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Birth interval and childhood undernutrition: Evidence from a large scale survey in India

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ABSTRACT

Background: The study of birth interval is important for maternal and child health. The long birth interval is favorable for maternal, child health, and nutritional outcomes. The present study is an attempt to explore the relationship between birth intervals and poor nutritional condition of children under five years of age in India.
Methods: The unit of analysis is children under five years of age in India. The data come from the fourth round of Indian National Family Health Survey, 2015–2016. Bivariate and logistic regression model were used to explore the relationship between birth intervals and the poor nutritional status of children.
Results: The logistic regression shows a 28% increase in stunting for those children born with a birth interval of less than 24 months. Also, there is a 26% increase in underweight for children of birth interval less than 24 months. It is evident that low birth weight, poor facilities during pregnancy are statistically associated with poor nutritional status of children.
Conclusion: Therefore, the present study attempts to determine to what extent the length of preceding birth interval influences the child undernutrition and the result revealed that short birth intervals are associated with an increased risk of child stunting and underweight even after controlling the biological, social and behavioral predictors. The study suggests that interventions that aim to increase birth intervals, including family planning and reproductive health services, may be important in improving nutritional status in children.

1. Introduction

The study of birth interval is important for maternal and child health.[1] The long birth interval is favorable for maternal, child health, and nutritional outcomes. Birth interval is the length of time between a child's birth and a previous and/or subsequent sibling's birth. A short subsequent birth interval can place the child at risk for several reasons. The short birth interval can lead to preterm birth and low birth weight as the mother may not have recovered her nutritional status. Because of short birth interval mother's nutrient reserves become depleted, which leads to the increased risk of intrauterine growth retardation, that adversely affect infant nutrient stores at birth and nutrient delivery via breast.[2–6] Due to short birth interval, caring for a new infant also reduces the amount of time that the mother can devote for the older child. The subsequent pregnancy may alter care practices that affect the current child's health.[7]

Infants should be exclusively breastfed for six months and subsequently breastfeeding be continued alongside the gradual introduction of nutritiously diverse and safe solids at an appropriate frequency.[8,9] Several studies have found that undernutrition among children is affected by breastfeeding and complementary feeding practices.[10–12] Besides, improved water, sanitation and hygiene practices protect against stunting,[13–15] indoor air pollution from solid fuel use has been suggested as a risk factor.[16] Childhood undernutrition is also affected by maternal characteristics, such as age,[17,18] nutritional status.[19] Besides, household characteristics i.e., economic status,[17,19] caste,[20] maternal[20,21] and paternal education,[21] occupation[22] and household decision-making roles[23] are major underlying determinants of childhood undernutrition. Healthcare utilization during pregnancy, birth, the postnatal period and continuing into childhood determines a health system's ability to prevent, diagnose and treat chronic undernutrition.[17,24,25]

Birth spacing influences different outcome measures for the mother, newborn and child. The prevalence of stunting and underweight decreases as birth interval increases.[26,27] Previous birth interval of at least 36 months was associated with a 10–50% reduction in childhood stunting.[28] Birth intervals of less than 12 months and 12–23 months were associated with higher risks for stunting as compared to 24–35

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months.[29] Because of the socio-cultural and spatial variations, the prevalence of childhood undernutrition varies widely both between and within countries.[18,30] Mothers who adequately space their pregnancies are able to provide their children with the necessary nutrition for growth development and a strong immune system, thereby reducing the likelihood of childhood undernutrition. Adequate spacing between births allows women to recover and be healthy for their next pregnancy.

2. Methods

2.1. Data

The four rounds of India's National Family Health Survey (NFHS) carried during 1992-93, 1998-99, 2004-05 and 2015-16, provide national representative data on child health and nutrition. The present study was based on the latest round of NFHS-4 (2015-16).[31] The survey collected information on socio-economic and hygienic conditions of households, full birth history of eligible women on a retrospective basis, child's survival status and birth intervals. The sampling design adopted is a multi-stage stratified cluster sampling. A total of 699686 eligible women in the reproductive ages 15–49 years completed the interview. As the outcomes are related to the anthropometric measures of a child, the whole data for the present analyses use child as the unit of observation, rather than the mother itself. The NFHS-4 provided related information on 259627 children born in the last five years preceding the survey.

