and poor utilisation of health care facilities [15–19]. However, according to the causes of death statistics, approximately half of neonatal deaths occurred due to complications from LBW and premature birth [20]. Low birth weight babies are more susceptible to illness due to infection, feeding difficulties, temperature instability, Pneumonia, cardiovascular disease, respiratory distress, and malnutrition [21–23]. In addition, LBW is highly correlated to cough and diarrhoea [24], which are the leading causes of childhood malnutrition in India [25, 26]. After growth faltering at the neonatal period, infants fail to attain average height and weight, leading to wasting [27]. Evidence suggests that wasting in early life likely contributes to stunting in childhood [28]. Also, malnutrition in the foetus results in malnutrition throughout infancy, childhood, and adulthood [29]. Therefore, low birth weight should be highly concerned about controlling childhood stunting, wasting, and underweight, which are the significant contributors to child mortality [30].

Since the 1970s, the Indian government has been implementing many schemes and programmes to improve the nutrition status, especially for children and women. The benefits of such schemes have received by most Asian countries; unfortunately, India has been failed. In India, approximately 38%, 21%, and 36% of children suffer from stunting, wasting, and underweight, respectively [14]. A study estimated that about 68% of children died due to child and maternal malnutrition [31]. Furthermore, India is losing 2.5% of its GDP due to the cost of micronutrient malnutrition [32]. Thus, reducing child malnutrition has become a highlighted concern to achieve the SDGs targets on hunger and child health. The Indian Prime Minister announced the holistic nutrition or POSHAN Abhiyaan or National Nutrition Mission in 2018 to make India malnutrition-free by 2022 [33]. However, the current trend of malnutrition indicates that India is not on track to achieve that.

The Global Nutrition Report (GNR) reported that a $1 investment in a nutritional scheme could generate an economic return of $16 [8]. Thus, the contribution of LBW to child malnutrition needs to be explored to raise the economic return by reducing malnutrition. A connection between low birth weight and childhood malnutrition is missing in the Indian context as previous studies conducted to explore the determinants of both [15–19, 34, 35]. Moreover, In India, most of the studies on low birth have been done using hospital data, and there is no such work done at the national level using recent data. This study aims to highlight the contribution of low birth weight on childhood malnutrition using a national-level cross-sectional dataset to fill this research gap. The findings may help implement evidence-based policy to achieve the targets of SDGs in India.

Data And Methods

The population-level study on the adverse birth outcome is limited in India due to the unavailability and the poor quality of data on birth weight. The recently conducted 4th round of National Family Health Survey (NFHS 4), 2015-16, was used for the study. The nationwide representative cross-sectional survey, equivalent to the DHS, provides information on reproductive and child health. The biometric components such as weight, height, anaemia, etc., were measured following international standards. In this large-scale survey, 699,686 women aged 15-49 years were interviewed from 601,509 households from January 2015 to December 2016. We have used the kids' file that provides the information of child and mother during the last five years preceding the survey, i.e. 2010 to 2015-16. A total of 259,267 births were recorded in the seven years of birth history. The study used the last birth information (190,898) due to the detailed availability of maternal care information. The height and weight were collected from 178,051 children. After excluding missing data, the analysis is based on a total sample of 164,213 infants.

Outcome variable

The main outcome variables were stunting, wasting, and underweight as these are the powerful predictors of the development of a country. Three anthropometric indices; stunting (height-for-age), wasting (weight-for-height) and underweight (weight-for-age) were considered for nutritional assessment. The indices were derived from the standard deviation units (Z-score) and the median of the reference population based on the standards of WHO. If the Z-score for height-for-age, weight-for-height, and weight-for-age is less than minus 2 standard deviations from the median, consider stunting, wasting, and underweight respectively. The stunting results from chronic malnutrition; wasting reflects acute malnutrition, and underweight represents the combined index of the above two. The unit of analysis in this study was the last births in the five years preceding the survey.

Exposure variables

The study was utilised low birth weight as an independent variable. Due to a 20% missing observation of infants' birth weight, birth size was used as a proxy of low birth weight. In NFHS, mothers' were asked: "When (the child) was born, was he/she: large, average, small or very small [14]. A study based on NHFS data has been reported that the baby's reported size at birth is closely related to birth weight[36]. The birth size was recoded as low birth weight (small and very small) and normal (average and large).

It is known that malnutrition not only predicts childhood morbidity but also controls nutritional status. Based on the previous evidence, various child characteristics, mother level, household level, and community-level variables were considered the independent variable. The study included the child's characteristics such as sex of the child (male and female), birth order (1^{st}, 2^{nd}, 3^{rd} and 3+), age of the child (< 12 months, 12 – 23 months, 24 – 35 months, and 36 months & above) and breastfeeding (>6 months and <6 months). Maternal variables include mother's education (illiterate/ primary, secondary, and higher education), mother's age at birth (< 20, 20 – 24, 25-29 and 30 & above), the height of the mother (>145cm and <145cm). In the current study, the mother's height was considered as an independent variable instead of BMI as the BMI measured at the time of the survey could be five years after the child's birth included in the analysis. So, the possibility of changing a mother's height is less than the BMI as a mother's nutrition status. Religion (Hindu, Muslim, and Others), economic status of the household (poor, middle, and rich), source of drinking water, and sanitation facilities were also included. The community-level variable considers the place of the residence viz. "rural/urban" and regions namely "North", "Central", "West", "South" and "North-East".

Statistical Analysis

The weighted prevalence of nutrition stunting, wasting, and underweight was estimated using the exposed sample of last birth, and the Chi-square test (χ2) was performed to evaluate the association between dependent and independent variables. A logistic regression model was used to understand the contribution of low birth weight on childhood morbidity and nutrition status by adjusting the socioeconomic, demographic, and child characteristics selected by bivariate analysis. For the analysis, a dichotomous variable was used as the dependent variable and all the states and union territories were included in the sample.

$$logit(p) = \log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 * x_1 \ldots\ldots + \beta_k * x_k + \varepsilon$$

Where β_0 is intercept and β1... βk are regression coefficients indicating the relative effect of a particular explanatory variable on the outcome, while ε is an error term.

