Science Journal of Public Health
2016; 4(1-1): 16-27
Published online October 27, 2015 (http://www.sciencepublishinggroup.com/j/sjph)
doi: 10.11648/j.sjph.s.2016040101.14
ISSN: 2328-7942 (Print); ISSN: 2328-7950 (Online)

Significant Risk Factors for Childhood Malnutrition: Evidence from an Asian Developing Country

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To cite this article:
Azizur Rahman. Significant Risk Factors for Childhood Malnutrition: Evidence from an Asian Developing Country. *Science Journal of Public Health*. Special Issue: Childhood Malnutrition in Developing Countries. Vol. 4, No. 1-1, 2016, pp. 16-27.
doi: 10.11648/j.sjph.s.2016040101.14

Abstract: Protein Energy Malnutrition (PEM) is a major health problem in developing countries and it affects the physical growth and logical development of children. Data from the Demographic and Health Survey Bangladesh were used to evaluate the influences of several significant socioeconomic, demographic, health system and community factors on the current status of malnutrition among 5333 under-5 years children. Results reveal that older age, smaller birth size and maternal poor nutritional status were most significant factors for high prevalence of malnutrition which was assessed using three standard anthropometric indicators, such as underweight, stunting and wasting each of two kinds severe and moderate, following the WHO guidelines and cut-off points. The variables that were associated with severe as well as moderate underweight and stunting were father's poor education, household lower economic condition and division of residence. Mother's poor education and increased age of household head were associated with severe underweight and stunting. Low media exposure and respiratory sickness had significant effects on severe as well as moderate underweight and wasting. Some factors such as fathers occupation, number of under-5 children, place of delivery, feeding practice of liquids and feeding practice of solid foods were significantly associated with severe underweight, among these factors some had significant effect on severe stunting, or moderate stunting or both, and also significant effect on severe wasting or moderate wasting or both. In addition, measles vaccine had strong positive effect on child nutritional status but higher level of months of breastfeeding had negative effect. The overall underweight stunting and wasting were observed in 47.1%, 44% and 10.4% (respectively among them 12.8%, 17.9% and1.1% were severely underweight, stunting and wasting) of the children respectively. A vast majority of Bangladeshi children (56.5%) were suffered some degree of PEM. Appropriate intervention programs should be formulated to improve socioeconomic and maternal conditions collaborated with vaccination and childcare to reduce the overall malnutrition.

Keywords: Childhood Malnutrition, Significant Variables, Stunting, Underweight, Wasting

1. Introduction

Ending malnutrition by 2020: an agenda for change in the millennium.[1] Each year about 13 million infants and children under-5 years of age die in developing countries and most of these deaths can be related to malnutrition.[2] Malnutrition is the biggest single contributor to child mortality in the developing countries.[3-4] Currently, over three-fourths (79%) of the world's malnourished children live in South East-Asia (SEA) region and it is now recognized that about 50 percent of child deaths in developing countries are related to malnutrition's potentiating effects and 83 percent of these deaths are attributable to mild to moderate malnutrition.[5] Increased morbidity among children living in poverty is strongly linked to malnutrition and an inadequate diet.[6] Chronic protein-energy malnutrition leads to stunted growth and increased morbidity and mortality among children in the developing world[7&8], and childhood malnutrition also decreases the survival chances of adults later in life[9] and Psychological and intellectual development[7&10]. In developing countries, the most important socio-economic constrains in achieving proper nutrition is poverty[11-13]. Malnutrition, as elsewhere in developing world, results from convergence of 'poverty', household food insecurity, ignorance, population pressure, lack of health service facilities compounded with cultural taboos and natural and manmade disasters. The major etiological factors contributing to protein calorie malnutrition in different countries of South–East Asia are similar and may be considered to fall under the following

heads: 1) Lack of calories and protein rich food for the feeding of infants and children due to socio-economic and agronomical factors. 2) Faulty-feeding habits arising from ignorance prejudices and superstitions. 3) Poor environmental condition leading to superimposition of additional stress in the natures of infections and infestations. There are few studies on the prevalence of different levels of malnutrition and the risk factors in abroad & Bangladesh[14-25] but no study has been made to measure the relative risk for malnutrition severe and moderate rather than normal.

