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Tracking Changes and Identifying Determinants of Child Malnutrition Status over the Past Decade in Bangladesh

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Abstract: Over the past decade Bangladesh has maintained an impressive track record of economic growth and poverty reduction. Despite achieving significant progress in the aforementioned sectors, Bangladesh lags far behind in case of child malnutrition. This study endeavors to track the trend in child malnutrition status in terms of different indicators over the past decade in Bangladesh. The study also investigated differential impact of some characteristics belonging to child, mother and household on nutritional status. The data extracted from BDHS (2004, 2007, 2011) were used for this purpose. Pearson's chi-square and binary logistic regression model were employed to identify the determinants of child malnutrition. Cutbacks in stunting and underweight status were observed whereas the number of wasted child was increased from BDHS (2004) to BDHS (2011). A child aged less than or equal to two years had lower risk of being stunted or under weighted in comparison with the child aged 2 to 5 years. It was found that the child whose mother was less educated was more likely to suffer from malnutrition than a well educated mother's child. It is also discerned that the child belonging to poor family or having no toilet facility was more likely to be malnourished comparing to the child belonging to non-poor family and getting better toilet facility.

Key words: Malnutrition, wasting, stunting, underweight, logistic regression model

INTRODUCTION

The term "Malnutrition" refers to both under-nutrition (inadequate nutrients) and over-nutrition (absorbing over nutrients from food than required). The major reasons behind malnutrition include having reduced mobility, long-term health condition, or low income. In general, a malnourished person encounters difficulty while performing normal activities, e.g., growing, resisting disease, diminution in learning abilities, physical work etc. In case of women, pregnancy becomes risky and they cannot be sure of producing nourishing breast milk. Even people may get malnourished despite eating enough on account of not getting the proper amounts of micronutrients-vitamins and minerals from the food they eat. The most common symptoms of under-nutrition include unintentional weight loss, weak muscles, tiredness, increase in illness whereas the main sign of over-nutrition is being overweight or obese. Signs of child malnutrition include failure to grow at the expected rate and changes in behavior, such as appearing unusually irritable, sluggish or anxious. Nearly half of all deaths in children under 5 are attributable to under-nutrition.

In this study, Anthropometric method has been employed to measure nutritional status. Growth faltering in children may be assessed by measuring height and weight and screening for clinical manifestations and biochemical markers. Three widely used indicators based on weight, height and age have been followed in this study to assess the nutritional status of a population, namely stunting (inadequate height comparing to age) which captures early chronic exposure to under-nutrition; wasting (inadequate weight as per height) which captures acute under-nutrition; underweight (inadequate weight according to age) is a composite indicator comprising elements of stunting and wasting.

The conceptual framework of UNICEF (1990) defined nutrition and captured the multi-factorial causality of under-nutrition (Fig. 1). Three underlying factors have substantial influence on nutritional status, namely food, care and health. Children having access to nutrient-rich food; sufficient maternal and child-care practices; a healthy environment including safe water, sanitation and good hygiene practices result in optimal nutritional status. A lethal cycle of exacerbating sickness and deteriorating nutritional status is developed owing to the reciprocal action between under-nutrition and infection. The aforementioned three factors are affected by social, economic and political factors. The combination and relative importance of these factors differ from country to country.

Smith and Haddad (2000) utilized the experience of 63 developing countries over the 25 years period to identify the determinants of child malnutrition for each developing region. They explored six factors and female

