DOI: 10.7860/JCDR/2021/49080.15301

Original Article

Public Health Section

Comparison of Growth in Children of 6 to 59 Months of Age According to Birth Order: Insights from the National Family Health Survey-4

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ABSTRACT

Introduction: Undernutrition continues to be a major public health problem throughout the world. Higher birth order of the child contributes to higher chance of being undernutrition. But, the relationship between birth order and undernutrition has not been fully studied and understood, especially in India where the fertility rate was high.

Aim: To understand the prevalence and determinants of undernutrition using National Family Health Survey-4 (NFHS-4) India.

Materials and Methods: A national cross-sectional survey was conducted during January 2015 to December 2016. This study used information from a total weighted sample of 128859 children from India NFHS-4. Univariate and multivariate binary logistic regression were used to investigate the association of undernutrition with birth order, other child, maternal and socio-economic factors. Three models were constructed for the study, model 1 as univariate, model 2 adjusting with birth order and socio-economic predictors and model 3 adjusting with all the predictors included in the study.

Results: Of the 128859 children, median Inter Quartile Range (IQR) age was 26 (16-41) months with female/male ratio was 1:1.2. The prevalence of stunting, underweight and wasting was 37.93% (95% Confidence Interval (CI) 37.67-38.20), 34.02% (95% CI 33.76-34.28) and 20.70% (95% CI 20.48-20.92), respectively. Model-1, 2 and 3 showed that the child's higher birth order was found to have higher odds of being stunted and underweight compared with first born children. Children with lower wealth quintiles, male, vaginal delivery had higher odds of being stunted, wasted and underweight in the model-3 adjusted analysis.

Conclusion: This study indicates that higher birth order was a significant predictor of a child being stunted and underweight, as it is significant in all three models. However, further longitudinal studies are required to establish a cause-effect relationship between birth order and undernutrition and future interventions to prevent undernutrition should consider birth order as an important factor.

Keywords: Models, Predictors, Stunting, Undernutrition, Underweight, Wasting

INTRODUCTION

Growth and infection among children under five years continue to be a major public health problem worldwide. Stunting, wasting and underweight are the major indicators that are used to measure undernutrition in children. Stunting is of low height for age; wasting is low weight for height, and underweight is low weight for age [1].

Globally, one in every three under-five years children is undernourished. In 2017, about 151 million children below five years of age were stunted, and 51 million were wasted globally. Southern Asia contributes 33.3% of stunting and 15.3% of wasting of the global undernutrition burden [2]. According to NFHS-4 report [3], the prevalence of stunting, wasting and underweight among Indian children below five years was 38.4%, 21% and 35.8%, respectively.

Childhood wasting, unsafe water and unsafe sanitation were the leading risk factors for diarrhoea, responsible for 80.4%, 72.1% and 56.4% of diarrhoea deaths in children younger than five years, respectively. Prevention of wasting in 1762 children could avert one death from diarrhoea [4]. Childhood wasting remains the leading risk factor for lower respiratory infection mortality among children younger than five years, responsible for 61.4% of lower respiratory infection deaths globally. Interventions to improve wasting, household air pollution, ambient particulate matter pollution, and expanded antibiotic use could avert one under-five years children death due to lower respiratory infection for every 4000 children treated in the countries with the highest lower respiratory infection burden [4].

Proportions of morbidity, stunting and wasting among Indian children were higher with higher birth order [3]. A study conducted in urban slums of Mumbai and Bhubaneswar, India found that higher birth order is associated with undernutrition [5-7]. Meanwhile, Andhra Pradesh and Telangana's study found that younger children experienced height deficits [8]. Parent's preference towards the child may depend upon birth order consciously or unconsciously. Also, the available literature on birth order and its associated morbidity are limited in India. Therefore, it was necessary to estimate the association between growths of below five years children by birth order.

The present study was conducted with the objective was to understand the prevalence and determinants of stunting, wasting, and underweight in India and determine what extents it differs by birth order, child, maternal and socio-economic factors using NFHS-4 India datasets.

MATERIALS AND METHODS

This analysis was based on individual-level data from the fourth round of the NFHS, a nationally representative cross-sectional survey of India conducted January 2015 to December 2016. It provides reliable estimates on fertility, mortality, reproduction, child health and other demographic indicators at the national, state and district level [3]. Around 628,900 households in 29 states and seven union territories in India were interviewed for NFHS-4, with a response rate of 98%. A two-stage stratified sampling design with villages in rural areas and Census Enumeration Blocks (CEBs)