Bangladesh is one of the poorest - developing countries in the world, more than three-fifths of its population living below the poverty line, per capita energy supply 2060 kcal/day (1994-96) and per capita total protein supply 43 g/day (1990-92) shows critical indices and remark household food insecurity. Bangladesh may be the only country in the world where people tends to be shorter due to malnutrition. According to UNICEF report the situation of infant, children and maternal malnutrition in Bangladesh is among the worst in the world[26]. About 50% children are born with low birth-weight (<2500 grams) [1,7&27-29], 54% of children under-5 years are severely or moderately malnourished and it is the major cause of morbidity and mortality in children. These and other problems of malnutrition adversely affect physical growth, mental capacity, learning ability, and productivity. The government of Bangladesh, UNICEF, and the World Bank are therefore collaborating to launch a major project designed to improve nutrition in Bangladesh. The aim of the research was to measure the current status of malnutrition and to investigate the effects of some socio-economic, demographic, health system and community factors on nutritional status among children aged 0-59 months in Bangladesh.

2. Materials and Methods

The data utilized for the present study were picked out from the Bangladesh Demographic and Health Survey (BDHS), a nationally representative survey collected information during the period early November 1999 to mid March 2000 as part of the worldwide Demographic and Health Surveys program, which is designed to collect data on fertility, family planning, infant and child mortality, maternal and child health, and knowledge of AIDS. A two-stage probability sample of 10,544 ever-married women age 10-49 years was interviewed and provides a complete birth history for all live births. More in-depth information, such as detailed information on breast-feeding practices, immunization practices are available for each live birth occurred during a 5-year period before the interview date. For anthropometric data all living children born since April 1994 and their mothers were eligible for height and weight measurement. From 6430 eligible children under-5 years 84 percent were weighed and measured and anthropometric measures of children aged 0-59 months at the time of the survey are also provided. Anthropometric measures provide a good indication of the nutritional status of very young children and the resources available to them[30]. A total sample of 5333 children was recruited for this study. Details of the survey methodology and sample as well as the principal findings have been published in a report[31].

For the analysis using anthropometric method, three standard indices of physical growth that describe the nutritional status of children are considered, which are Weight-for-age (underweight), Height-for-age (stunting) and Weight-for-height (wasting). Each of these indices is expressed in terms of the number of standard deviation (SD) units (Z-score) from the median of the NCHS/WHO international reference population and provides somewhat different information about the nutritional status of children. A drop in weight-for-height (wasting) therefore reflects an acute problem; that is, one that occurred recently. A drop in height-for-age (stunting) signals a chronic problem, one that has persisted for several months, but is not necessarily present when the measurement is taken. A decline in weight-for-age (underweight) may be connected with one or the other or both of the above-mentioned explanations, since it expresses an overall situation. Both the 1977 and 1986 reports of WHO working group on measuring nutritional status of children, recommended the use of Z-scores [32&33] and it has some important advantages than other measures.

According to the WHO recommendation, the prevalence of malnutrition be calculated either on the basis of the proportion of individuals in the observed population whose index is below minus 2 standard deviation of the index for the reference population[7&34]. Also the total prevalence of malnutrition can be classified as severe and moderate if children with Z-scores below minus 3 standard deviations (-3 SD) and children with Z-scores between minus 3 standard deviations (-3 SD) to below minus 2 standard deviation (-2 SD) from the median of the NCHS reference population respectively[12&35]. Thus, for the analytic purposes, this study used the cut-off points recommended by WHO for defining malnutrition with categories, and the general approach adopted in the analysis is to differentiate among (between) children who were relatively well-nourished (i.e. Z-scores >= -2SD) [*reference category in the multivariate analysis*], those who were moderately malnourished (-3SD <= Z-scores < -2SD) and those who were severely malnourished (i.e. Z-scores < -3SD) on the basis of the socio-economic, demographic, health system and community factors considered.

Logistic regression is most frequently used to predict the relationship between a dichotomous outcome variable and a set of covariates but with a few modifications it may also be used when the outcome variable is polytomous[36]. Since each of our dependent variables has three categories then polytomous logistic regression model is used in this study for estimating regression parameters in multivariate analysis.