As the main objective of the present study is to explore the relationship between preceding birth interval and the outcomes of interest – stunting and underweight, the first births born to eligible women are excluded from the analytical sample due to lack of preceding birth intervals for these indexed children. Also, to eliminate the confounding effect induced by sharing characteristics of multiple births, the analytical sample is restricted to only single births. With these restrictions, the anthropometric measures were available for a total analytical sample of 159862 index children of birth order two or higher. The NFHS-4 provides the normalized *z*-scores for height-for-age and weight-for-age. The two outcome variables, stunting and underweight are calculated from the normalized scores as per the definition provided by the National Center for Health Statistics (NCHS)/World Health Organization.[32] As per the standards of WHO, a child is classified as stunted or underweight if his/her z-score is two or more standard deviations below the mean. Using this standard criterion the prevalence of stunting and underweight in the entire population of under-five children was 38.4% and 34.5%, respectively. The analytical sub-sample in the present study gives 57103 cases (40.9%) of stunting and 50985 cases (36.6%) of underweight. Overall, including wasting, the analytical sample indicates that 79754 children (49.9%) suffer from some form of undernutrition.

The earlier three rounds of NFHS (1992-93, 1998-99, and 2004-05) reported median birth intervals of 32, 33 and 31 months respectively. The present analytical sample from the NFHS-4 shows 27% of the index children were born following short birth intervals of less than 24 months, 32% after intervals of 24–35 months, 28% after 36–59 months, and 13% after intervals of 60 months or more (Table 1).

2.2. Statistical analysis

The association between outcome variables (stunting and underweight) and a set of predictors was examined by two-way bivariate analyses using chi-squared tests. Next multiple logistic regression model was used to explore the relationship between birth intervals and outcome variables stunting and underweight controlling for several characteristics of child and mother. Some of the children in the analytical sample of 159862 observations are from the same household and same mother, so they share some of the household and maternal characteristics. This may inflate the standard errors of the estimated odds ratio from the fitted logistic regression, therefore we controlled for this clustering effect by using the "robust cluster" in the regression model to obtain unbiased standard errors. Analyses were performed using STATA version 13.

Table 1
Percentage distributions of predictors for stunting and underweight.

Variables	Frequency(n = 159,862)	Percentage
Birth intervals		
0–23 months	42,787	26.76
24–35 moths	50,867	31.82
36–59 months	44,640	27.92
60 months and more	21,568	13.49
Wealth index		
Poorest	49,361	30.88
Poorer	39,611	24.78
Middle	30,542	19.11
Richer	23,385	14.63
Richest	16,963	10.61
Place of residence		
Urban	34,877	21.82
Rural	124,985	78.18
Mother's educational level		
No education	62,093	38.84
Primary	25,840	16.16
Secondary	62,583	39.15
Higher	9346	5.85
Birth order		
Order 2	78,309	48.99
Order 3	40,615	25.41
Order 4 and above	40,938	25.61
Age of child		
0–11 months	30,765	19.24
12–23 months	31,801	19.89
24–35 months	31,506	19.71
36–47 months	33,259	20.8
48–59 months	32,531	20.35
Survival status		
No previous child died	149,024	93.41
Previous child died	10,520	6.59
Intention to pregnancy		
Wanted	149,615	93.67
Unwanted	10,111	6.33
Prenatal Care		
Standard	81,167	63.79
Below standard	19,538	15.36
No care	26,535	20.85
Birth weight (kg.)		
Low	40,722	25.47
Normal	69,526	43.49
Missing	49,614	31.04
Place of delivery		
Delivery at health facility	110,774	69.35
Delivery at home	48,952	30.65

2.3. Predictors

The prominent risk factors for determining the adverse nutritional outcomes during infancy and childhood include a child's prenatal and post-natal practices, household's socio-economic condition, breastfeeding practices and size of household. The present study also considers similar categories of risk factors used in other studies.[32] The present study classifies the risk factors as household resources, household structure, reproductive history and outcomes, and the social environment of the household.[32] A complete description and treatment of outcomes and predictors used in the present analysis are shown in Table 1.

Table 2
Percent of stunted and underweight by birth intervals and region.