Furthermore, we have used the extension of Binder Oaxaca decomposition given by Fairlie (2005), a non-linear decomposition technique appropriate for binary outcome variables. This technique decomposes the gap in the prevalence of diseases over the residence where the individual has spent most of their lives, and we observe the percentage contribution of each of the attributable factors. Thus, a non-linear equation Y = F(Xβ), can be decomposed as:

$$Y^r - Y^u = \left[\sum_{i=1}^{N^r} \frac{F(x_i^r \beta^r)}{N^r} - \sum_{i=1}^{N^u} \frac{F(x_i^u \beta^r)}{N^u}\right] + \left[\sum_{i=1}^{N^u} \frac{F(x_i^u \beta^r)}{N^u} - \sum_{i=1}^{N^u} \frac{F(x_i^u \beta^u)}{N^u}\right]$$

Where Y^r and Y^u represents the nutritional status among children with LBW and no LBW with samples N^r and N^u, respectively. The first term in the equation represents the part of the gap due to the group differences in the distributions of independent variables. The second term represents part due to differences in the group processes determining levels of Y and captures a portion of the group gap due to group differences in immeasurable or unobserved endowments. To identify the contribution of individual explanatory factors on the observed gap, we assume that the two-sample sizes are equal and there is an exact match between the samples. Using coefficient estimates from a logit regression for a pooled sample β*, the independent contribution of x_i's to the group gap can then be expressed as:

$$contribution_i = \frac{1}{N^u} \sum_{j=1}^{N^u} F(\alpha^* + x_{ij}^r \beta_i^* + x_{i'j}^r \beta_{i'}^*) + F\left(\alpha^* + x_{ij}^u \beta_i^* + x_{i'j}^r \beta_{i'}^*\right), \qquad \forall \ i \neq i'$$

The contribution of each variable to the gap is thus equal to the change in the average predicted probability from replacing nutritional status among LBW and No LBW children while holding the distributions of the other variables constant [37]. The analysis was performed by STATA version 13.1, R Version 1.1.44, and Arc GIS version 10.3.

Results

Table 1 represents the percentage distribution of the sample size used in the current study. Nearly 54% of the sample consists of male children, and the rest of the sample consists of female children. 63% of the children suffered from stunting, whereas 66% of the children were underweighted. More than half of the sample, around 77%, suffered from wasting. Around 41% of the children's mothers were illiterate, and every four out of five children follow the Hindu religion. Almost three in ten households belonged to urban areas, and about 28% of the household belonged to the Central region of India.

Table 1
Sample distribution of the study

Determinants	Percent	Sample (N)
Stunting		
> 2 SD	63.66	1,04,533
< 2SD	36.34	59,680
Wasting		
> 2 SD	77.97	1,28,029
< 2SD	22.03	36,184
Under-weight		
> 2SD	66.38	1,09,006
< 2SD	33.62	55,207
Low birth weight		
No	88.13	1,44,725
Yes	11.87	19,488
Sex of the child		
Male	54.05	88,751
Female	45.95	75,462
Age of the child (months)		
< 12	24.81	40,743
12–23	25.53	41,919
24–35	20.01	32,854
=>36	29.65	48,697
Birth Order		
1	32.58	53,498
2	33.19	54,502
3	17.31	28,424
3+	16.92	27,789
Breastfeeding		
< 6 months	9.89	16,243

Determinants	Percent	Sample (N)
> 6 months	90.11	1,47,970
Age at birth		
Below 20	9.81	16,109
20–24	41.54	68,214
25–29	30.76	50,512
30&Above	17.89	29,378
Mother's height		
< 145 cm	10.88	17,864
> 155 cm	89.12	1,46,349
Mother's Education		
Illiterate/primary	41.85	68,720
Secondary	47.36	77,775
Higher	10.79	17,718
Wealth Index		
Poor	46.43	76,246
Middle	20.3	33,336
Rich	33.27	54,631
Religion		
Hindu	73.23	1,20,246
Muslim	15.14	24,857
Others	11.64	19,110
Place of residence		
Rural	74.64	1,22,568
Urban	25.36	41,645
Toilet facility		
Don't have	39.68	65,161
Have	60.32	99,052
Source of drinking water		

Determinants	Percent	Sample (N)
Unimproved	11.47	18,839
Improved	88.53	1,45,374
Region		
North	19.07	31,323
Central	28.35	46,553
East	20.96	34,424
North East	14.3	23,482
West	7.07	11,613
South	10.24	16,818

The estimated result (**Fig. 1**) shows that the prevalence of stunting was the highest in Bihar (45%), much higher than at the national level (37 %). The state of Uttar Pradesh ranked second, where 44% of children were stunted (Table 2), followed by Jharkhand, Dadra and Nagar Havel, Meghalaya, and Rajasthan. The lowest prevalence was observed in Goa in India. On the other hand, the percentage of wasting ranges from 31 % in Jharkhand to 7 % in Manipur. One forth infants were wasted in Chhattisgarh, Gujarat, Karnataka, Madhya Pradesh, and Maharashtra. The severity in underweight incidence is observed more in Jharkhand, ranges from 47 to 11 %. Also, states like Uttar Pradesh, Madhya Pradesh, Gujarat, Chhattisgarh, and Bihar had a higher percentage of underweight children.

Table 2
State wise percentage distribution of low birth weight, stunting, wasting and underweight in India, 2015-16.

States and UTs	Low birth weight (%)	Stunting (%)	Wasting (%)	Underweight (%)
Andaman And Nicobar	6.00	23.81	21.35	20.78
Andhra Pradesh	8.25	30.55	19.66	31.63
Arunachal Pradesh	12.43	27.86	17.99	19.28
Assam	16.12	34.89	17.63	29.36
Bihar	14.18	45.39	23.91	43.49
Chandigarh	12.02	26.51	12.09	22.29
Chhattisgarh	9.10	36.38	25.18	37.92
Dadra And Nagar Havel	5.88	41.31	28.48	38.36
Daman And Diu	6.26	21.43	23.23	24.42
Delhi	8.99	33.63	16.59	28.53
Goa	8.96	19.92	20.02	21.89
Gujarat	13.02	36.55	28.45	38.12
Haryana	9.00	33.1	22.94	29.53
Himachal Pradesh	14.15	26.25	14.2	20.83
Jammu And Kashmir	11.45	27.17	12.82	15.79
Jharkhand	9.20	43.84	31.38	46.8
Karnataka	8.30	35.67	27.23	34.87
Kerala	7.03	20.65	16.23	16.52
Lakshadweep	13.88	25.8	15.36	22.52
Madhya Pradesh	13.09	39.19	28.2	42.18
Maharashtra	10.14	34.02	26.99	35.48
Manipur	13.01	27.27	7.35	13.36
Meghalaya	8.61	38.73	17.33	27.2
Mizoram	7.11	26.08	6.32	11.11
Nagaland	10.92	25.69	11.85	15.59
Odisha	13.38	33.4	21.84	34.49
Puducherry	6.69	24.41	24.15	23.29