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education was found to be the most important amid those. They reported that ameliorations in female secondary school enrolment rates were accountable for 43% of the total reduction in the child underweight rate of developing countries during the period of 1970-1995. Islam *et al.* (1994) conducted a case-control study on 250 children aged less than 36 months in Bangladesh and found that maternal education was significantly associated with severe malnutrition. Thang and Popkin (2003) examined the factors other than income whose might have substantial effect on the inability of reducing child malnutrition rapidly. They also identified the socioeconomic factors that explain the high rates of stunting and underweight status of many Vietnamese children. They used the data extracting from the 1997-98 Vietnam Living Standards Survey (VLSS) and performed Multivariate logit regression analysis for analyzing the data. de Onis *et al.* (2004) specified that global stunting and underweight prevalence declined from 34 to 27% and 27 to 22%, respectively during 1990-2000. They also stated that Eastern and South-eastern Asia were able to reduce the rate of child malnutrition to greater extent whereas South-central Asia continued to suffer from higher level of malnutrition. Substantial improvements were found in Latin America and Caribbean, whereas in Africa numbers of stunted and underweight children increased from 40 to 45 and 25 to 31 million, respectively. In accordance with their study, linear mixed-effect models performed reasonably well and made best use of all available information. An association was found between a longer birth interval and a lower nourish of malnutrition in some populations (Dewey and Cohen, 2007). The diminution in stunting associated with a previous birth interval greater than 36 months ranged from approximately 10 to 50% in the countries where the relationship was found significant. Rayhan and Khan (2006) explored that 45% of the children under age five in Bangladesh were suffering from chronic malnutrition, 10.5% were acutely malnourished and 48% had under-weight problem. As per their study, the main determinants for under five malnutrition were previous birth interval, size at birth, mother's body mass index at birth and parent's education. In another study conducted by Ricci and Becker (1996) in Philippines, it was disclosed that place of residence and child age are important risk factors for both stunting and wasting. They also reported that Low birth weight and short previous birth interval (<24 months) contributed most to stunting. Father's education, source of water, toilet facilities, current breast feeding status and health status were identified as important risk factors for malnutrition in that study. Binary and Multivariate Logistic regression are widely used in malnutrition related studies (For instance, Mashal *et al.*, 2008; Mueller, 2003). Ojiako (2009) employed Tobit model to find out the determinants of malnutrition among preschool children in Nigeria.

Bangladesh is the most densely populated country in the world, with 156.6 million people living in a land area. It has achieved remarkable progress in the areas of poverty alleviation, primary school enrollment, gender parity in primary and secondary level education, immunization coverage and incidence of communicable diseases. In spite of poverty, low expenditure on health care and a fragile health system, a forty percent reduction in maternal mortality between 2001 and 2010 and a twenty six percent reduction in under 5 child mortality between 2004 and 2010 have paved the way for Bangladesh to achieve the Millennium Development Goals (MDG, 2013). In Bangladesh low dietary diversity with 70 percent of the diet comprising cereals and deficient protein and micronutrient intake make under-nutrition aggravated (HIES, 2010). Poor sanitation and hygiene and gender inequality in decision making related to household production and consumption also contribute to under-nutrition in children. Sixteen percent of children under 5 and a quarter of women of reproductive age are found acutely malnourished and undernourished, respectively (BDHS, 2011). Chronic under-nutrition is found to be more prevalent in rural areas and urban slums, with the highest rates in Barisal and Sylhet.

Analytical work on tracking changes in child malnutrition status in Bangladesh is scanty. In this study, we have used data of three consecutive Bangladesh Demographic and Health Surveys (BDHS) namely, BDHS (2004, 2007, 2011). The major objectives of this study are to trace the changes in child malnutrition status over the past decade and identify the key determinants of child malnutrition in Bangladesh using logistic regression model. SPSS (version 16) was used for analyzing the data.

This paper is organized in the following manner. Section 2 describes the data source and provides a brief description about data and variables used in this study. Section 3 elaborates the methods employed in finding the existence of significant association between categories of malnutrition and selected risk factors and exploring the key determinants of child malnutrition. Section 4 contains results and discussions. The concluding remarks have been provided in section 5.