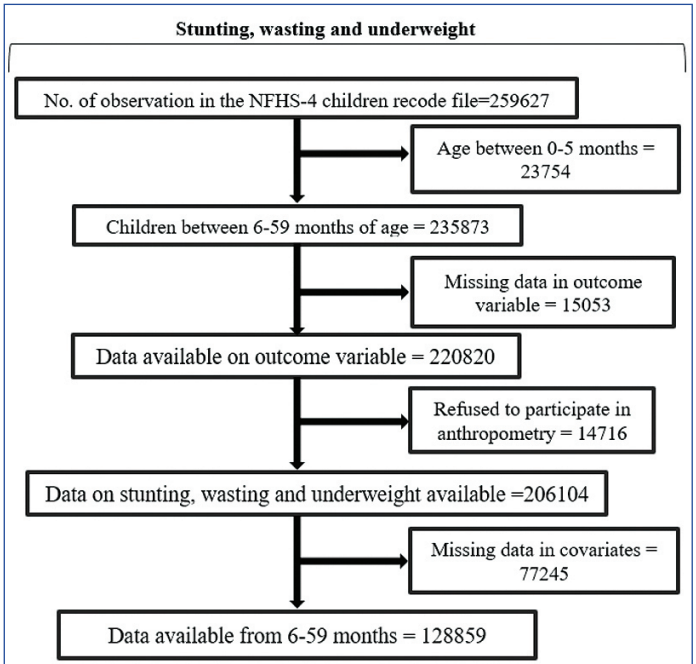
in urban areas, forming the Primary Sampling Units (PSU), were adopted during the first stage. Within each PSU, the households were selected using systematic random sampling in the second stage. Clinical, anthropometric and biochemical measurements for men, women and children were done. A detailed description of the sampling design and instruments used in the survey has been provided elsewhere [3].

In this study, children recode file (n=259627) was used, available from the Demography and Health Survey (DHS) program website, for this analysis [9]. Ethical clearance was not needed as the analysis used secondary data available in the public domain. Approval was sought from Measure DHS and permission was granted for this use. The guidelines for data use as required by the DHS program were strictly followed.

Inclusion criteria: The children aged 6 to 59 months, children with data availability for outcome variable and those with values in co-variates and outcome variable were included in the study.

Exclusion criteria: The children aged below six months , those with missing data in outcome variable stunting, wasting and underweight children, those children who refused to participate in anthropometry measurement or are not alive and had missing data in co-variates were excluded from the study.

After following the complete inclusion and exclusion criteria, the sample of the study was 128859 [Table/Fig-1].



[Table/Fig-1]: Flowchart depicting the data extraction process from the NFHS-4 dataset.

In the present study, information related to the birth order, stunting, wasting, underweight information of the child, and data for household and maternal characteristics of the child were included. As per the World Health Organisation (WHO) children stunting, wasting and underweight was defined as <2 standard deviation (SD) [1] and birth weight was defined as <2500 g as low birth weight and ≥2500 g as normal birth weight [10].

Sample zone division: India is a federal union that comprises 29 states and seven union territories a total of 36 jurisdictional entities. The states and union territories are aggregated into six zonal councils to facilitate better economic integration, resource allocation and inter-state cooperation [11]. In the present study, authors used the six zonal regions, including North, South, East, West, Central and North-Eastern India. The Northern region (n=22612) consists of Jammu and Kashmir, Himachal Pradesh, Haryana, Delhi, Chandigarh, Punjab and Rajasthan. The Southern region (n=13415) consists of the states of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Telangana, Andaman and Nicobar Islands, Lakshadweep Islands and the Union Territory of Puducherry. The Eastern region (n=28015) consists of Bihar, Jharkhand, Odisha and West Bengal. The Western region (n=9490) consists of Gujarat, Maharashtra, Goa, Daman and Diu, and Dadra and Nagar Haveli. The Central region (n=37102) consists of the states of Chhattisgarh, Madhya Pradesh, Uttar Pradesh and Uttarakhand. The North-Eastern region (n=18225) consists of the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura.

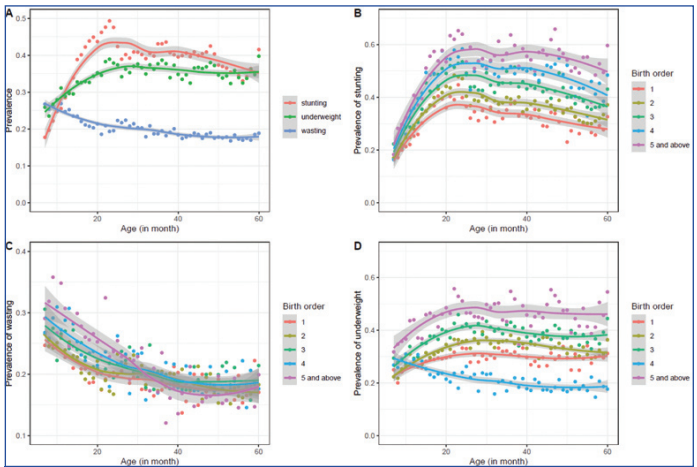
STATISTICAL ANALYSIS

RStudio (version 1.2.5019) was used for data analysis. Analysis was performed using a descriptive statistics and binary logistic regression. First, descriptive statistics were performed to see the prevalence of stunting, wasting and underweight by socio-demographic characteristics of the sample. Further, univariate and multivariate binary logistic regression were used to examine the determinants of all three indices of child nutritional status. Three models were constructed for the study. Model 1 assessed the univariate association between child nutritional status and independent study variables. Model 2 examined the influence of birth order on child nutritional status while controlling for the effects of socio-economic indicators (wealth index, state-wise region, place of residence, house type and type of family). In model 3, child-level factors (sex of the child, age of the child, anaemia status of child and birth weight of child) and maternal factors (age of mother, mother's education, mode of delivery, Body Mass Index (BMI) and anaemia status) were added. Logistic regression was performed to calculate Odds Ratios (OR) and (95% CI) and p-value less than 0.05 were considered as statistically significant.