States and UTs	Low birth weight (%)	Stunting (%)	Wasting (%)	Underweight (%)
Punjab	12.81	25.66	16.73	21.35
Rajasthan	10.72	38.08	24.28	35.85
Sikkim	4.18	29.2	14.15	13.85
Tamil Nadu	9.36	28.06	20.6	23.89
Telangana	7.58	26.41	20.19	26.89
Tripura	13.49	22.91	17.26	23.92
Uttar Pradesh	15.84	43.92	20.58	39.02
Uttarakhand	14.47	32.92	20.82	25.99
West Bengal	11.79	31.2	20.9	31
India	**12.00**	**36.55**	**22.86**	**34.94**

In **Fig. 2**, the age-wise prevalence of low birth weight was plotted from age 0 months to 59 months. The graph shows that the LBW infants had a higher prevalence of malnutrition than a child with normal birth. The percentage of stunting increased rapidly in the first 23 months, and then the curve flattened in later childhood. A vast proportion of newborns were facing wasting at an early age; a decreasing slope was observed with the increase of their age. It also found that the prevalence of wasting was increasing at the end of childhood among LBW infants. The prevalence of underweight increased with the age of the child, which was more significant among LBW babies

Table 3 presents the association between LBW and malnutrition, i.e. stunting, wasting, and underweight. A strong association between low birth weight and childhood malnutrition was observed in India. The infant who was born with low birth weight was more likely to have stunted (OR = 1.67; 95% CI: 1.60–1.75), wasting (OR = 1.32; 95% CI: 1.26–1.39), and underweight (OR = 1.44; 95% CI: 1.38–1.51) in their childhood as compared to infants with no low birth weight. The result also showed that male children were more undernourished than female children. As expected, the probability of having a malnourished infant increased with the decreasing level of the mother's education and household wealth status. Children of the young mother, short stature mother, and children from the urban areas were the strongest predictors of childhood malnutrition in India. In addition, the chances of stunting and being underweight were greatly increased with increasing birth order, whereas the result was vice versa for wasting. Child belonged to central region were more prone to stunting (OR = 1.20; 95% CI: 1.14–1.27) and underweight (OR = 1.26; 95% CI: 1.19–1.33).

Table 3
Logistic regression model to examine the association of low birth weight with stunting, wasting and underweight, India 2015-16

Determinants	Stunting	Wasting	Under-weight
Low Birth Weight			
No			
Yes®	1.67**(1.60 1.75)	1.32**(1.26 1.39)	1.44**(1.38 1.51)
Sex of the child			
Female®			
Male	1.09**(1.06 1.12)	1.11**(1.07 1.15)	1.11**(1.08 1.15)
Age of the child (months)			
> 12®			
12–23	1.46**(1.39 1.52)	0.68**(0.65 0.72)	2.89**(2.76 3.03)
24–35	1.71**(1.63 1.79)	0.61**(0.57 0.64)	2.86**(2.72 3.01)
36&more	1.64**(1.57 1.72)	0.55**(0.52 0.58)	2.54**(2.43 2.67)
Birth Order			
1®			
2	1.09**(1.05 1.14)	0.96(0.91 1.00)	1.16**(1.11 1.21)
3	1.14**(1.09 1.21)	0.95(0.90 1.01)	1.26**(1.19 1.32)
3+	1.35**(1.27 1.42)	0.96(0.90 1.03)	1.51**(1.42 1.59)
Breastfeeding			
> 6®			
< 6	0.91**(0.86 0 .96)	0.91*(0.85 0.98)	0.91**(0.86 0.96)
Age at birth			
Above 30®			
Below 20	1.31**(1.22 1.41)	0.92*(0.85 0.99)	1.40**(1.31 1.51)
20–24	1.20**(1.13 1.26)	0.98(0.93 1.04)	1.22**(1.16 1.29)
25–29	1.04(0.99 1.09)	0.94*(0.89 1.00)	1.06*(1.01 1.11)
Mother's height			
> 145 cm®			

Note: ® Reference category; ** p < 0.01 *p < 0.005

Determinants	Stunting	Wasting	Under-weight
< 145 cm	1.82**(1.73 1.91)	1.07*(1.01 1.13)	2.10**(2.00 2.21)
Mother's Education			
Higher®			
Illiterate/Primary	1.86**(1.74 2.00)	1.23**(1.14 1.32)	1.78**(1.66 1.90)
Secondary	1.43**(1.33 1.52)	1.13**(1.06 1.21)	1.31**(1.23 1.40)
Wealth Index			
Rich®			
Poor	1.70**(1.61 1.80)	1.28**(1.20 1.36)	1.57**(1.49 1.66)
Middle	1.27**(1.20 1.33)	1.05(0.99 1.11)	1.28**(1.21 1.35)
Religion			
Hindu®			
Muslim	0.95(0.91 1.00)	0.91**(0.86 0.96)	1.06*(1.01 1.11)
Others	0.96(0.89 1.04)	0.96(0.87 1.05)	0.95(0.87 1.03)
Place of residence			
Rural®			
Urban	1.06*(1.01 1.11)	1.05*(0.99 1.10)	1.03(0.98 1.08)
Toilet facilities			
Don't have toilet®			
Have toilet	1.21**(1.16 1.26)	1.11**(1.06 1.17)	1.20**(1.15 1.25)
Source of drinking water			
Unimproved®			
Improved	1.02(0.96 1.07)	1.05(0.99 1.11)	0.95(0.90 1.01)
Region			
South®			
North	1.03(0.97 1.10)	0.93*(0.87 1.00)	1.16**(1.09 1.24)
Central	1.20**(1.14 1.27)	0.91**(0.85 0.96)	1.26**(1.19 1.33)
East	1.03(0.97 1.09)	0.93*(0.87 0.99)	0.98(0.92 1.04)