Nutritional status/Birth Intervals	Stunted						Underweight					
	0–23	24–35	36–59	≥60	Total	p*	0–23	24–35	36–59	≥60	Total	p*
North												
Haryana	40.3	37.4	34.6	30.6	37.0	0.002	34.3	34.8	29.5	24.9	32.4	< 0.001
Himachal Pradesh	31.6	32.5	27.2	15.7	28.3	< 0.001	26.9	24.1	21.9	16.7	23.1	0.004
Jammu & Kashmir	35.8	33.1	27.3	23.8	30.3	< 0.001	23.4	19.8	15.4	14.4	18.3	< 0.001
Delhi	39.3	37.5	32.8	27.7	34.2	0.131	45.0	27.3	28.4	22.0	30.0	< 0.001
Punjab	32.0	31.0	21.3	25.1	27.6	< 0.001	25.7	23.4	21.4	22.1	23.2	0.296
Rajasthan	44.9	43.2	38.0	30.6	41.0	< 0.001	42.0	41.1	37.0	31.9	39.3	< 0.001
Uttarakhand	41.2	37.9	31.4	28.5	35.6	< 0.001	33.2	30.8	25.2	21.7	28.6	< 0.001
Central												
Chhattisgarh	41.5	37.7	39.2	33.8	38.5	0.010	41.9	40.6	39.4	35.8	39.9	0.07
Madhya Pradesh	49.2	45.1	38.1	34.8	43.7	< 0.001	51.6	46.4	40.7	35.9	45.6	< 0.001
Uttar Pradesh	52.4	49.6	45.6	39.8	48.3	< 0.001	44.2	41.3	38.2	34.1	40.5	< 0.001
East												
Bihar	52.7	50.5	47.3	44.1	49.9	< 0.001	48.9	46.3	43.4	39.5	45.9	< 0.001
Jharkhand	50.4	47.6	45.4	38.9	46.4	< 0.001	53.7	50.6	47.4	42.8	49.2	< 0.001
Odisha	43.7	41.7	36.2	32.2	37.8	< 0.001	42.4	41.6	38.4	33.7	38.8	< 0.001
West Bengal	47.6	39.9	36.7	30.2	37.7	< 0.001	43.2	40.5	33.3	32.7	36.7	< 0.001
North-East												
Arunachal Pradesh	40.8	32.7	26.9	27.3	31.4	< 0.001	21.8	19.4	16.9	18.8	19.0	0.189
Assam	43.9	42.8	37.0	33.4	38.5	< 0.001	34.4	33.9	30.7	24.4	30.4	< 0.001
Manipur	39.6	34.9	29.6	26.6	32.4	< 0.001	17.5	14.8	12.4	15.0	14.5	0.039
Meghalaya	50.8	46.7	39.9	43.8	45.5	< 0.001	33.5	30.7	28.9	29.3	30.7	0.258
Mizoram	36.7	33.2	30.9	26.9	32.2	0.002	17.9	15.4	12.5	10.9	14.3	0.002
Nagaland	34.2	32.7	28.0	18.8	30.4	< 0.001	18.4	19.5	16.8	12.8	17.7	0.053
Sikkim	40.4	47.7	27.8	27.9	32.7	0.010	17.5	18.5	19.4	12.0	15.7	0.317
Tripura	33.8	42.7	30.8	20.2	29.8	0.001	28.6	32.0	25.4	25.0	27.0	0.57
West												
Goa	17.5	39.6	14.3	20.4	22.7	0.013	12.5	39.6	25.0	25.9	26.3	0.039
Gujarat	49.0	45.5	38.0	32.9	42.4	< 0.001	48.8	47.5	38.6	36.5	43.7	< 0.001
Maharashtra	43.6	38.3	35.2	25.5	37.3	< 0.001	43.4	40.9	37.2	28.2	39.0	< 0.001
South												
Andhra Pradesh	36.4	34.3	32.5	33.8	34.5	0.719	33.4	33.3	32.4	31.0	32.9	0.952
Karnataka	44.2	43.3	37.9	33.3	41.0	< 0.001	40.3	40.9	37.1	29.0	38.4	< 0.001
Kerala	18.0	22.8	21.7	19.2	20.6	0.603	19.5	16.9	15.9	17.1	16.9	0.817
Tamil Nadu	35.5	29.1	25.0	23.6	28.9	< 0.001	31.8	27.1	22.7	20.6	26.2	< 0.001
Telangana	38.4	30.3	28.1	36.0	33.2	0.022	33.4	29.7	27.3	41.2	31.8	0.028
UTs												
A & N Islands	24.7	26.0	23.4	28.4	25.6	0.910	19.2	19.2	31.2	10.8	20.2	0.02
Chandigarh	41.7	23.1	31.0	30.0	31.3	0.566	16.7	34.6	24.1	30.0	26.3	0.514
D & N Haveli	48.3	52.1	41.2	20.0	42.5	0.060	44.8	62.5	35.3	28.0	44.4	0.013
Daman & Diu	22.2	38.0	29.7	16.7	28.3	0.153	25.9	28.0	31.3	22.2	27.7	0.804
Lakshadweep	33.3	20.8	17.4	23.8	22.3	0.614	20.0	25.0	23.9	14.3	19.6	0.548
Puducherry	31.9	27.5	22.6	25.0	26.6	0.407	23.9	26.7	18.8	19.2	22.1	0.391
India	**46.1**	**43.0**	**37.9**	**32.2**	**40.9**	**< 0.001**	**41.0**	**38.5**	**33.9**	**28.7**	**36.5**	**< 0.001**