RESULTS

Of the 128859 children, total males were 54.5% and females were 45.5% with median (IQR) age was 26 (16-41) months with female/male ratio was 1:1.2 with the majority were second-order birth (33.6%), anaemic (58.9%) and normal birth weight (87.2%). Mothers of most of the children were in the age group between 25 to 34 years (58.7%), 60.8% were of normal weight, 54.6% were anaemic.

The most common nutritional abnormality observed in the study sample was stunting followed by underweight and wasting [Table/Fig-2 a-d] with 37.93 (48880/128859, 95% CI 37.67-38.20), 34.02 (43841/128859, 95% CI 33.76-34.28) and 20.70 (26675/128859, 95% CI 20.48-20.92), respectively [Table/Fig-3-5].



[Table/Fig-2a-d]: Prevalence of stunting, wasting and underweight.

[Table/Fig-3-5] shows the results from binary logistic regression analysis for stunting, underweight and wasting respectively. Model 1, 2 and 3 showed that the child's higher birth order was found to have higher odds of children being stunted and underweight compared with first born children. Therefore, suggesting higher

Characteristics	Model 1		Model 2		Model 3	
	cOR(95% CI)	p-value	aOR(95% CI)	p-value	aOR(95% CI)	p-value
Child birth order						
First order birth	1		1		1	
Second order birth	1.19 (1.16-1.23)	<0.001	1.14 (1.11-1.17)	<0.001	1.14 (1.10-1.17)	<0.001
Third order birth	1.53 (1.48-1.58)	<0.001	1.28 (1.23-1.32)	<0.001	1.25 (1.20-1.30)	<0.001
Fourth order birth	1.85 (1.77-1.93)	<0.001	1.40 (1.34-1.47)	<0.001	1.37 (1.30-1.44)	<0.001
Fifth and higher order birth	2.30 (2.21-2.40)	<0.001	1.60 (1.53-1.68)	<0.001	1.57 (1.49-1.66)	<0.001
Region						
East	1		1		1	
Central	0.99 (0.96-1.02)	0.361	1.18 (1.14-1.21)	<0.001	1.15 (1.11-1.19)	<0.001
North	0.66 (0.64-0.69)	<0.001	1.03 (0.99-1.07)	0.217	0.96 (0.92-1.00)	0.033
North East	0.62 (0.60-0.65)	<0.001	0.73 (0.70-0.76)	<0.001	0.84 (0.81-0.88)	<0.001
South	0.57 (0.54-0.59)	<0.001	0.91 (0.86-0.95)	<0.001	0.96 (0.92-1.01)	0.133
West	0.79 (0.75-0.82)	<0.001	1.16 (1.10-1.22)	<0.001	1.14 (1.08-1.20)	<0.001
Place of residence						
Rural	1		1		1	
Urban	0.66 (0.64-0.68)	<0.001	1.06 (1.03-1.09)	<0.001	1.06 (1.03-1.10)	<0.001
Wealth index						
Poorest	1		1		1	
Poorer	0.71 (0.69-0.74)	<0.001	0.78 (0.75-0.80)	<0.001	0.84 (0.81-0.88)	<0.001
Middle	0.53 (0.51-0.55)	<0.001	0.59 (0.57-0.62)	<0.001	0.70 (0.67-0.74)	<0.001
Richer	0.39 (0.37-0.40)	<0.001	0.43 (0.41-0.46)	<0.001	0.57 (0.54-0.60)	<0.001
Richest	0.27 (0.26-0.29)	<0.001	0.30 (0.29-0.32)	<0.001	0.46 (0.43-0.49)	<0.001
House type						
Kaccha	1		1		1	
Pucca	0.49 (0.47-0.51)	<0.001	0.99 (0.93-1.04)	0.628	0.97 (0.92-1.03)	0.323
Semi pucca	0.85 (0.82-0.89)	<0.001	1.01 (0.97-1.06)	0.526	1.01 (0.97-1.06)	0.613
Type of family						
Non nuclear	1		1		1	
Nuclear	1.26 (1.24-1.29)	<0.001	1.01 (0.99-1.04)	0.281	1.00 (0.97-1.02)	0.874
Sex of child						
Female	1				1	
Male	1.11 (1.09-1.14)	<0.001			1.12 (1.09-1.14)	<0.001
Age of child (in months)						
<12	1				1	
12 to 23	2.40 (2.30-2.49)	<0.001			2.54 (2.44-2.64)	<0.001
24 to 35	2.25 (2.16-2.34)	<0.001			2.56 (2.45-2.67)	<0.001
36 to 47	2.26 2.17-2.36)	<0.001			2.70 (2.58-2.82)	<0.001
48 to 59	1.88 (1.80-1.97)	<0.001			2.28 (2.17-2.39)	<0.001
Anaemia (Child)						
Not Anaemic	1				1	
Anaemic	1.46 (1.43-1.50)	<0.001			1.32 (1.28-1.35)	<0.001
Child's birth weight						
Normal Birth Weight	1				1	
Low birth weight	1.39 (1.34-1.43)	<0.001			1.46 (1.41-1.51)	<0.001
Mode of delivery						
Caesarean	1				1	
Vaginal	1.78 (1.72-1.84)	<0.001			1.16 (1.12-1.20)	<0.001
Mother's age (years)						
15 to 24	1				1	
25 to 34	0.99 (0.96-1.01)	0.373			0.89 (0.86-0.91)	<0.001
35 to 49	1.16 (1.11-1.20)	<0.001			0.82 (0.78-0.86)	<0.001
Mother's education						
No education	1				1	
Primary education	0.76 (0.74-0.79)	<0.001			0.89 (0.86-0.93)	<0.001
Secondary education	0.49 (0.47-0.50)	<0.001			0.74 (0.71-0.76)	<0.001