Note: ® Reference category; ** p < 0.01 *p < 0.005

Determinants	Stunting	Wasting	Under-weight
North-East	0.69**(0.64 0.74)	0.64**(0.59 0.70)	0.88**(0.82 0.95)
West	1.40**(1.30 1.51)	1.34**(1.23 1.46)	1.21**(1.12 1.31)
Note: ® Reference category; ** p < 0.01 *p < 0.005			

Table 4 shows the results of Fairlie decomposition analysis, examining the contribution of low birth weight to stunting, wasting, and underweight among children. The study showed that the model could explain 19 % of the difference in stunting, 12% in wasting, and 16% in underweight among the children born with low birth weight after controlling for background characteristics of the individuals. Among other independent variables, age of the child, education, religion, wealth index, height, age of mother at birth, and toilet facilities had significant contributions to the low birth weight of the child. For low birth weights leading to stunting, other independent variables such as the age of the child (6.4%), education (25.4%), religion (3.8%), wealth index (23.0%), height (36.6%), age of mother at birth (3.8%) and toilet facilities (6.6%) had a significant effect. Among the children with wasting other independent variables such as the age of the child (52.7%), education (17.6%), religion (9.1%), wealth index (22.8%), height (7.7%), age of mother at birth (3.7%), and toilet facilities (11.1%) had significant contribution apart from significant contribution from low birth weight. Education (20.7%), religion (8.4%), wealth index (25.5%), height (29.3%), age of mother at birth (3.7%), and toilet facilities (13.9%) had a significant contribution to underweight among children apart from low birth weight.

Table 4
Decomposition model estimates the contribution of low birth weight to stunting, wasting and underweight, India 2015-16

Independent Variables	Stunting		Wasting		Underweight	
	Coefficient (95% CI)	**% Contribution**	**Coefficient (95% CI)**	**% Contribution**	**Coefficient (95% CI)**	**% Contribution**
Sex of Child	0.001 (0.001–0.001) **	-7.000	0.001 (0.001–0.001) **	-16.500	0.001 (0.001–0.001) **	-4.700
Age of Child	-0.001 (-0.001–0.001)**	6.400	-0.003 (-0.004–0.003) **	52.700	-0.001 (-0.001-0.000) **	2.700
Birth Order	0.000 (0.000–0.000) **	2.300	0.000 (0.000–0.000) **	0.000	0.000 (-0.001-0.000) **	2.500
Breastfeeding	0.000 (0.000-0.001) **	-2.500	0.000 (0.000–0.000) **	-2.300	0.000 (0.000-0.001) **	-2.000
Age at birth	-0.001 (-0.001–0.001) **	3.800	0.000 (0.000–0.000) **	3.700	-0.001 (-0.001–0.001) **	3.700
Mother’s height	-0.006 (-0.007–0.006) **	36.600	0.000 (-0.001-0.000) **	7.700	-0.006 (-0.006–0.005) **	29.300
Mother’s education	-0.004 (-0.005–0.004) **	25.400	-0.001 (-0.001–0.001) **	17.600	-0.004 (-0.004–0.004) **	20.700
Wealth Index	-0.004 (-0.004–0.004) **	23.000	-0.001 (-0.002–0.001) **	22.800	-0.005 (-0.005–0.005) **	25.500
Religion	-0.001 (-0.001-0.000) **	3.800	-0.001 (-0.001-0.000) **	9.100	-0.002 (-0.002–0.001) **	8.400
Toilet Facility	-0.001 (-0.001–0.001) **	6.600	-0.001 (-0.001–0.001) **	11.100	-0.003 (-0.003–0.002) **	13.900
Region	-0.001 (-0.001-0.000) **	3.300	0.000 (0.000–0.000) **	-4.900	0.000 (-0.001-0.000) *	1.700
N of obs G = 0	144725		144725		144725	

Note: ** p < 0.01 *p < 0.005, Dependent variable- Stunting (0 = No, 1 = Yes), Wasting (0 = No, 1 = Yes), Underweight (0 = No, 1 = Yes); Group Variable- Low Birth Weight (0 = No, 1 = Yes)

Independent Variables	Stunting		Wasting		Underweight	
	Coefficient (95% CI)	% Contribution	Coefficient (95% CI)	% Contribution	Coefficient (95% CI)	% Contribution
N of obs G = 1	19488		19488		19488	
Pr(Y! = 0G = 0)[a]	0.353		0.214		0.322	
Pr(Y! = 0G = 1)[b]	0.443		0.264		0.443	
Difference[a-b]	-0.09		-0.05		-0.121	
Total explained[c]	-0.017		-0.006		-0.019	
% Total Contribution c/[a-b]*100	**19.07**		**12.64**		**15.99**	
Note: ** p < 0.01 *p < 0.005, Dependent variable- Stunting (0 = No, 1 = Yes), Wasting (0 = No, 1 = Yes), Underweight (0 = No, 1 = Yes); Group Variable- Low Birth Weight (0 = No, 1 = Yes)						

Discussion

Since 1970, the Indian government has been implementing several programmes to combat the burden of childhood malnutrition. After National Nutritional Anemia Prophylaxis Program (NNAPP), Integrated Child Development Services (ICDS) scheme, the largest programme in the world, was launched to improve child nutrition through providing health and nutritional services to pregnant mothers and children up to 6years [38]. In 2018, the Prime Minister announced POSHAN Abhiyaan to make India malnutrition-free by 2022 [33]. After all these efforts, India is not on track to achieve the second goal of SDGs, which reflects in the rank of the Global Hunger Index [8].

A bunch of previous studies examined the socioeconomic and demographic determinants of childhood undernutrition. However, unfortunately, no study has been done in India to investigate the contribution of LBW to childhood undernutrition. Moreover, the burden of low birth weight in India is still greater than in other developing countries, which is a strong determinant of malnutrition. The present study investigated the effects the low birth weight on childhood nutritional status. The findings suggested that the prevalence of low birth weight was highest in Assam, followed by Uttar Pradesh, Uttarakhand, Bihar, and Himachal Pradesh. Previous studies also stated that socioeconomic status and maternal and child health care are directly related to LBW. Assam contributes the highest maternal mortality in India, indicates the lack of maternal and child health care services [39]. Other states with high rates of LBW come under the Empowerment Action Group (EAG) states, which was formed to improve health care and socioeconomic status. In addition, the EAG states have a greater level of malnutrition among children, which is consistent with previous studies [40–42].