Data: The data used in this study were extracted from the 2004, 2007 and 2011 Bangladesh Demographic and Health Survey (BDHS) which were conducted under the authority of the National Institute for Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare of the Government of Bangladesh. The survey collected detailed information on demographic and socioeconomic characteristics of the household population including age, sex, residence, educational attainment, employment status, asset ownership, housing characteristics, nutritional status and access to basic services. BDHS (2004) is a
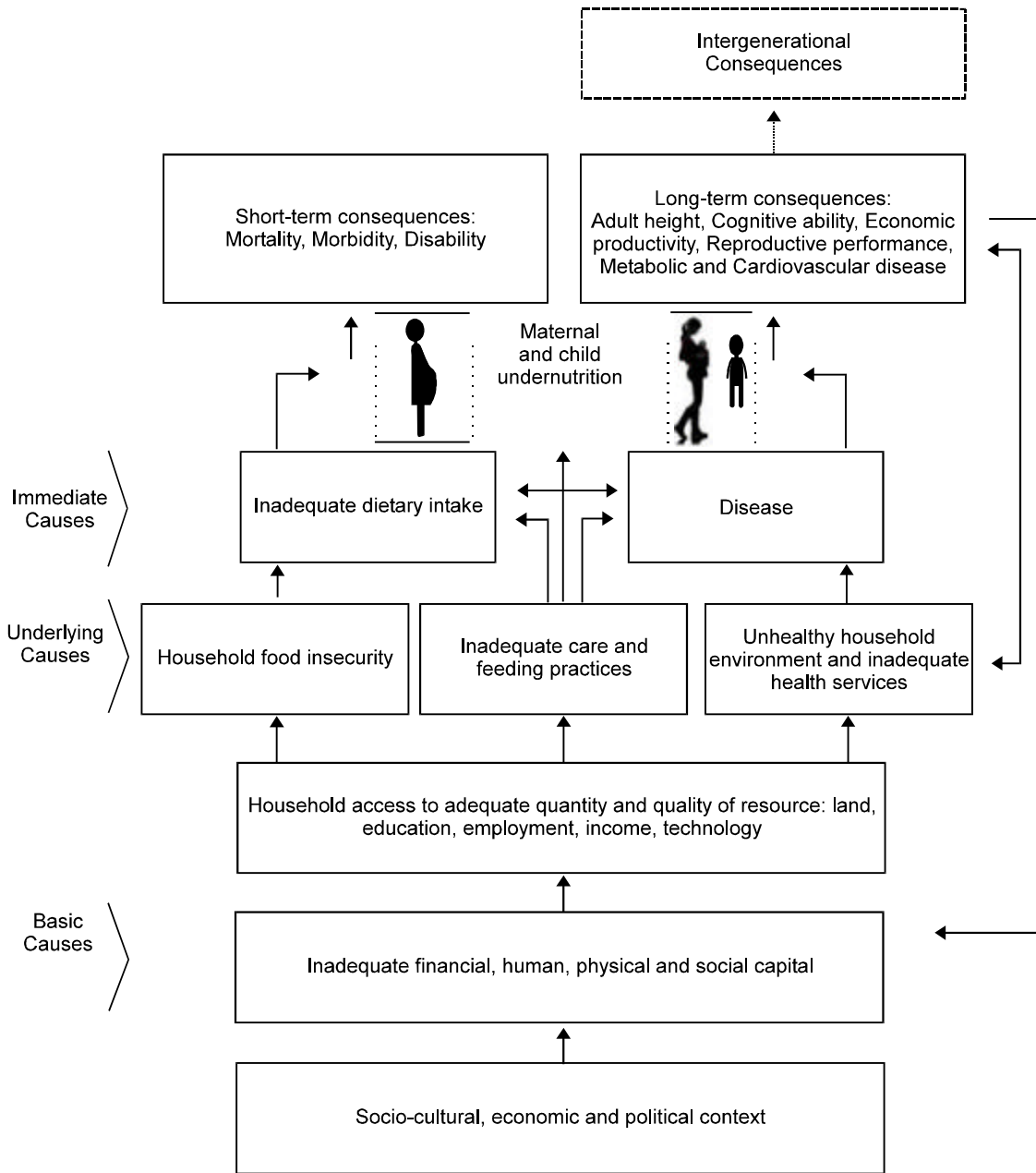
Fig. 1: Conceptual framework for the determinants of child under-nutrition (Source: UNICEF, 1990)