Note: A & N = Andaman and Nicobar; D & N = Dadar and Nagar; **chi-square* test for significance difference between stunting/underweight and birth intervals for each state.

3. Results

3.1. Stunting and underweight by birth interval

Table 2 presents the percent distribution of stunted and underweight within the categories of birth intervals by regions and union territories of India. The results show that across the regions the percentage of stunting and underweight among the children born after an interval of less than 24 months is higher than the percentage of stunting and underweight among the children born after an interval of greater than 59 months. At the all India level, the percentages of stunting and underweight of children born after an interval of less than 24 months are 46 and 41 respectively. The bivariate analysis shows a significant association between stunting and preceding birth interval for most of the states ($p < 0.001$). Also, a similar significant association was observed between underweight and preceding birth interval across the regions. But there is no significant association between the outcomes (stunting and underweight) and preceding birth interval in the Union Territories.

3.2. Predictors of stunting

The main relationship that we want to explore in the present study is between the birth interval and the nutritional outcomes - stunting and underweight. It is evident that as the birth interval decreases the rate of stunting increases. Children born after an interval of less than 24 months experience 46% of stunting (Table 3). Among children born after 60 months or more, 32% are stunted. We retained the multiple logistic regression controlled for several backgrounds against the model without controlling the backgrounds (BIC: 138520.7 vs 139748.8). The interpretations are for the model with controlled variables. The multiple logistic regression model once again confirms the increase in the rate of stunting with a decrease in birth intervals after controlling for other characteristics in the model. Children born after less than 24 months (OR = 1.28, 95%CI: 1.24, 1.33) were significantly more likely to be stunted than those born after 36–59 months. Similarly, the odds of being stunted for children born after 24–35 months (OR = 1.14, 95% CI:1.10, 1.18) were significantly higher than those born after 36–59 months. Increase in birth interval shows lower chances of stunting where children born after 60 months or more (OR = 0.89,95% CI:0.85, 0.93) were significantly less likely to be stunted compared to those born

Table 3
Rate of stunting by predictors and likelihood of stunting for under-five children[a].