Higher education	0.27 (0.26-0.28)	<0.001			0.58 (0.55-0.62)	<0.001
Mother's Body Mass Index (BMI)						
Normal weight	1				1	
Underweight	1.43 (1.39-1.47)	<0.001			1.20 (1.17-1.24)	<0.001
Overweight	0.64 (0.62-0.67)	<0.001			0.83 (0.80-0.86)	<0.001
Obese	0.55 (0.51-0.59)	<0.001			0.78 (0.72-0.84)	<0.001
Anaemia (Mother)						
Not anaemic	1				1	
Anaemic	1.19 (1.17-1.22)	<0.001			1.05 (1.02-1.07)	<0.001

[Table/Fig-3]: Determinants of stunting among children aged 6-59 months from NFHS-4 Survey.
*p-value less than 0.05 is considered as statistically significant; aOR: Adjusted odds ratio; cOR: Crude odds ratio

	Model 1		Model 2		Model 3	
Characteristics	**cOR (95% CI)**	**p-value**	**aOR (95% CI)**	**p-value**	**aOR (95% CI)**	**p-value**
Child birth order						
First order birth	1		1		1	
Second order birth	1.19 (1.15-1.22)	<0.001	1.12 (1.08-1.15)	<0.001	1.10 (1.06-1.14)	<0.001
Third order birth	1.48 (1.43-1.53)	<0.001	1.20 (1.16-1.24)	<0.001	1.14 (1.10-1.19)	<0.001
Fourth order birth	1.68 (1.61-1.75)	<0.001	1.23 (1.17-1.28)	<0.001	1.16 (1.10-1.22)	<0.001
Fifth and higher order birth	2.04 (1.96-2.14)	<0.001	1.37 (1.30-1.43)	<0.001	1.31 (1.24-1.39)	<0.001
Region						
East	1		1		1	
Central	0.87 (0.84-0.90)	<0.001	1.06 (1.02-1.09)	<0.001	1.04 (1.00-1.07)	0.043*
North	0.52 (0.50-0.54)	<0.001	0.84 (0.80-0.87)	<0.001	0.78 (0.75-0.81)	<0.001
North East	0.36 (0.34-0.37)	<0.001	0.43 (0.41-0.45)	<0.001	0.51 (0.49-0.53)	<0.001
South	0.51 (0.49-0.54)	<0.001	0.84 (0.80-0.88)	<0.001	0.92 (0.88-0.97)	<0.001
West	0.83 (0.79-0.87)	<0.001	1.27 (1.21-1.33)	<0.001	1.22 (1.15-1.28)	<0.001
Place of residence						
Rural	1		1		1	
Urban	0.66 (0.65-0.68)	<0.001	1.11 (1.08-1.15)	<0.001	1.13 (1.10-1.17)	<0.001
Wealth index						
Poorest	1		1		1	
Poorer	0.64 (0.61-0.66)	<0.001	0.70 (0.68-0.73)	<0.001	0.78 (0.75-0.81)	<0.001
Middle	0.45 (0.44-0.47)	<0.001	0.50 (0.48-0.52)	<0.001	0.62 (0.59-0.65)	<0.001
Richer	0.34 (0.33-0.36)	<0.001	0.37 (0.35-0.39)	<0.001	0.51 (0.49-0.54)	<0.001
Richest	0.24 (0.23-0.25)	<0.001	0.25 (0.23-0.26)	<0.001	0.42 (0.39-0.45)	<0.001
House type						
Kaccha	1		1		1	
Pucca	0.51 (0.49-0.54)	<0.001	1.10 (1.04-1.16)	<0.001	1.08 (1.02-1.14)	0.009*
Semi pucca	0.92 (0.88-0.96)	<0.001	1.14 (1.09-1.20)	<0.001	1.13 (1.07-1.18)	<0.001
Type of family						
Non nuclear	1		1		1	
Nuclear	1.24 (1.22-1.27)	<0.001	1.03 (1.00-1.06)	0.031*	1.02 (0.99-1.05)	0.170
Sex of child						
Female	1				1	
Male	1.09 (1.07-1.12)	<0.001			1.09 (1.07-1.12)	<0.001
Age of child (in months)						
<12	1				1	
12 to 23	1.36 (1.31-1.42)	<0.001			1.40 (1.35-1.46)	<0.001
24 to 35	1.53 (1.47-1.59)	<0.001			1.77 (1.69-1.84)	<0.001
36 to 47	1.47 (1.41-1.53)	<0.001			1.81 (1.73-1.89)	<0.001
48 to 59	1.42 (1.36-1.48)	<0.001			1.81 (1.72-190)	<0.001
Anaemia (Child)						
Not Anaemic	1				1	
Anaemic	1.52 (1.49-1.56)	<0.001			1.31 (1.27-1.34)	<0.001
Child's birth weight						
Normal birth weight	1				1	