nationally representative survey of 11,440 women aged 10-49 and 4,297 men aged 15-54 from 10,500 households covering 361 sample points (clusters) throughout Bangladesh. BDHS (2007) is a nationally representative survey comprising 10,996 women aged 15-49 and 3,771 men aged 15-54 from 10,400 households covering 361 sample points (clusters) throughout Bangladesh. In BDHS 2011, total 17,141 households were surveyed including 17,842 ever married women aged 12-49 and 3,997 ever married

men whose ages are above 15. The response rate in BDHS (2011) was similar to BDHS (2007).

The surveys undertook a two-stage stratified sample (except BDHS (2004) which utilized a multistage cluster sample) using the sampling frame from the adjacent population census. Stratification of the sample was achieved by separating the sample into divisions and, within divisions, into urban and rural areas. At the first stage of sampling, primary sampling units (clusters) were selected and among these selected clusters,

some clusters were allocated to urban areas and some were allocated to rural areas. A household listing operation was carried out in all selected primary sampling units (PSU) which was used as the sampling frame for the selection of households in the second stage of sampling. On an average, 30 households were selected from each PSU, using an equal probability systematic sampling technique.

MATERIALS AND METHODS

This study deemed the U.S. National Center for Health Statistics (NCHS) standard for the classification of malnutrition owing to its widely acceptance and recommendation of the World Health Organization (WHO, 1986). For reporting of height-for-age, weight-for-height and weight-for-age relative to the NCHS reference, Z-scores (standard deviation, i.e., SD scores) are commonly used. Children are classified as stunted (chronic malnourished), wasted (acute malnourished) and under weighted (stunted, wasted, or both) if the height-for-age Z-score (HAZ), weight-for-height Z-score (WHZ), weight-for-age Z-score (WAZ) are below minus two standard deviations (-2 SD) from the median of the reference population. We considered some predictor variables which are specific to child, some are specific to mother and some are specific to household characteristics with a view to identifying the probable factors affecting child malnutrition. Sex of the child, child age and birth order are specific to the child; mother's age, education and working status are specific to mother; place of residence, division, religion, media exposure, poverty and toilet facility are specific to household characteristics. All these predictor variables are recorded differently for analysis purpose.

Bivariate analysis was employed to determine the differentials of child malnutrition by predictor variables. One of the objectives of this paper is to use the survey data to look at structural determinants of child malnutrition related to some specific characteristics of child, mother and households. Pearson's chi-square test of independence was performed to test the existence of significant association between categories of malnutrition and selected predictor variables. The significant variables (p-value <0.05) observed in chi-square test were subsequently included in binary logistic regression model. Binary logistic regression model is algebraically simple, computationally straightforward and efficient with acceptable degree of precision for a binary dependent variable.

In logistic regression model, a dichotomous variable referring to malnutrition status (Wasting, Stunting and Underweight) was introduced to determine whether the child is affected by malnutrition or not. The following model was used:

$$\text{Logit } (P_i) = \log \left(\frac{P_i}{1-P_i}\right) = \sum_i \beta_i x_i$$

where:

$$P_i = P\,(Y_i = 1|X_i) = \frac{\exp(\sum_i \beta_i x_i)}{1+\exp(\sum_i \beta_i x_i)}$$

= Probability that the ith child is suffering from malnutrition

Y_i = 1, if the child is affected by malnutrition

$\quad$ = 0, otherwise

X_i = i^{th} predictor variable and

β_i = i^{th} parameter associated with X_i

This study deemed three different models. The first, second and third model assumed stunting (<-2 SD), wasting (<-2 SD) and underweight (<-2 SD) as response variable, respectively. In each case, the response was coded as "1" if the child was stunted or wasted or under weighted; otherwise it was "0".