Predictors	Frequency (n = 159,862)	Rate per 100 Children		Odds ratios	
		Value	*p-value**	Value	95%CI
Birth intervals					
0–23 months	16,865	46.12		1.28	1.24, 1.33
24–35 moths	19,255	43.00		1.14	1.10, 1.18
36–59 months	14,922	37.95	< 0.001	1.00	
60 months or more	6061	32.22		0.89	0.85, 0.93
Wealth index					
Poorest	21,790	51.34		1.38	1.32, 1.43
Poorer	15,285	44.17		1.20	1.15, 1.24
Middle	10,082	37.53	< 0.001	1.00	
Richer	6390	30.90		0.82	0.79, 0.86
Richest	3556	23.89		0.68	0.65, 0.72
Place of residence					
Urban	10,374	34.03	< 0.001	1.00	
Rural	46,729	42.87		0.94	0.90, 0.97
Mother's educational level					
No education	26,604	49.85	< 0.001	1.00	
Primary	9854	43.67		0.90	0.86, 0.93
Secondary	18,835	34.06		0.76	0.74, 0.79
Higher	1810	21.96		0.59	0.55, 0.64
Birth order					
Order 2	25,356	36.87	< 0.001	1.00	
Order 3	14,849	41.80		1.09	1.05, 1.12
Order 4 and above	16,898	48.05		1.23	1.19, 1.28
Age of child					
0–11 months	5731	22.25	< 0.001	1.00	
12–23 months	12,690	45.29		3.00	2.88, 3.12
24–35 months	12,679	45.62		2.90	2.79, 3.03
36–47 months	13,758	46.85		2.95	2.83, 3.08
48–59 months	12,245	42.89		2.42	2.31, 2.53
Survival status					
No previous child died	53,347	40.86	0.005	1.00	
Previous child died	3668	42.40		0.91	0.86, 0.96
Intention to pregnancy					
Wanted	53,160	40.62	< 0.001	1.00	
Unwanted	3943	45.83		1.04	0.99, 1.09
Prenatal Care					
Standard	25,557	35.37	< 0.001	1.00	
Below standard	7208	41.21		1.05	1.02, 1.09
No care	10,407	45.84		1.08	1.04, 1.12
Birth Weight (kg.)					
Normal	15,868	44.52	< 0.001	1.00	
Low	21,388	34.43		1.44	1.40, 1.49
Missing	19,847	47.58		1.21	1.16, 1.26
Place of delivery					
Delivery at health facility	37,433	38.48	< 0.001	1.00	
Delivery at home	19,670	46.62		0.98	0.94, 1.02

[a] controlling for caste, sex of index child, religion, region, and mother's age at birth of child; **chi-square* test for significance difference between stunting and birth intervals for each state.

after 36–59 months.

Among the household resources, there is a statistically significant relationship between the household wealth index (standard of living index) and stunting. Almost 51% and 24% of children in the poorest and richest quintiles of wealth index are respectively stunted. The risk of stunting decreases as the wealth index quintile increases, where children who are in the poorest quintile (OR = 1.38, 95% CI:1.32, 1.43) were significantly more likely to be stunted compared to those in the middle quintile. Those children who are in better off household i.e. in the richest quintile are 32% (OR = 0.68, 95% CI:0.65, 0.72) less likely to be stunted compared to those who are in the middle quintile. Maternal education is also associated with stunting. The bivariate analysis shows that children whose mothers do not have any education are 50% stunted and this figure goes down to 22% when children are from mothers with higher education. The odds of stunting for children whose mothers have primary (OR = 0.90, 95% CI:0.86, 0.93), secondary (OR = 0.76, 95% CI:0.74, 0.79) and higher (OR = 0.59, 95% CI:0.55, 0.64) education were significantly less likely than those mothers who do not have any education.

Both the factors related to the household structure are statistically associated with the rate of stunting. The odds of stunting ranges between 2.42 and 3.00 for older children compared to infants. The high-birth order is also related to stunting; the bivariate analysis shows that higher-birth order children experience higher rates of stunting. This is again confirmed by the logistic regression model where children of birth orders three (OR = 1.09, 95% CI:1.05, 1.12) and four or more (OR = 1.23, 95% CI:1.19, 1.28) were significantly more likely to be stunted than children of birth-order two.

Most of the factors related to reproductive and outcomes are significantly associated with stunting. The odd of stunting for children of unwanted pregnancy (OR = 1.04, 95% CI: 0.99, 1.09) were significantly higher as compared to children of wanted pregnancy. But the relation is not statistically significant. Children having older sibling's death have lesser odds of stunting compared to their counterparts. Children who have low birth weight (OR = 1.44, 95% CI:1.40, 1.49) were significantly having higher odds of experiencing stunting than children of normal birth weight. Quality cares given to mothers before birth of a child is also very important; children of mothers who got prenatal care of below-standard have a 1.09 time higher odds of being stunted compared to those who got standard prenatal care. The relationship is also statistically significant. After controlling for several confounders, the study reveals a higher percentage of stunting for those children who were born less than 24 months (Table 5, Appendix).