For this study some new variables were created by combining information of the other variables with original codes. Household economic status was measured by the computational procedure "The presence of each item puccua housing, hygienic toilet, TV, radio, bicycle, motorcycle and electricity in the household score 1 is assigned otherwise 0. Thus the highest of the total of possible score is 7 and lowest is

0; that is, the range of the total score is 0 to 7. According to the total scores range 0-2, 3-4 and 5-7 we classified the household poor class, middle class and rich class respectively". Respondent were asked in the BDHS 1999-2000 whether they usually read a newspaper, listen to radio, or watch television at least once a week. Using this information exposure to mass media variable is indirectly computed and categorized as- no mass media, one of the three media and at least two Medias. In our study two levels of father's occupation are considered. Father's with 'profession, tech. & manager' 'agric-self employed' and skilled manual are considered as "skilled worker" and 'agric-employee', 'skilled manual' are considered as "unskilled worker".

Respiratory sickness computed indirectly from the information whether the child had fever in last two weeks and had cough in last two weeks preceding the survey and categorized as- no sickness, moderate sickness (fever or cough in last two weeks) and severe sickness (both fever and cough in the last two weeks).

In BDHS 1999-2000 respondent were asked whether they usually gave their child, "banana, papaya, mango", "dal", "green leafy vegetables", "eggs, fish, poultry" and "other solid, semi-solid food". Feeding practices of solid foods variable computed indirectly from these information and classified as- at last three of the five items, one to two of the five items and no. As like as this variable 'Feeding practices of liquids' variable computed indirectly from the information whether, gave child "plain water", "sugar water", "fresh milk" and "other liquid" and categorized as- one of the four liquids, at least two of the four liquids and no.

Other independent variables studied in this paper were available from the original information of BDHS with actual categorizes or as usual categorizes. The variables that were significant in the bivariate analysis were considered for multivariate analysis. Statistical analysis was done by a well-known statistical software package 'SPSS for WINDOWS'.

3. Results

Characteristics of the study children are summarized in Table 1. Socioeconomic profile of the study population shows that standards of living in Bangladesh are relatively low. Nearly three-fourth (3628; 69% children) lived in poor economic class.

Table 1. *Socio-economic, demographic, health system and community characteristics of studied children aged 0-59 months and their percentage distribution by severe and moderate underweight, stunting and wasting in Bangladesh.*

Characteristic with categories	No. of children♠	Underweight (U)		Stunting (S)		Wasting (W)	
		Severe	Moderate	Severe	Moderate	Severe	Moderate
Socio-economic							
Mother's educational level: A****							
No education	2384	17.5	37.8	23.8	28.8	1.4	10.7
Primary	1547	12.5	36.3	18.4	27.5	1.1	9.0
Secondary to higher‡	1402	5.1	26.1	7.2	20.0	0.5	7.3
Father's educational level: A****							
No education	2238	17.0	38.7	22.9	29.2	1.4	11.0
Incomplete primary	813	14.8	38.0	24.0	26.8	0.6	8.0
Primary to incomplete secondary	1365	10.2	32.8	13.6	26.7	1.1	9.3
Secondary to higher‡	908	4.3	22.4	6.4	16.6	0.7	6.2
Father's occupation: A****							
Skilled worker	3575	10.5	32.2	15.6	24.5	1.0	8.1
Unskilled worker‡	1728	17.6	38.5	22.6	29.3	1.3	11.7
Household economic Status: A****							
Poor class	3628	15.7	37.5	21.6	28.6	1.2	10.6
Middle class	1039	8.3	31.4	12.5	23.9	0.9	6.8
Rich class‡	572	3.1	19.9	4.5	15.0	0.4	5.6
Exposure to mass media: A****							
No mass media	2822	16.2	37.5	21.9	29.3	1.2	10.7
One of the three media	1456	11.1	34.4	16.9	23.8	1.3	8.3
At least two medias‡	1025	5.7	25.6	8.4	20.7	0.4	6.7
No. of children under-5 yrs: U&S****;W,p<0.14							
One	2667	11.4	34.0	14.4	25.5	1.3	9.3
More than one‡	2666	14.2	34.7	21.3	26.8	0.8	9.3
Place of delivery: A****							
Respondents home	3503	15.0	35.1	20.5	26.8	1.1	10.3
Other home	1264	10.9	37.2	15.8	28.9	1.1	8.2
Hospital‡	561	3.6	22.8	6.1	15.7	0.7	5.5
Demographic							
Age of child in months: A****							
35 – 59 months	2147	12.0	37.9	22.6	27.9	0.7	7.7