RESULTS AND DISCUSSION

Table 1 presents the results showing the statuses of different categories of malnutrition according to predictor variables in last three consecutive BDHSs, i.e., 2004, 2007 and 2011. According to the last three surveys, on an average the incidence of wasted children was consistently around 16 percent, more than 44 percent children under age 5 were stunted and around 40 percent children were under weighted. The ameliorations with respect to stunted and under weighted child were ostensible. A monotonic decreasing trend was found in most of the cases (predictor variables) in the context of aforementioned two categories of malnutrition. On the other hand, the situation fluctuated for wasted child during the given period. Table 1 also reveals that boy child suffered much from malnutrition than girl child. Malnutrition was found higher for older and higher birth ordered children. Table 1 also reports that the children whose mother was younger, better educated and didn't work outside were better nourished (except mother's age in wasted category). Malnutrition in rural areas was found higher than that of urban areas. In case of division, Khulna recovered the situation of malnutrition rapidly compared to other divisions. Malnutrition was higher for the household which is poor, unexposed to media or does not have toilet facility. These observations are born out irrespective of the measure of malnutrition and are consistent with the findings in the literature. Muslim people were mostly affected by malnutrition in comparison with Non-Muslim people.

Figure 2 shows trends in different categories of malnutrition over the last decade in Bangladesh. Wasted child were increased by 4%, stunted and under weighted child were decreased by 17.7 and 13.8%, respectively from BDHS (2004-2011). The figure also divulges that most of the children were suffering from stunting and underweight. A monotonic decreasing trend was noticed in both stunting and underweight cases throughout the

Table 1: Characteristics-wise child malnutrition status in Bangladesh (%)

Characteristics		Wasted			Stunted			Under-weighted		
		2004	2007	2011	2004	2007	2011	2004	2007	2011
Sex of child	Male	16	18	16	50	43	40	42	39	34
	Female	14	16	15	49	41	41	42	41	38
Child's age	< = 2 years	19	21	15	40	31	35	38	33	28
	2-5 years	13	15	16	57	50	44	45	45	41
Birth order	1	15	16	15	46	38	37	39	37	32
	2	14	17	15	45	38	39	38	38	34
	3 or more	16	18	17	54	48	46	47	44	42
Mothers age	15-24	15	18	16	48	41	41	40	40	35
	25-34	15	17	15	50	42	40	43	39	36
	35-49	13	16	17	59	48	43	47	45	43
Mother's education	No education	18	20	18	59	52	53	51	49	49
	Primary	15	19	18	53	48	47	43	46	42
	Secondary (+)	12	14	13	37	31	33	30	30	28
Working status	No	15	17	16	49	41	41	42	39	36
	Yes	17	19	16	52	46	42	44	43	36
Residence	Urban	14	15	14	44	36	35	37	34	29
	Rural	16	18	16	52	46	43	44	44	39
Division	Barisal	10	18	15	55	46	42	41	44	38
	Chittagong	16	17	16	52	44	41	46	41	37
	Dhaka	14	15	16	51	43	43	41	39	36
	Khulna	17	18	14	41	33	33	36	32	29
	Rajshahi	17	18	17	46	39	33	41	41	32
	Sylhet	15	18	18	53	45	47	45	43	44
	Rangpur	-	-	13	-	-	42	-	-	34
Religion	Non-Muslim	15	21	13	44	41	36	40	41	31
	Muslim	15	17	16	50	42	41	42	40	37
Media	Unexposed	17	18	18	59	49	50	51	46	46
	Exposed	14	17	14	45	38	36	38	36	30
Poverty	Poor	18	19	17	60	52	51	53	49	47
	Non-poor	13	16	15	43	35	33	34	34	28
Toilet facility	No	18	21	18	61	55	54	56	51	50
	Pit latrine	15	18	16	51	45	42	42	43	37
	Flush latrine	11	13	13	30	33	29	24	28	24
Total		15.1	17.3	15.7	49.7	42.1	40.9	41.9	40.1	36.1