3.3. Predictors of underweight

The results of bivariate and logistic regression analyses are shown in Table 4. Once again it is seen that children born after an interval of less than 24 months experience 41% of being underweight as compared to 28% of those children born after an interval of 60 months or more. The multiple logistic regression model with controlled variables (BIC: 134464.5 vs 137141.3) was selected as the final model for interpretation. The multiple logistics regression model shows the increase in the rate of underweight with a decrease in birth intervals after controlling for other characteristics in the model. Children born after less than 24 months (OR = 1.26, 95% CI: 1.22, 1.31) were significantly more likely to be underweight than those born after 36–59 months. The chances of being underweight for children born after 24–35 months (OR = 1.13, 95% CI:1.09, 1.17) were significantly higher than those born after 36–59 months. Lower chances of underweight were associated with higher birth interval, children born after 60 months or more (OR = 0.93, 95% CI:0.89, 0.97) were significantly less likely to be underweight compared to those born after 36–59 months.

Increasing in the household wealth status is statistically significantly related to lower risk of childhood underweight. Almost 48 and 20 %s of children in the poorest and richest quintiles of wealth index are respectively underweight. Children who are in the poorest quintile (OR = 1.51, 95% CI:1.44, 1.57) were significantly more likely to be underweight compared to those in the middle quintile. Those children who are in the wealthier household, i.e., in the richest quintile were (OR = 0.72, 95% CI:0.68, 0.76) less likely to be underweight

Table 4
Rate of underweight by predictors and likelihood of underweight for under-five children[a].

Variables	Frequency (n = 159,862)	Rate per 100 Children		Odds ratios	
		Value	*P-value**	Value	95%CI
Birth interval					
0–23 months	14,992	41.00		1.26	1.22, 1.31
24–35 moths	17,241	38.50		1.13	1.09, 1.17
36–59 months	13,354	33.96	< 0.001	1.00	
60 months or more	5398	28.69		0.93	0.89, 0.97
Wealth index					
Poorest	20,443	48.16		1.51	1.44, 1.57
Poorer	13,309	38.46		1.21	1.16, 1.26
Middle	8609	32.05	< 0.001	1.00	
Richer	5575	26.96		0.85	0.81, 0.89
Richest	3049	20.49		0.72	0.68, 0.76
Place of residence					
Urban	9268	30.40	< 0.001	1.00	
Rural	41,717	38.28		0.87	0.84, 0.91
Mother's educational level					
No education	24,280	45.49	< 0.001	1.00	
Primary	8708	38.59		0.89	0.86, 0.93
Secondary	16,447	29.74		0.77	0.74, 0.80
Higher	1550	18.81		0.61	0.57, 0.66
Birth order					
Order 2	22,932	33.34	< 0.001	1.00	
Order 3	13,294	37.42		1.06	1.02, 1.09
Order 4 and above	14,759	41.96		1.14	1.09, 1.19
Age of child					
0–11 months	6943	26.96	< 0.001	1.00	
12–23 months	10,210	36.44		1.58	1.52, 1.64
24–35 months	10,995	39.56		1.89	1.82, 1.97
36–47 months	11,654	39.69		1.85	1.77, 1.93
48–59 months	11,183	39.17		1.75	1.68, 1.83
Survival status					
No previous child died	47,531	36.41	0.005	1.00	
Previous child died	3375	39.01		0.95	0.90, 1.01
Intention to pregnancy					
Wanted	47,588	36.36	< 0.001	1.00	
Unwanted	3397	39.49		0.97	0.92, 1.02
Prenatal care					
Standard	23,138	32.02	< 0.001	1.00	
Below standard	6937	39.66		1.07	1.03, 1.11
No care	9360	41.23		1.01	0.97, 1.04
Birth weight (kg.)					
Normal	18,023	29.01	< 0.001	1.00	
Low	15,721	44.11		1.75	1.70, 1.81
Missing	17,241	41.33		1.24	1.19, 1.29
Place of delivery					
Delivery at health facility	33,646	34.59	< 0.001	1.00	
Delivery at home	17,339	41.09		1.05	1.01, 1.09

[a] **:** controlling forcaste, sex of index child, religion, region, and mother's age at birth of child; **chi-square* test for significance difference between underweight and birth intervals for each state.

compared to those who are in the middle quintile. Maternal education is also associated with underweight. The bivariate analysis shows that 45 and 19 %s of children from mothers who do not have any education and from mothers with higher are respectively underweight. The odds of underweight for children whose mothers have primary (OR = 0.89, 95% CI:0.86, 0.93), secondary (OR = 0.77, 95% CI:0.74, 0.80) and higher (OR = 0.61, 95% CI:0.57, 0.66) education were significantly less likely than those mothers who do not have any education.