Low birth weight	1.71 (1.66-1.77)	<0.001			1.77 (1.71-1.84)	<0.001
Mode of delivery						
Caesarean	1				1	
Vaginal	1.91 (1.84-1.98)	<0.001			1.23 (1.18-1.28)	<0.001
Mother's age (years)						
15 to 24	1				1	
25 to 34	0.96 (0.94-0.99)	0.005*			0.94 (0.91-0.97)	<0.001
35 to 49	1.05 (1.01-1.09)	0.025*			0.87 (0.82-0.92)	<0.001
Mother's education						
No education	1				1	
Primary education	0.73 (0.70-0.76)	<0.001			0.88 (0.85-0.92)	<0.001
Secondary education	0.47 (0.46-0.48)	<0.001			0.75 (0.72-0.77)	<0.001
Higher education	0.25 (0.24-0.27)	<0.001			0.58 (0.54-0.61)	<0.001
Mother's BMI						
Normal weight	1				1	
Underweight	1.91 (1.86-1.96)	<0.001			1.59 (1.54-1.63)	<0.001
Overweight	0.54 (0.51-0.56)	<0.001			0.68 (0.65-0.71)	<0.001
Obese	0.43 (0.40-0.47)	<0.001			0.59 (0.54-0.65)	<0.001
Anaemia (Mother)						
Not anaemic	1				1	
Anaemic	1.32 (1.29-1.35)	<0.001			1.10 (1.07-1.13)	<0.001

[Table/Fig-4]: Determinants of underweight among children aged 6-59 months from NFHS-4 survey.
*p-value less than 0.05 is considered as statistically significant; aOR: Adjusted odds ratio; cOR: Crude odds ratio

	Model 1		Model 2		Model 3	
Characteristics	cOR (95% CI)	p-value	aOR (95% CI)	p-value	aOR (95% CI)	p-value
Child birth order						
First order birth	1		1		1	
Second order birth	1.00 (0.97-1.04)	0.836	0.96 (0.93-0.99)	0.016*	0.98 (0.94-1.01)	0.193
Third order birth	1.07 (1.03-1.12)	<0.001	0.95 (0.91-0.99)	0.023*	0.96 (0.92-1.01)	0.096
Fourth order birth	1.10 (1.05-1.16)	<0.001	0.93 (0.89-0.98)	0.012*	0.94 (0.89-1.00)	0.040*
Fifth and higher order birth	1.11 (1.06-1.17)	<0.001	0.90 (0.85-0.95)	<0.001	0.91 (0.86-0.97)	0.006*
Region						
East	1		1		1	
Central	0.88 (0.85-0.91)	<0.001	0.98 (0.95-1.02)	0.362	0.96 (0.93-1.00)	0.045*
North	0.72 (0.69-0.75)	<0.001	0.93 (0.89-0.98)	0.003*	0.91 (0.86-0.95)	<0.001
North East	0.46 (0.44-0.48)	<0.001	0.52 (0.49-0.55)	<0.001	0.57 (0.54-0.60)	<0.001
South	0.79 (0.76-0.84)	<0.001	1.03 (0.97-1.08)	0.305	1.11 (1.05-1.17)	<0.001
West	1.10 (1.04-1.16)	<0.001	1.36 (1.29-1.44)	<0.001	1.33 (1.26-1.41)	<0.001
Place of residence						
Rural	1		1		1	
Urban	0.83 (0.81-0.86)	<0.001	1.06 (1.03-1.10)	0.001*	1.10 (1.05-1.14)	<0.001
Wealth index						
Poorest	1		1		1	
Poorer	0.76 (0.73-0.79)	<0.001	0.78 (0.75-0.81)	<0.001	0.83 (0.79-0.86)	<0.001
Middle	0.65 (0.62-0.68)	<0.001	0.65 (0.62-0.68)	<0.001	0.74 (0.70-0.78)	<0.001
Richer	0.59 (0.57-0.62)	<0.001	0.56 (0.53-0.59)	<0.001	0.69 (0.65-0.74)	<0.001
Richest	0.51 (0.49-0.54)	<0.001	0.47 (0.44-0.50)	<0.001	0.66 (0.61-0.71)	<0.001
House type						
Kaccha	1		1		1	
Pucca	0.76 (0.72-0.80)	<0.001	1.08 (1.01-1.15)	0.018*	1.07 (1.00-1.14)	0.036*
Semi pucca	0.98 (0.93-1.03)	0.411	1.10 (1.05-1.16)	<0.001	1.09 (1.03-1.15)	0.002*
Type of family						
Non nuclear	1		1		1	
Nuclear	1.06 (1.03-1.09)	<0.001	1.01 (0.98-1.04)	0.371	1.05 (1.02-1.08)	0.002*
Sex of child						
Female	1				1	
Male	1.13 (1.10-1.16)	<0.001			1.15 (1.12-1.18)	<0.001