Table 2: Results of pearson's chi-square test of independence

Characteristics	Wasting			Stunting			Underweight		
	2004	2007	2011	2004	2007	2011	2004	2007	2011
Sex of child	**0.01**	**0.03**	0.22	0.18	0.31	0.51	**0.03**	0.10	**0.00**
Child's age	**0.00**	**0.00**	0.15	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Birth order	0.07	0.14	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Mothers age	0.27	0.55	0.65	**0.00**	**0.00**	0.34	**0.01**	0.05	**0.00**
Mother's education	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Working status	0.63	0.07	0.97	0.86	**0.00**	0.47	0.12	**0.01**	0.81
Place of residence	0.12	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Division	**0.00**	0.22	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Religion	0.84	**0.03**	**0.02**	**0.01**	0.63	**0.00**	0.29	0.80	**0.00**
Media exposure	**0.01**	0.27	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Poverty	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Toilet facility	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

observed period. On the other hand, the percentage of wasted child was not very high (around 16%). No strict monotonic (increasing or decreasing) trend was detected.

Table 2 shows the p-values resulted from Chi-square test. This was done to identify whether the factors are significantly associated with malnutrition status. The significant factors at 5% level of significance are denoted boldly in the Table. Results given in Table 2 reveal that mother's education, poverty status and toilet facility of household had statistical association with wasting in three surveys. On the contrary, mother's age and working status were found having no association with being wasted. Albeit there was significant association between wasting and sex or age of child as per BDHS (2004, 2007) but the association was missing according

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Table 3: Results of binary logistic regression analysis for different categories of malnutrition

Characteristics	Wasting (odds ratio)			Stunting (odds ratio)			Underweight (odds ratio)		
	2004	2007	2011	2004	2007	2011	2004	2007	2011
Sex of child									
Female	1.221	1.13					0.945		0.868**
Child's age									
< = 2 years	1.67**	1.60**		0.497**	0.425**	0.739**	0.741**	0.636**	0.565**
Birth order									
1			1.06	0.981	0.833	1.05	0.986	1.04	0.8412
2			1.08	0.815**	0.782**	1.004	0.829*	0.986	0.897
Mother's age									
15-24				1.02	1.24		1.09		1.22
25-34				0.858	0.977		1		1.01
Mother's education									
No education	1.35**	1.33**	1.22	1.64**	1.57**	1.43**	1.61**	1.63**	1.45**
Primary	1.24*	1.24*	1.25**	1.50**	1.58**	1.33**	1.40**	1.58**	1.35**
Working status									
No					0.983			0.933	
Residence									
Urban		0.938	1.02	1.02	0.931	1.02	1.07	0.912	0.977
Division									
Barisal	0.713*		0.758*	1.08	1.1	0.788*	0.826	1.09	0.801*
Chittagong	1.14		0.839	1.02	1.25	0.863	1.06	1.14	0.831*
Dhaka	0.976		0.88	0.872	1.11	0.903	0.822*	0.978	0.780**
Khulna	1.3		0.792	0.675	0.784	0.656**	0.722**	0.761*	0.616**
Rajshahi	1.24		0.931	0.67	0.952	0.523**	0.745**	1.02	0.648**
Rangpur	-		0.687**	-	-	0.756**	-	-	0.609**
Religion									
Non-Muslim		1.33*	0.776*	0.86		0.779**			0.785**
Media									
Unexposed	1.06		1.17	1.19**	1.03	1.20**	1.16*	0.964	1.22**
Poverty									
Poor	1.29**	1.04	1.03	1.39**	1.31**	1.59**	1.55**	1.24**	1.60**
Toilet facility									
No facility	1.15	1.59**	1.23	2.15**	1.72**	1.58**	2.15**	1.83**	1.57**
Pit latrine	1.17	1.37**	1.18	1.70**	1.37**	1.33**	1.58*	1.58**	1.34**