This study showed a high prevalence of stunting (37%), wasting (23%), and being underweight (35%). In line with our hypothesis, we found a significant association between low birth weight, and malnutrition among children; stunting, wasting and underweight. Furthermore, low birth weight accounts for 19%, 13%, and 16% of total stunting, wasting, and underweight, respectively, in India. The percentage of stunting and underweight rapidly rose up to 23 months of age among children with low birth weight, whereas the percentage of wasting declined rapidly with the increases of the age of the children. In the expected direction, the study found that along with LBW, age of the child, mother's height, household wealth status, mother's education, and toilet facility of the household are the main contributors of childhood malnutrition in India, in the of previous studies [34, 35, 41, 41–45].

Low birth weight is a predetermined which affects growth after the birth of a child, which can be correlated with preterm birth and Intra-Uterine Growth Rate (IUGR) or both [46]. IUGR and preterm birth could increase the risk for the lower immune system, respiratory disorder, and metabolic dysfunction which are directly related to childhood illness, injection, and improper physical development [47, 48]. A study in Zimbabwe revealed that the Growth of LBW babies is behind the growth of normal weight babies and significant length differences were evident at 12 months of age [49]. The life cycle approach stated that the process of becoming undernutrition starts in utero. Children born with low birth become undernourished children [43]. There is a high probability of being an undernourished mother of a malnourished girl. In addition to threatening her own health and productivity, poor nutrition that contributes to stunting and low weight in her adult life increases her children's chances of being born malnourished. And so the cycle is spinning [50]. Although WHO recommended Kangaroo Mother Care (KMC) to protect premature birth and newborns with low birth weight [51], all Indian mothers are not getting that facility as the program has not yet covered all over India [52]. In the past studies, we can conclude that India can improve birth weight by improving antenatal care facilities, educating mothers, and reducing child marriage and unnecessary caesarian delivery [53–56].

Maternal height is an indicator of the nutrient status of the mother. Short-stature mothers have reduced protein and energy reserves, smaller reproductive organs, and limited space for fetal development [57, 58]. These factors affect the growth of the fetus through the placenta and the growth of the baby through the quantity and quality of breast milk [59]. In addition, the connection between a mother’s and baby's height is expected to be strongly influenced by genetics [60]. In line with our findings, a study conducted in lower and middle-income countries stated that the short stature of a mother is directly associated with childhood stunting and being underweight [35].

In the present study's analysis, the mother's education and wealth status was found to be a protective factor of malnutrition of the children. Previous studies have proved the strong association between stunting, wasting, and underweight and a mother's education and wealth status [35, 43]. The knowledge about nutrition and health of the children rises with years of education of the mother; hence they avoid the unhygienic practices. Moreover, the probability of utilising the maternal and child health care services increases with the level of the mother's education and wealth status of the household [44].

The study found that a household with no toilet facility practices open defecation is a significant contributor to stunting, wasting, and underweight. The finding is in line with the previous studies, which examined the effects of inadequate sanitation facilities on malnutrition [61, 62]. The medical studies revealed that exposure to inadequate sanitation facilities leads the physiologic damages such as inflammation of intestinal tissue, which is responsible for poor nutrient absorption [63, 64]. Moreover, unimproved sanitation facility of open defecation is a leading contributor to water-borne diseases such as diarrhoea. Diarrhoea is the second leading cause of child mortality, and each episode of diarrhoea makes children more malnourished [65]. According to the NFHS report still, 39% of households in India practice open defecation. Thus an urgent programme is required to universalize the improved sanitation facility to combat the burden of under nutrition among children.

The study first time highlighted the contribution of low birth weight to child malnutrition in India using the large-scale survey. Although the height and weight of mothers and their children were collected through anthropometric measurement, the size of the child at the time of birth was reported by the mother's memory recall. Thus, the study can't ignore the possibility of bias reporting.

Conclusion

The study found that Low Birth Weight has accounted for 19% of stunting, 13% of wasting, and 16% of being underweighted children. Furthermore, the child's age, mother's height, and education, economic status, and toilet facility of the household were also found to be important contributors to malnutrition in India. Although many programmes are going on to control the nutrition status of children, the Indian government should focus more on control LBW. Since these nutritional events throughout the life cycle are crucial and cannot be neglected thus the study recommends that government should take all the necessary steps to implement and monitor some special schemes like the Kangaroo Mother Care (KMC) at the ground level to reduce the burden of LBW. The in-depth study also suggests that the high prevalence of malnutrition can also be reduced with the improvement of toilet facilities, mother's nutrition status, and of course, with the prohibition of child marriage in India.

Abbreviations

OR: Odds Ratio

IUGR: Intrauterine Growth Retardation

LBW: Low Birth Weight

KMC: Kangaroo Mother Care

BMI: Body Mass Index

NFHS: National Family Health Survey

DHS: Demographic and Health Survey

FAO: Food and Agriculture Organization

GDP: Gross Domestic Product

Declarations

Ethical Approval and Consent to participate: Ethics and consent for population: The data is freely available in the website of Demographic and Health Surveys (DHS) programme. The consent has taken from the respondent before conduct the survey. According to the ethics committee of International Institute for Population Sciences (IIPS), no formal ethics approval is required to use the dataset.

Consent for publication: The analysis is based on secondary data available in public domain for research; thus, no approval was required from any institutional review board (IRB).

Availability of data and materials: The study utilised the secondary data which is publicly available through http://rchiips.org/nfhs/

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Author's contribution:

AJ conceptualized the research and decided on thestudy design. AJ, DDand RG performed the data analysis. AJ, DD and RG were involved in writing the first draft of the manuscript. All the authors read and finalized the final version ofthe article

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References

1. Ramakrishnan U. Nutrition and low birth weight: from research to practice. The American Journal of Clinical Nutrition. 2004;79:17–21. doi:10.1093/ajcn/79.1.17.

2. Arnold F, Nangia P, Kapil U. Indicators of nutrition for women and children: current status and recommendations. Economic and Political Weekly.2004 Feb 14:664-70.

3. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013;382:427–51.

4. Cavallo MC, Gugiatti A, Fattore G, Gerzeli S, Barbieri D, Zanini R. Cost of care and social consequences of very low birth weight infants without premature- related morbidities in Italy. Ital J Pediatr. 2015;41:59. doi:10.1186/s13052-015-0165-z.

5. Beam AL, Fried I, Palmer N, Agniel D, Brat G, Fox K, et al. Estimates of healthcare spending for preterm and low-birthweight infants in a commercially insured population: 2008–2016. J Perinatol. 2020;40:1091–9. doi:10.1038/s41372-020-0635-z.