Characteristic with categories	No. of children[♠]	Underweight (U)		Stunting (S)		Wasting (W)	
		Severe	Moderate	Severe	Moderate	Severe	Moderate
22 – 34 months	1138	16.9	39.7	20.5	30.8	0.9	9.9
12 – 21 months	966	18.3	40.1	18.4	31.0	2.7	17.5
0 – 11 months‡	1082	5.1	16.4	5.3	13.5	0.5	4.3
Birth order: U,p<0.017; S****; W,p<0.082							
First birth	1512	10.7	35.4	14.4	27.8	1.1	7.9
2nd to higher‡	3821	13.6	33.9	19.3	25.5	1.1	9.8
Months of breastfeeding: A****							
25+ months	1724	14.3	39.7	20.8	29.5	0.7	8.7
7– 24 months	2721	14.7	37.9	19.5	28.3	1.5	11.4
0 – 6 months‡	870	3.8	12.2	6.9	12.8	0.5	3.8
Size of child at birth: A****							
Larger than average	851	8.8	25.3	12.1	22.0	0.5	7.1
Average	3469	10.9	35.2	16.9	26.5	0.9	8.7
Smaller than average‡	1004	22.6	39.1	26.3	28.4	2.2	13.3
Mother's body mass index: A****							
Low (<=18.50kg/m^2)	2249	18.4	40.1	22.1	28.1	1.7	12.2
Desirable (18.51-20.50 kg/m^2)	1637	10.7	34.6	18.0	28.2	0.9	7.5
Obese (>20.50 kg/m^2)‡	1416	6.1	24.8	10.9	20.3	0.3	6.9
Mother's height: A****							
<= 145 cm	865	21.2	40.7	31.0	32.0	0.7	12.7
> 145 cm‡	4455	11.2	33.1	15.3	25.0	1.1	8.6
Age of household head: U****; S**; W***							
> 35 years	2991	12.6	32.2	18.5	24.8	1.1	8.2
26 – 35 years	2029	12.3	36.9	16.5	27.7	0.9	10.8
<= 25 years‡	313	17.3	37.7	20.4	28.1	2.2	9.3
Health-system							
Measles vaccine: U&S****; W*							
No	2006	12.9	29.7	17.4	22.3	1.3	8.4
Yes‡	3325	12.8	37.1	18.2	28.5	0.9	9.8
Respiratory sickness (RS): U&W****; S,p<0.12							
No RS	2578	11.6	33.3	17.6	26.5	0.8	7.4
Moderate RS	1111	11.7	31.8	17.6	23.5	1.0	8.3
Severe RS‡	1636	15.4	37.7	18.5	27.4	1.6	13.0
Feeding practice of liquids: A****							
One of the four liquids	3073	15.2	38.2	21.5	28.9	1.3	10.4
At least two of them	1789	10.9	33.1	15.0	24.1	0.8	8.2
No‡	424	4.2	11.1	4.7	14.6	0.9	5.4
Feeding practice of solid foods: U&S****; W*							
At least three of the five items	1337	11.4	35.5	17.1	27.2	1.0	8.5
One to two of the five items	2784	14.6	37.9	21.2	28.5	1.1	10.4
No‡	1093	10.8	23.0	10.2	18.8	1.0	7.8
Community							
Division of residence: U&S****; W,p<0.32							
Barisal	470	16.0	33.6	21.9	23.4	2.3	10.4
Chittagong	1163	12.9	32.8	18.9	25.4	0.9	8.9
Dhaka	1283	11.1	35.2	17.5	26.7	1.0	8.6
Khulna	792	9.3	31.4	11.1	25.8	0.9	8.8
Rajashahi	941	12.8	35.1	16.7	24.5	1.1	9.7
Sylhet‡	684	17.5	38.0	23.5	31.0	0.7	10.4
Overall	5333	13.0	34.0	18.0	26.0	1.0	9.0

‡Reference category in the multivariate analysis
[A]For all indices
[U]For underweight (Weight-for-age); [S]For stunting (Height-for-age); [W]For wasting (Weight-for-height)
*p<0.10; **p<0.05; ***p<0.01; ****p<0.001, (based on Chi-square).

The poverty in education is striking: 2384(45%) mothers and 2238(42%) fathers had no formal education. More than fifty percent (2822) children mother did not exposed any mass medias Newspapers, Television or Radio and about ninety percent (4767) children delivered at home without medical facility among them 3507 children delivered at respondent

home. Half of the total children come from household having one under-5 children and also 3575 children father (68%) were occupation with "prof., tech., manager, agric-self employed and skilled manual" considered as skilled worker.