Category which is not displayed in this table is considered reference category. *Significant at 5% level of significance. **Significant at 1% level of significance
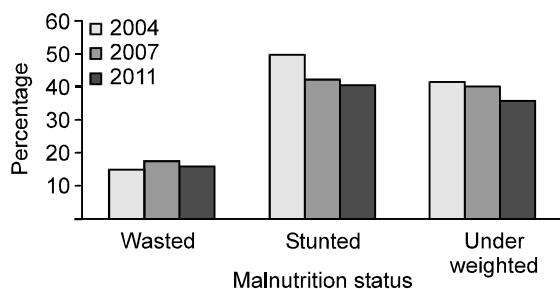

Fig. 2: Indicator-wise malnutrition status in BDHS (2004, 2007, 2011)

to BDHS (2011). There was significant association found between birth orders and wasting in only BDHS (2011). Sex of child didn't have significant association with stunting in any of three surveys. On the other hand, child's age, birth order, mother's education, place of residence, division, media exposure, poverty status and toilet facility of household had significant association with stunting throughout all the surveys considered. Age and birth order of child, mother's education, place of residence, division, media exposure, economical status and toilet facility had significant association with underweight.

The BDHS data were analyzed to identify the determinants of each category of malnutrition in Bangladesh by performing binary logit regression model using the maximum likelihood method (Table 3). Three models were estimated separately for wasted, stunted and underweight categories of malnutrition. Merely those predictor variables were considered in the modeling which had significant association with the response variable, i.e., any category of malnutrition. In the case of child specific variables, odds ratios (OR) were found significant for sex of the child in the context of wasting and underweight in BDHS (2004, 2011), respectively. The probability of female child being wasted increased (22%) in 2004 and being under weighted decreased (13.2%) in 2011 compared to male child. All the ORs for the variable child age were found significant. It was found that a child with age less equal to 2 years was more likely to be wasted (67% in 2004 and 60% in 2007) in comparison with a child aged 2 to 5 years old. Since the values of OR are less than 1 in rest of the situations, the probability of being stunted or under weighted for a

child aged less equal to 2 years was less likely compared to a child aged 2 to 5 years. In accordance with significant OR values, a child who is second in birth order had lower risk of being stunted or under weighted than a child ranked third or above according to birth order.

The results reported in Table 3 also disclose that mother's age and working status had no effect on malnutrition since the values of OR were not found significant. Mother's education had significant impact on malnutrition status. The probability of malnutrition increases with the decrease in level of mother's education. It was discerned that the child belonging to poor family or having no toilet facility is likely to suffer more from malnutrition compared to the child belonging to non-poor family and getting better toilet facility. As per BDHS (2004), a child who is unexposed to media had 1.19 and 1.16 times higher risk of being stunted and under weighted, respectively compared to a child who is exposed to media. The probabilities were higher in the aforementioned ground in BDHS (2011) (0.2 and 0.22). On the other hand, place of residence didn't have significant effect on any category of malnutrition. Non-Muslim child had lower risk of being malnourished as compared to Muslim child as per data analysis of BDHS 2011. Finally, the significant OR values imply that all the division has lower risk of malnutrition compared to Sylhet division.

Conclusions: The Government of Bangladesh has laid out multifarious nutrition strategies, plans and policies over the last decade taking the gravity of malnutrition and its long-term effects into account. Acknowledging that investing in nutrition is a key way to advance global welfare, the government has set up several development programs to reduce the prevalence of malnutrition. Paying heed to the first 1,000 days (the period from pregnancy to a child's second birthday), the government intends to ensure universal access to nutrition services, strengthen human resource capacity and nutrition information systems. The rate of malnutrition reduction is very slow in Bangladesh till date which is retarding other areas of human development and reduction of child mortality. In accordance with our study, child's age and mother's education play vital role in child malnutrition. Hence, necessary measures should be adopted for looking after child of different ages properly and ameliorating female education and making them more conscious of child malnutrition. The government should also take steps to make the mother more exposed to media and supply nutritious food to poor households. Toilet facility may be improved by providing sanitary latrine to each household who doesn't have. Reduction of severe malnutrition should be the first priority of direct nutrition intervention policy and feeding programs like food for work (FFW). The right start in life is a healthy start and that is the only start from which children can realize their promise and potential.

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