6. Lewit EM, Baker LS, Corman H, Shiono PH. The direct cost of low birth weight.Future Child. 1995;5:35–56.

7. Haddad L, Achadi E, Bendech MA, Ahuja A, Bhatia K, Bhutta Z, Blössner M, Borghi E, Colecraft E, De Onis M, Eriksen K. The Global Nutrition Report 2014: actions and accountability to accelerate the world's progress on nutrition. The Journal of nutrition. 2015 Apr 1;145(4):663-71.

8. Micha R, Mannar V, Afshin A, Allemandi L, Baker P, Battersby J, et al. 2020 Global nutrition report: action on equity to end malnutrition. 2020. https://globalnutritionreport.org/reports/2020-global-nutrition-report/.Accessed 19 Aug 2021.

9. Saimin J, Nugraha AF, Asmarani A, Ashaeryanto A. LOW BIRTH WEIGHT IS A RISK FACTOR OF MALNUTRITION IN CHILDREN UNDER FIVE YEARS OLD IN COASTAL AREAS. Public Health of Indonesia. 2019;5:25–9. doi:10.36685/phi.v5i2.243.

10. Ntenda PAM. Association of low birth weight with undernutrition in preschool-aged children in Malawi. Nutrition Journal. 2019;18:51. doi:10.1186/s12937-019-0477-8.

11. Rahman MS, Howlader T, Masud MS, Rahman ML. Association of Low-Birth Weight with Malnutrition in Children under Five Years in Bangladesh: Do Mother's Education, Socio-Economic Status, and Birth Interval Matter? PLOS ONE. 2016;11:e0157814. doi:10.1371/journal.pone.0157814.

12. World Health Organization. Global nutrition targets 2025: low birth weight policy brief. World Health Organization; 2014. https://apps.who.int/iris/handle/10665/149020. Accessed 20 Aug 2021.

13. Lancet T. The global burden of preterm birth.The Lancet. 2009;374:1214.

14.International Institute of Population Science (IIPS) & ICF. National Family Health Survey India (NFHS-4)2015-2016 Report, 2016. Available from: http://rchiips.org/nfhs/factsheet_nfhs-4.shtml.

15. Sutan R, Mohtar M, Mahat AN, Tamil AM. Determinant of Low Birth Weight Infants: A Matched Case Control Study. Open Journal of Preventive Medicine. 2014;4:91–9. doi:10.4236/ojpm.2014.43013.

16. Ballot DE, Chirwa TF, Cooper PA. Determinants of survival in very low birth weight neonates in a public sector hospital in Johannesburg. BMC Pediatrics. 2010;10:30. doi:10.1186/1471-2431-10-30.

17. Anjum F, Javed T, Afzal MF, Sheikh GA. Maternal Risk Factors Associated with Low Birth Weight: A Case Control Study. Annals KEMU. 2011;17:223–223. doi:10.21649/akemu.v17i3.338.

18. Zaveri A, Paul P, Saha J, Barman B, Chouhan P. Maternal determinants of low birth weight among Indian children: Evidence from the National Family Health Survey-4, 2015-16. PLOS ONE. 2020;15:e0244562. doi:10.1371/journal.pone.0244562.

19. Yadav DK, Chaudhary U, Shrestha N. Risk factors associated with low birth weight. J Nepal Health Res Counc. 2011;9:159–64.

20. Government of India .Causes of Death Statistics.2015 https://censusindia.gov.in/vital_statistics/causesofdeath.html.Accessed 10 Aug 2021.

21. Al Hazzani F, Al-Alaiyan S, Hassanein J, Khadawardi E. Short-term outcome of very low-birth-weight infants in a tertiary care hospital in Saudi Arabia. Ann Saudi Med. 2011;31:581–5. doi:10.4103/0256-4947.87093.

22. Hilaire M, Andrianou XD, Lenglet A, Ariti C, Charles K, Buitenhuis S, et al. Growth and neurodevelopment in low birth weight versus normal birth weight infants from birth to 24 months, born in an obstetric

emergency hospital in Haiti, a prospective cohort study. BMC Pediatrics. 2021;21:143. doi:10.1186/s12887-021-02605-3.

23. Hack M, Klein NK, Taylor HG. Long-term developmental outcomes of low birth weight infants. Future Child. 1995;5:176–96.

24. Lira PI, Ashworth A, Morris SS. Low birth weight and morbidity from diarrhea and respiratory infection in northeast Brazil. J Pediatr. 1996;128:497–504.

25. Ansuya, Nayak BS, Unnikrishnan B, George A, N. SY, Mundkur SC, et al. Risk factors for malnutrition among preschool children in rural Karnataka: a case-control study. BMC Public Health. 2018;18:283. doi:10.1186/s12889-018-5124-3.

26. Huey SL, Finkelstein JL, Venkatramanan S, Udipi SA, Ghugre P, Thakker V, et al. Prevalence and Correlates of Undernutrition in Young Children Living in Urban Slums of Mumbai, India: A Cross Sectional Study. Frontiers in Public Health. 2019;7:191. doi:10.3389/fpubh.2019.00191.

27. Aneja S, Kumar P, Choudhary TS, Srivastava A, Chowdhury R, Taneja S, et al. Growth faltering in early infancy: highlights from a two-day scientific consultation. BMC Proc. 2020;14 Suppl 12:12. doi:10.1186/s12919-020-00195-z.

28. Richard SA, Black RE, Gilman RH, Guerrant RL, Kang G, Lanata CF, et al. Wasting Is Associated with Stunting in Early Childhood. The Journal of Nutrition. 2012;142(7):1291–6. pmid:22623393.

29. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and child undernutrition: consequences for adult health and human capital. Lancet. 2008;371:340–57. doi:10.1016/S0140-6736(07)61692-4.

30. Liu L, Johnson HL, Cousens S, Perin J, Scott S, Lawn JE, et al. Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. The Lancet. 2012;379:2151–61. doi:10.1016/S0140-6736(12)60560-1.

31. Dandona R, Kumar GA, Henry NJ, Joshua V, Ramji S, Gupta SS, et al. Subnational mapping of under-5 and neonatal mortality trends in India: the Global Burden of Disease Study 2000–17. The Lancet. 2020;395:1640–58. doi:10.1016/S0140-6736(20)30471-2.