In demographic characteristic, only a few, 851 children (16%) birth size had larger than average that may be due to the maternal poor nutrition. Two thousand two hundred forty nine mothers (42.2%) had low BMI and most of the household head (2991; 56.1) were older than 35 years, more than one quarter (1512) children had first birth order and nearly three-fourth of the children were breastfed up to two years among them 870 children (16%) breastfed less than seven months. About one-fifths children (1082) were aged less than one year and the mean age of this sample was approximately 29 months.

Two thousand six children (38%) had not taken measles vaccine, 2747 children (52%) had suffered respiratory sickness (RS) among them 1636 (31%) had suffered severe RS (both cough & fever) and only 424 (8%) had not drunk any of the four liquids such as "plain water, sugar water, fresh milk or other liquid available in market. Nearly one quarter children (1283) were lived in the community of Dhaka division, also 470, 941 and 684 children (9%, 18% and 13%) were resided in Barisal, Rajashahi and Sylhet division respectively; these are relatively poor regions in Bangladesh (analysis are available from the author).

Table 1 also shows the percentage of severely and moderately underweight children, stunted children and wasted children according to the studied covariates (bivariate relationships between studied independent variables and the three dependent variables underweight, stunting and wasting in which each of the outcomes has three categories). Overall, approximately 13% of children under-5 years are observed severely underweight and more than one-third (34%) of children are moderately underweight i.e. the prevalence of underweight of children in Bangladesh is 47%, which is lower than the figure of 56% reported by Mitra et al. (1997) [34] in 1995-96. Results reveals that total prevalence of stunting is 44% among them slightly less than one fifth (18%) of children are observed severely stunted and also the prevalence of wasting of children in Bangladesh is 10% among them severely wasted has only one percent. These figure of total stinting and wasting are also lower than the figures of nearly 55% and 18% respectively reported by Mitra et al, (1997)[37] in 1995-96. This report is an agreement with the report represented by Bangladesh at World Summit for children, *UN General Assembly Special Session 2002*.

In the present study (Table 1) mothers education shows a very strong link to child nutritional status. The percentage of children with severe and moderate underweight, stunting and wasting decreases with increasing levels of mother's education, father's education, household economic status, mass media exposure, size of child at birth, mother's body mass index, mother's height and age of household head. Father's occupation indicates that severely as well as moderately underweight, stunted and wasted child growth is associated with unskilled worker families and more than one under-5 years children household have a higher percentage of children with severely and moderately underweight (14.2% and 34.7%) and stunted (21.3% and 26.8%) compared to household with only one under-5 years child. Children delivered in hospital under medical facility have fewer percentage of severely and moderately underweight stunted and wasted children relative to children births occurred at respondent home or other home. The percentage of severely stunted children increases with age and also the bivariate results indicate that the percentage of moderate stunting and severe as well as moderate underweight and wasting are highest among children aged 12-21 months, after this age group increasing age group represent decreasing percentage of malnutrition. Prevalence of underweight, stunting and wasting are higher among children with birth order 2+ compared to first birth order children. Percentage of severe and moderate wasting is highest among children breastfed 7-24 months and the percentage of underweight and stunting increases with months of breastfeeding.

In terms of health system characteristic, at the bivariate level, some factors are associated with the occurrences of malnutrition (Table 1) such as measles vaccine, feeding practice of liquids, feeding practice of solid foods etc. Total prevalence of underweight, stunting and wasting is higher to the children who received measles vaccine. The percentage of moderate underweight is lowest (31.8%) among children who have moderate respiratory sickness (had cough or fever) and the result point out that RS have a positive association with the prevalence of wasting. In addition, the percentage of severe and moderate underweight as well as stunting both are highest in Sylhet division (17.5% and 38.0%; 23.5% and 31.0%)and both the percentage of underweight and also the total percentage of stunting are lowest in Khulna division (9.3% and 31.4%; 36.9%) but percentage of moderate stunting (25.8%) in Khulna division is somewhat more than Barisal division (23.4%), Rajashahi division (24.5%) and Chittagong division (25.4%). Highest prevalence o f wasting is observed in Barisal division (12.7%) and it is lowest in Dhaka division (9.6%). In Barisal and Sylhet division, the percentage of moderate wasting is same (10.4%) that is highest and percentage of severe wasting is so much highest in Barisal division (2.3%) and lowest is Sylhet division (0.7%) i.e. differences by division show that, children in Sylhet division are somewhat more likely and those in Khulna division are somewhat less likely to be malnourished than children in other divisions is in agreement with the 1999-2000 BDHS report[38].