The odds of underweight for children age 12–23 months (OR = 1.58, 95% CI:1.52, 1.64) and age 48–59 months (OR = 1.75, 95% CI:1.68, 1.83) were more likely as compared to infants. The bivariate analysis shows that higher birth order is linked with an increased risk of underweight. Multiple logistic regression model confirms that children of birth orders three (OR = 1.06, 95% CI:1.02, 09) and four or more (OR = 1.14, 95% CI:1.09, 1.19) were significantly more likely to be underweight than children of birth-order two.

The odd of underweight for children of unwanted pregnancy (OR = 0.97, 95% CI: 0.92, 1.02) were significantly lesser as compared to children of wanted pregnancy. Children having older siblings' death have lesser odds of underweight compared to their counterparts. Low birth weight children (OR = 1.75, 95% CI:1.70, 1.81) were significantly having higher odds of underweight than children of normal birth weight. Children were more likely to be underweight if the mothers received prenatal care of below-standard (OR = 1.07, 95% CI:1.03, 1.11) and delivered a child at home (OR = 1.05, 95% CI:1.01, 1.09). Similar to stunting there is a high percentage of underweight for those born less than 24 months after controlling for several confounders (Table 6, Appendix). We did not find much difference in the odds ratios for stunting and underweight between controlled and uncontrolled background characteristics (Figure 1 and Figure 2, Appendix).

4. Discussion

It has been a topic of discussion in the literatures that undernutrition leads to child mortality and morbidity in most developing countries. Therefore, it is important to investigate the biological, social, and behavioral mechanisms by which adequate birth spacing might contribute to child health. Of these birth interval plays an important role in child undernutrition. The finding shows that short birth intervals are associated with an increased risk of child stunting and underweight. A child of birth interval 0–23 months has a higher odds of experiencing stunting and underweight as compared to a child of higher birth interval. Older children experience a higher chance of stunting and underweight as compared to infants. A child age 12–23 has a higher chance of experience stunting whereas a child age 24–35 months has a higher chance of underweight. Low birth weight is another predictor of stunting and underweight. The other significant associations with stunting and underweight were maternal education, household wealth index, prenatal care and place of delivery. The risk of a child experience stunting and underweight decreases as the mother's level of education increases. Children whose mothers were belonging from the poorest wealth quintile have a higher chance of being stunting and underweight. The odds of underweight for children of unwanted pregnancy were significantly lesser as compared to children of wanted pregnancy. Children of those mothers who have received quality prenatal care were less likely to experience stunting and overweight.

Another predictor of stunting and underweight is the low birth weight which has adverse consequences on infant and child health. In corroboration with earlier studies, our study once again confirms a statistically significant association between low birthweight and poor nutritional status during infancy and early childhood. This finding is an indication to plan for intervention during pregnancy/prior to pregnancy to prevent low birthweight infants. However, the relationships between low birthweight, short birth intervals and poor childhood nutrition are complex and hence further research is immediate to better understand the relationships.

Our results indicate that short proceeding birth intervals are associated with diminished height by early childhood. Our results suggest that interventions that aim to increase birth intervals, including family planning and reproductive health services, may still be important in improving stunting in children (particularly at early ages) as well as positively contributing to child health more generally. Encouraging women to space births through family planning services and educational awareness could contribute to reducing childhood undernutrition, improve maternal health, and provide healthy childhood development. Birth intervals can be lengthened through various approaches, but are principally increased through the use of family planning methods, extended exclusive breast-feeding, spontaneous or induced abortions. Longer spacing between two births allows for the optimum use of the parent time inputs and resources for each child, which in turn improves child health.

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Ethics approval and consent to participate

The Ethics Review Board at the International Institute for Population Sciences, Mumbai, India granted Measure DHS/ICF International ethical approvals before the surveys were conducted, with written informed consent obtained from participants during the surveys. The questionnaires used for the survey were reviewed and approved by ICF International Institutional Review Board (IRB) to ensure they met the United States Department of Health and Human Services regulations for the protection of human participants, as well as the host country's IRB, to ensure compliance with national laws. Approval was sought from Measure DHS and permission was granted for this use.

Contributors

HSC and HS designed the study. HSC analysed the data. HSC wrote the first version. All authors revised it critically and interpreted the data and they have also seen and approved the final version.

Declaration of competing interest

The authors declare that they have no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cegh.2020.04.012.

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