32. India loses up to $46 billion to malnourishment. https://www.downtoearth.org.in/news/india-loses-up-to-46-billion-to-malnourishment-41181. Accessed 19 Aug 2021.

33. Kapur K, Suri S. Towards a Malnutrition-Free India: Best Practices and Innovations from POSHAN Abhiyaan. ORF Special Report No; 2020 Mar.

34. Ntenda PAM. Association of low birth weight with undernutrition in preschool-aged children in Malawi. Nutrition Journal. 2019;18:51. doi:10.1186/s12937-019-0477-8.

35. Li Z, Kim R, Vollmer S, Subramanian SV. Factors Associated With Child Stunting, Wasting, and Underweight in 35 Low- and Middle-Income Countries. JAMA Network Open. 2020;3:e203386–e203386. doi:10.1001/jamanetworkopen.2020.3386.

36. Dharmalingam A, Navaneetham K, Krishnakumar CS. Nutritional status of mothers and low birth weight in India. Matern Child Health J. 2010;14:290–8.

37. Fairlie RW. An extension of the Blinder-Oaxaca decomposition technique to logit and probit models.Journal of Economic and Social Measurement. 2005;30:305–16.

38. Government of India. Mynistry of women & child development.Integrated child development survices.portal Page. https://icds-wcd.nic.in/icds.aspx. Accessed 2 Aug 2021.

39. Cousins S. Assam: India's state with the highest maternal mortality. BMJ. 2016;353:i1908. doi:10.1136/bmj.i1908.

40. Kumar R, Paswan B. Changes in socioeconomic inequality in nutritional status among children in EAG states, India. Public Health Nutrition. 2021;24:1304–17. doi:10.1017/S1368980021000343.

41. Kanjilal B, Mazumdar PG, Mukherjee M, Rahman MH. Nutritional status of children in India: household socioeconomic condition as the contextual determinant. International Journal for Equity in Health. 2010;9:19. doi:10.1186/1475-9276-9-19.

42. Mishra PK, Mishra VK. Scenario of under nutrition among under five years children in India and its states: findings from National Family Health Survey. International Journal Of Community Medicine And Public Health. 2020;7:3087–94. doi:10.18203/2394-6040.ijcmph20203382.

43. Rahman MS, Howlader T, Masud MS, Rahman ML. Association of Low-Birth Weight with Malnutrition in Children under Five Years in Bangladesh: Do Mother's Education, Socio-Economic Status, and Birth Interval Matter? PLoS One. 2016;11:e0157814. doi:10.1371/journal.pone.0157814.

44. Tariq J, Sajjad A, Zakar R, Zakar MZ, Fischer F. Factors Associated with Undernutrition in Children under the Age of Two Years: Secondary Data Analysis Based on the Pakistan Demographic and Health Survey 2012–2013. Nutrients. 2018;10:676. doi:10.3390/nu10060676.

45. Addo OY, Stein AD, Fall CH, Gigante DP, Guntupalli AM, Horta BL, et al. Maternal Height and Child Growth Patterns. The Journal of Pediatrics. 2013;163:549-554.e1. doi:10.1016/j.jpeds.2013.02.002.

46. Aryastami NK, Shankar A, Kusumawardani N, Besral B, Jahari AB, Achadi E. Low birth weight was the most dominant predictor associated with stunting among children aged 12–23 months in Indonesia. BMC Nutrition. 2017;3:16. doi:10.1186/s40795-017-0130-x.

47. Institute of Medicine (US) Committee on Understanding Premature Birth and Assuring Healthy Outcomes. Preterm Birth: Causes, Consequences, and Prevention. Washington (DC): National Academies Press (US); 2007. http://www.ncbi.nlm.nih.gov/books/NBK11362/. Accessed 2 Aug 2021.

48. Ortigosa Rocha C, Bittar RE, Zugaib M. Neonatal Outcomes of Late-Preterm Birth Associated or Not with Intrauterine Growth Restriction. Obstet Gynecol Int. 2010;2010:231842. doi:10.1155/2010/231842.

49. Mbuya MNN, Chidem M, Chasekwa B, Mishra V. Biological, social, and environmental determinants of low birth weight and stunting among infants and young children in Zimbabwe. 2010. https://dhsprogram.com/publications/publication-wpz7-working-papers.cfm.Accessed 2 Aug 2021.

50.Gillespie S, Flores R. The life cycle of malnutrition.IFRI. 2000.

51. Care KM. A practical guide. Geneva: World Health Organization. 2003.. https://www.who.int/publications-detail-redirect/9241590351. Accessed 2 Aug 2021.

52. Medhanyie AA, Alemu H, Asefa A, Beyene SA, Gebregizabher FA, Aziz K, Bhandari N, Beyene H, Brune T, Chan G, Cranmer JN. Kangaroo Mother Care implementation research to develop models for accelerating scale-up in India and Ethiopia: study protocol for an adequacy evaluation. BMJ open. 2019 Nov 1;9(11):e025879.

53. Khanal V, Zhao Y, Sauer K. Role of antenatal care and iron supplementation during pregnancy in preventing low birth weight in Nepal: comparison of national surveys 2006 and 2011. Arch Public Health. 2014;72:4. doi:10.1186/2049-3258-72-4.

54. Souza JP, Gülmezoglu A, Lumbiganon P, Laopaiboon M, Carroli G, Fawole B, et al. Caesarean section without medical indications is associated with an increased risk of adverse short-term maternal outcomes: the 2004-2008 WHO Global Survey on Maternal and Perinatal Health. BMC Med. 2010;8:71.

55. Rai RK, Singh PK, Singh L. Utilization of maternal health care services among married adolescent women: insights from the Nigeria Demographic and Health Survey, 2008. Womens Health Issues. 2012;22:e407-414.

56. Raj A, Saggurti N, Winter M, Labonte A, Decker MR, Balaiah D, et al. The effect of maternal child marriage on morbidity and mortality of children under 5 in India: cross sectional study of a nationally representative sample. BMJ. 2010;340:b4258. doi:10.1136/bmj.b4258.

57. Duggleby SL, Jackson AA. Relationship of maternal protein turnover and lean body mass during pregnancy and birth length.Clinical science. 2001 Jul 1;101(1):65-72.