Age of child (in months)						
<12	1				1	
12 to 23	0.78 (0.75-0.82)	<0.001			0.78 (0.75-0.81)	<0.001
24 to 35	0.74 (0.71-0.78)	<0.001			0.77 (0.74-0.81)	<0.001
36 to 47	0.65 (0.62-0.68)	<0.001			0.69 (0.66-0.73)	<0.001
48 to 59	0.62 (0.59-0.65)	<0.001			0.67 (0.63-0.70)	<0.001
Anaemia (Child)						
Not Anaemic	1				1	
Anaemic	1.30 (1.26-1.33)	<0.001			1.10 (1.07-1.13)	<0.001
Child's birth weight						
Normal birth weight	1				1	
Low birth weight	1.46 (1.40-1.51)	<0.001			1.41 (1.36-1.47)	<0.001
Mode of delivery						
Caesarean	1				1	
Vaginal	1.42 (1.36-1.48)	<0.001			1.19 (1.14-1.24)	<0.001
Mother's age						
15 to 24	1				1	
25 to 34	0.88 (0.85-0.90)	<0.001			1.03 (1.00-1.07)	0.080
35 to 49	0.83 (0.79-0.87)	<0.001			1.05 (0.99-1.12)	0.082
Mother's education						
No education	1				1	
Primary education	0.82 (0.79-0.86)	<0.001			0.91 (0.87-0.96)	<0.001
Secondary education	0.73 (0.71-0.76)	<0.001			0.92 (0.89-0.96)	<0.001
Higher education	0.58 (0.55-0.61)	<0.001			0.85 (0.80-0.90)	<0.001
Mother's BMI						
Normal weight	1				1	
Underweight	1.55 (1.50-1.60)	<0.001			1.36 (1.31-1.40)	<0.001
Overweight	0.58 (0.55-0.61)	<0.001			0.66 (0.63-0.69)	<0.001
Obese	0.45 (0.41-0.50)	<0.001			0.52 (0.46-0.57)	<0.001
Anaemia (Mother)						
Not anaemic	1				1	
Anaemic	1.14 (1.11-1.17)	<0.001			1.00 (0.98-1.03)	0.824

[Table/Fig-5]: Determinants of wasting among children aged 6-59 months from NFHS-4 survey.
*p-value less than 0.05 is considered as statistically significant; aOR: Adjusted odds ratio; cOR: Crude odds ratio

birth order was a significant predictor of a child being stunted and underweight, as it is significant in all three models. Prevalence of stunting and underweight was increasing with the birth order of the child [Table/Fig-2].

From model 3, male children had higher odds of being stunted (aOR 1.12, 95% CI 1.09-1.14), wasted (aOR 1.15, 95% CI 1.12-1.18) and underweight (aOR 1.09, 95% CI 1.07-1.12) as compared to female children. Compared to children from the highest wealth quintile, those from lower wealth quintiles had higher odds of being stunted, wasted and underweight in the adjusted analysis. Children of mothers with primary and above education had lower odds of being stunted, wasted and underweight, compared to mothers with no education.

State-wise prevalence of stunting was highest in Bihar (48.97%) whereas underweight and wasting were highest in Jharkhand (48.85% and 31.10%), respectively [Supplementary Table-1] [3].

DISCUSSION

This study was conducted to understand the association of birth order with child undernutrition in terms of stunting, underweight and wasting among under-five year Indian children using the NFHS-4 data. This study suggested that higher birth order increases the likelihood of being stunted and underweight of a child despite the influences of other child, maternal and socio-economic factors.

Total Fertility Rate (TFR) in India is 2.3 births per women [12]. Over the past few decades, TFR has declined but it is still higher in states such as Uttar Pradesh and Bihar. Furthermore, India has one of the highest child undernutrition rates in the world. So, there was a need for understanding the relationship between birth order and nutritional abnormalities among children in India. This present study observed that higher birth order has a strong association with child stunting and underweight even after controlling for other relevant variables. It suggests that a mother having a fewest number of children is an important factor for child nutritional fulfilment. One of the reasons for this association could be that higher order births are more likely to be considered unwanted by the parents because of their socio-economic status resulting in less care, attention, food and other resources from them. This finding is consistent with several previous researches done in India [5,13] and other countries [14,15].

Apart from birth order, this study indicates several children, maternal and socio-economic factors have a strong effect on child nutritional abnormalities. In the present study, children with lower wealth index, lower maternal education level and low birth weight are strong undernutrition predictors. Similar to this result, a study from Ghana and Ethiopia DHS revealed higher odds of being undernutrition among low birth weight, higher birth order, lower wealth index and lower maternal educational level [16,17]. In the present study, children born with low birth weight had higher odds of being stunted, wasted and underweight. A systematic review conducted in low and middle income countries found that low birth weight was associated with higher odds of undernutrition [18]. A study conducted in Uttar Pradesh among children 3-5 years and West Bengal among children 6-39 months of age revealed anaemic children had higher odds of undernutrition

[19,20]. A similar result was found in the our present study. In the present study, authors found that male children had higher odds of nutritional abnormalities. This result is consistent with the previous studies in Pakistan and Iran [21,22]. The strength of the study should be considered before interpreting the results. The NFHS surveys collect individual, household, and community-level information by conducting face-to-face interviews. There is overwhelming evidence that the NFHS surveys have provided valuable information on key population and health issues and helped build India's research capacity. And the data were collected by trained staff with a high response rate.