58. Ibáñez L, Potau N, Enriquez G, De Zegher F. Reduced Uterine and Ovarian Size in Adolescent Girls Born Small for Gestational Age. Pediatr Res. 2000;47:575–7. doi:10.1203/00006450-200005000-00003.

59. Martorell R, Zongrone A. Intergenerational Influences on Child Growth and Undernutrition. Paediatric and Perinatal Epidemiology. 2012;26:302–14. doi:10.1111/j.1365-3016.2012.01298.x.

60. Tanner JM. Growth at adolescence, 2nd ed. Thomas: Springfield, Ill.; 1962.

61. Panigrahi A, Das SC. Undernutrition and Its Correlates among Children of 3–9 Years of Age Residing in Slum Areas of Bhubaneswar, India. The Scientific World Journal. 2014;2014:e719673. doi:10.1155/2014/719673.

62. Sinha RK, Dua R, Bijalwan V, Rohatgi S, Kumar P. Determinants of Stunting, Wasting, and Underweight in Five High-Burden Pockets of Four Indian States. Indian J Community Med. 2018;43:279–83. doi:10.4103/ijcm.IJCM_151_18.

63. Lindenbaum J, Harmon JW, Gerson CD. Subclinical malabsorption in developing countries.Am J Clin Nutr. 1972;25:1056–61.

64. Lindenbaum J, Gerson CD, Kent TH. Recovery of small-intestinal structure and function after residence in the tropics. I. Studies in Peace Corps volunteers. Ann Intern Med. 1971;74:218–22.

65. World Health Organization. Diarrhoeal disease. WHO fact sheet. Updated May 2017.

Figures

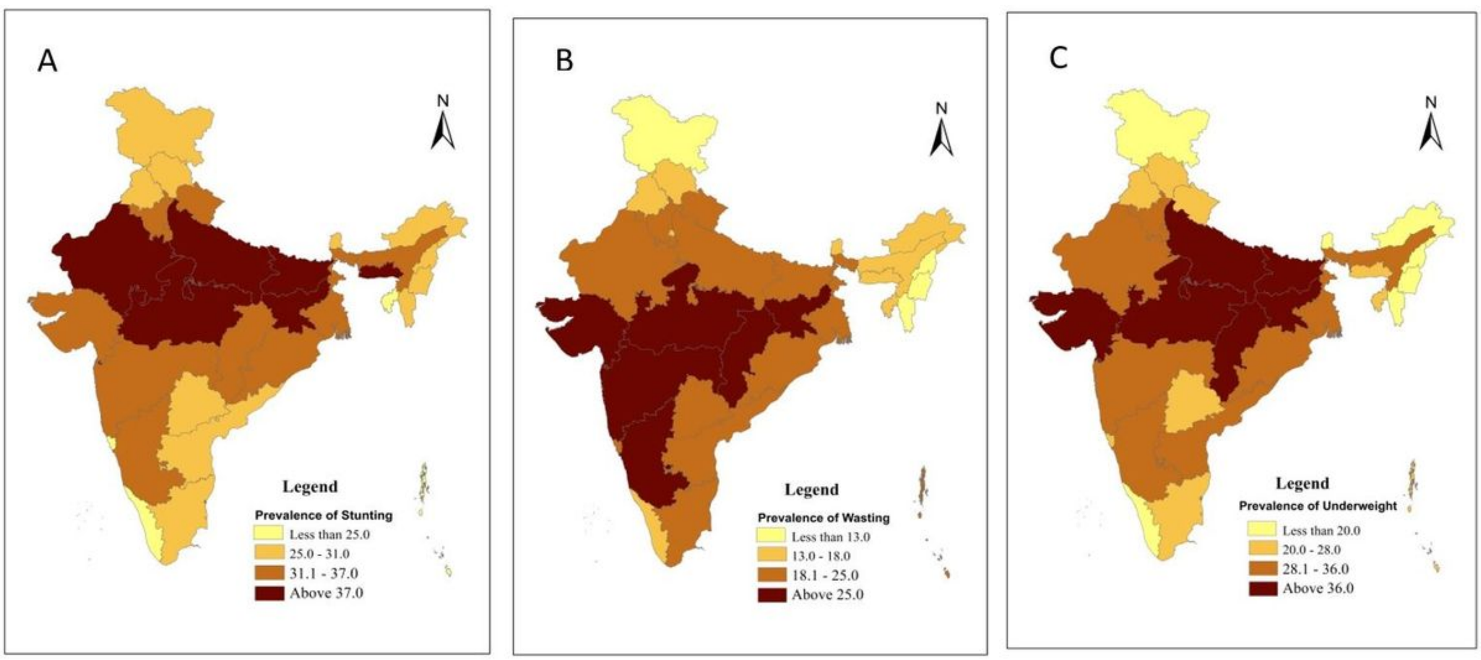

Figure 1

Spatial distribution of Stunting (A), Wasting (B) and Underweight (C) in India, 2015-16.

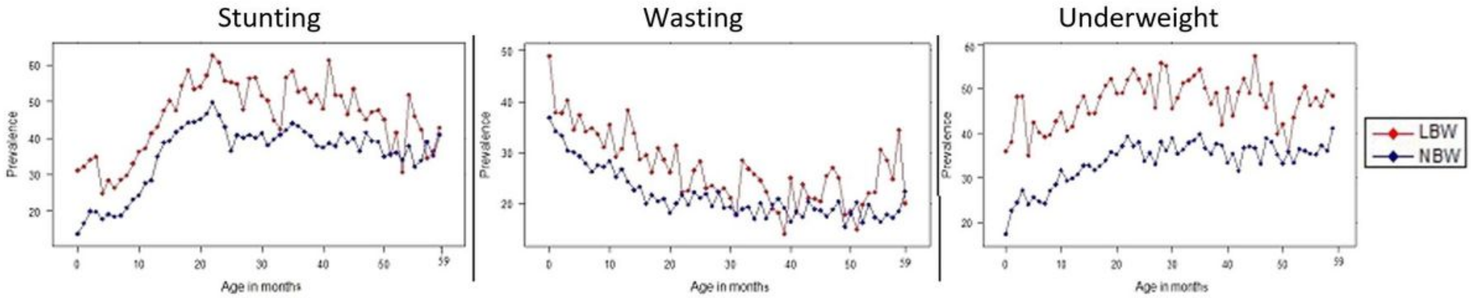

Figure 2

Age wise self-reported prevalence of stunting wasting and underweight by birth weight, India 2015-16