Limitation(s)

First limitation of the study was its study design, which was cross-sectional due to which causal relationships between different variables cannot be established. Another limitation of this study is that certain potentially essential variables such as dietary factors and micronutrients consumption were not included due to its unavailability.

CONCLUSION(S)

There is still a high burden of child undernutrition in India. The maternal education, age, wealth index of the household, and the size of children at birth and birth order were the immediate factors associated with child undernutrition. The intermediate factors associated with child undernutrition were mainly maternal nutritional related factors and socio-economic indicators. These study findings provide an important interaction between birth order and child undernutrition status in India. However, further longitudinal studies are required to establish a cause-effect relationship between birth order and undernutrition. Furthermore, interventions such as community-based education and targeted nutritional interventions are required to decrease undernutrition among Indian children. Regardless of other factors higher birth order was associated with stunting and underweight. The present study has suggested that future intervention should consider higher birth order as an important factor.

Author Declaration

Availability of data and materials: The study was based on the 2015-2016 India NFHS-4. Approval to use these data was sought from Measure DHS/ICF International, and permission was granted for this use. The data are available to apply online at https://dhsprogram.com/data/available-datasets.cfm. Contact information-email: info@dhsprogram.com.

Acknowledgement

The authors are grateful to the Measure DHS for providing the data for the analysis.

REFERENCES

[1] WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development [Internet]. [cited 2021 May 15]. Available from: https://www.who.int/publications-detail-redirect/924154693X.
[2] Joint-malnutrition-estimates-2019.pdf [Internet]. [cited 2021 May 12]. Available from: https://www.unicef.org/media/60626/file/Joint-malnutrition-estimates-2019.pdf.
[3] National Family Health Survey (NFHS-4) India.pdf [Internet]. [cited 2021 May 12]. Available from: http://rchiips.org/nfhs/nfhs-4Reports/India.pdf.
[4] GBD 2016 Diarrhoeal Disease Collaborators. Estimates of the global, regional, and national morbidity, mortality, and aetiologies of diarrhoea in 195 countries: A systematic analysis for the Global Burden of Disease Study 2016. Lancet Infect Dis. 2018;18(11):1211-28.
[5] 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. Front Public Health [Internet]. 2019 Jul 12 [cited 2021 May 12];7. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6639755/.
[6] Panigrahi A, Das SC. Undernutrition and its correlates among children of 3–9 years of age residing in slum areas of Bhubaneswar, India. Sci World J. 2014;2014:e719673. Available from: https://doi.org/10.1155/2014/719673.
[7] Rana MJ, Goli S. Does planning of births affect childhood undernutrition? Evidence from demographic and health surveys of selected South Asian countries. Nutr Burbank Los Angel Cty Calif. 2018;47:90-96. Doi: 10.1016/j.nut.2017.10.006. Epub 2018 Jan 5.
[8] Krishna A, Oh J, Perkins JM, Lee HY, Heo J, Lee JK, et al. Is there a female disadvantage in child undernutrition in South India?: Exploring gender differences in height in infancy, childhood, and adolescence in Andhra Pradesh and Telangana. Am J Hum Biol. 2019;31(1):e23153.
[9] Guide to DHS Statistics [Internet]. [cited 2021 May 12]. Available from: https://dhsprogram.com/data/Guide-to-DHS-Statistics/index.cfm.
[10] Organization WH. ICD-10: International statistical classification of diseases and related health problems: Tenth revision [Internet]. World Health Organization; 2004 [cited 2021 May 15]. Available from: https://apps.who.int/iris/handle/10665/42980.
[11] Zonal Council|Ministry of Home Affairs | GoI [Internet]. [cited 2021 May 12]. Available from: https://www.mha.gov.in/zonal-council.
[12] Total Fertility Rate (TFR) (Birth/ woman) | NITI Aayog [Internet]. [cited 2021 May 12]. Available from: http://niti.gov.in/content/total-fertility-rate-tfr-birth-woman.
[13] Saxton J, Rath S, Nair N, Gope R, Mahapatra R, Tripathy P, et al. Handwashing, sanitation and family planning practices are the strongest underlying determinants of child stunting in rural indigenous communities of Jharkhand and Odisha, Eastern India: A cross-sectional study. Matern Child Nutr. 2016;12(4):869-84.
[14] Berhanu G, Mekonnen S, Sisay M. Prevalence of stunting and associated factors among preschool children: A community based comparative cross sectional study in Ethiopia. BMC Nutr. 2018;4:28. https://doi.org/10.1186/s40795-018-0236-9.
[15] Rahman M. Association between order of birth and chronic malnutrition of children: a study of nationally representative Bangladeshi sample. Cad Saude Publica. 2016;32(2):e00011215.
[16] Mohammed S, Asfaw ZG. Bayesian Gaussian regression analysis of malnutrition for children under five years of age in Ethiopia, EMDHS 2014. Arch Public Health. 2018;76(1):21. https://doi.org/10.1186/s13690-018-0264-6.
[17] Boah M, Azupogo F, Amporfro DA, Abada LA. The epidemiology of undernutrition and its determinants in children under five years in Ghana. PLOS ONE. 2019;14(7):e0219665.
[18] Christian P, Lee SE, Donahue Angel M, Adair LS, Arifeen SE, Ashorn P, et al. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries. Int J Epidemiol. 2013;42(5):1340-55.
[19] Stiller CK, Golembiewski SKE, Golembiewski M, Mondal S, Biesalski HK, Scherbaum V. Prevalence of undernutrition and Anaemia among Santal Adivasi children, Birbhum District, West Bengal, India. Int J Environ Res Public Health. 2020;17(1):342.
[20] Awasthi S, Das R, Verma T, Vir S. Anaemia and undernutrition among preschool children in Uttar Pradesh, India. Indian Pediatr. 2003;40(10):985-90.
[21] Khan S, Zaheer S, Safdar NF. Determinants of stunting, underweight and wasting among children <5 years of age: Evidence from 2012-2013 Pakistan demographic and health survey. BMC Public Health. 2019;19(1):358.
[22] Kavosi E, Hassanzadeh Rostami Z, Kavosi Z, Nasihatkon A, Moghadami M, Heidari M. Prevalence and determinants of under-nutrition among children under six: a cross-sectional survey in fars province, Iran. Int J Health Policy Manag. 2014;3(2):71-76.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Feb 20, 2021
- Manual Googling: Jun 21, 2021
- iThenticate Software: Jul 26, 2021 (22%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? No
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Feb 19, 2021**
Date of Peer Review: **May 04, 2021**
Date of Acceptance: **Jun 24, 2021**
Date of Publishing: **Aug 01, 2021**

Characteristics	Total (n=128859)		Stunted	Wasted	Underweight
	n	%	%	%	%
Child birth order					
First order birth	40939	31.8	26.7	31.0	27.0
Second order birth	43262	33.6	31.8	32.8	32.1
Third order birth	22553	17.5	19.3	18.0	19.3
Fourth order birth	11189	8.7	10.6	9.1	10.3
Fifth and higher order birth	10916	8.5	11.6	9.0	11.3
Sex of child					
Female	58695	45.5	43.9	43.1	44.1
Male	70164	54.5	56.1	56.9	55.9
Age of child (in months)					
<12	18718	14.5	8.9	18.1	11.7
12 to 23	37962	29.5	32.7	30.4	29.4
24 to 35	29358	22.8	24.4	22.5	24.4
36 to 47	23714	18.4	19.7	16.4	19.3
48 to 59	19107	14.8	14.2	12.6	15.2
Anemia (Child)					
Anemic	75893	58.9	64.6	63.8	65.5
Not anemic	52966	41.1	35.4	36.2	34.5
Child's birth weight					
Low birth weight	16476	12.8	15.1	16.4	16.9
Normal birth weight	112383	87.2	84.9	83.6	83.1
Mode of delivery					
Caesarean	20406	15.8	11.4	12.4	10.6
Vaginal	108453	84.2	88.6	87.6	89.4
Age of mother (in years)					
15 to 24	38465	29.9	29.7	32.2	30.2
25 to 34	75658	58.7	57.9	57.2	57.9
35 to 49	14736	11.4	12.4	10.6	11.9
Mother's education					
No education	36138	28.0	37.1	33.4	38.3
Primary education	17819	13.8	15.9	14.1	15.7
Secondary education	60895	47.3	40.9	44.2	40.2
Higher education	14007	10.9	6.2	8.3	5.8
BMI (Mother)					
Normal weight	78404	60.8	60.1	58.9	57.8
Obese	4001	3.1	2.0	1.5	1.6
Overweight	15894	12.3	9.0	7.6	7.4
Underweight	30560	23.7	28.8	32.0	33.3
Anemia (Mother)					
Anemic	70310	54.6	57.3	57.1	59.1
Not anemic	58549	45.4	42.7	42.9	40.9
Region					
East	28015	21.7	24.7	25.5	27.2
Central	37102	28.8	32.4	30.5	33.2
North	22612	17.5	15.4	15.8	14.3
North East	18225	14.1	11.9	8.8	8.7
South	13415	10.4	8.3	10.2	8.4
West	9490	7.4	7.2	9.2	8.2
Wealth index					
Poorest	29809	23.1	31.5	29.9	33.7
Poorer	29042	22.5	25.7	23.6	25.5
Middle	26287	20.4	19.4	18.9	18.5
Richer	23305	18.1	13.9	15.5	13.4
Richest	20416	15.8	9.5	12.1	8.9
Place of residence					
Rural	95604	74.2	79.0	76.9	79.2
Urban	33255	25.8	21.0	23.1	20.8
House type					
Kaccha	9276	7.2	9.0	8.0	8.9
Pucca	59916	46.5	37.7	41.6	36.9
Semi pucca	59667	46.3	53.3	50.5	54.2
Type of family					
Non nuclear	75874	58.9	55.3	57.7	55.4
Nuclear	52985	41.1	44.7	42.3	44.6

[Supplementary Table-1:]: Child, maternal and socio-demographic characteristics of children aged 6 to 59 months from NFHS-4 survey.
BMI: Body mass index