The results of multivariate analysis are presented in Table 2. The coefficients showed that mother's education had significant association with severe underweight and stunting only. Children with uneducated mothers (no formal education) were 1.7 times and 1.8 times more likely to be severely underweight and stunted than children with secondary to higher educated mothers. Primary education of mothers had no significant effect on child nutrition, except to severe stunting had 1.5 times higher risk relative to more highly educated mothers. Relative odds are calculated by taking the exponent of the coefficient ($e^{coefficient}$). Similar to mother's

education, father's education had no significant association with wasting. A significantly higher percentage of severely as well as moderately underweight and stunted children were observed among the children of low educated fathers group compared to the children of secondary to higher educated fathers group. In particular, children with incomplete primary educated fathers were respectively 1.7 times and 1.5 times, 2.1 times and 1.5 times more likely to be severely and moderately underweight, stunted than children with father's higher educational level.

Children living in household in which the father was a skilled worker were 1.4 times (26%) and 1.3 times (23%) less likely to be severely underweight and moderately wasted than children with unskilled worker fathers. Reductions in odds are by taking the reciprocal of the odds ratio ($1/e^{coefficient}$). Household having only one under-5 years children reduces the likelihood that the child were severely underweight by almost 21%, severely and moderately stunted by 39% and 20% respectively, but they were 2.1 times more likely to be severely wasted than household having two or more children. In particular, children living in poor class were significantly more likely to be severely as well as moderately underweight and stunted than the rich class children. Middle class children were 1.4 times more likely to be moderately underweight and 2.3 times and twice more risk to be severely and moderately stunted compare to the rich class children and also results indicates that household economic status has no significant effect on wasting. Coefficients reveled that, mother's who did not read newspapers, listen radio or watches TV at least once a week (no mass media) had 1.6 times and 1.2 times higher risk of having severely and moderately underweight children, 1.3 times higher risk of having severely stunted children and also, 2.5 times and 1.3 times higher risk of having severely as well as moderately wasted children than the mothers who had exposed at least two of the three medias. Children whose mother exposed any one of the three medias were 3.2 times more likely to be severely wasted than children whose mothers exposed more than one media and also a low significant difference in the risk of severe underweight was observed among this two group of children. Children delivered in hospital under medical care were less likely to be severely underweight, severely and moderately stunted and also moderately wasted relative to children delivered at respondent home. Results showed that, there was only significant difference in the risk of moderate stunting among children born in other home (1.5 times higher risk) against those born in hospital.

Table 2. *Effect of socioeconomic, demographic, health system and community characteristics on nutritional status of under-5 years children in Bangladesh.*

Characteristic	Underweight		Stunting		Wasting	
	Severe	Moderate	Severe	Moderate	Severe	Moderate
Socioeconomic						
Mother's educational level:						
No education	0.518***	0.143	0.564****	0.177		
Primary	0.276	7.819E-02	0.421***	0.127		
Father's educational level:						
No education	0.533**	0.420***	0.607***			
Incomplete primary	0.505**	0.421***	0.755****			
Primary to incomplete secondary	0.317	0.244**	0.270			
Father's occupation:						
Skilled worker	-0.306***	-0.110			-0.135	-0.263***
Household economic Status:						
Poor class	0.552*	0.358**	0.832****	0.565****		
Middle class	0.459	0.307**	0.667***	0.445***		
Exposure to mass media:						
No mass media	0.481***	0.206*	0.259*	0.120	0.932*	0.246*
One of the three media	0.306*	0.152	0.226	-9.192E-02	1.154**	7.856E-02
No. of children under –5 years:						
One	-0.232**	-8.389E-02	-0.492****	-0.217***	0.751	8.205E-02
Place of delivery:						
Respondents home	0.601**	0.116	0.370*	0.312**	-0.176	0.414**
Other home	0.428	0.202	0.334	0.390***	-0.295	0.186
Demographic						
Age of child in months:						
35 – 59 months	1.417****	1.061****	2.225****	1.156****	1.231*	0.515**
22 – 34 months	1.837****	1.197****	2.053****	1.235****	1.278*	0.744***
12 – 21 months	1.882****	1.201****	1.850****	1.171****	2.204****	1.322****
Birth order:						
First birth	7.110E-02	0.163*	-1.336E-02	0.223***		
Months of breastfeeding:						
25+ months	1.333****	1.043****	0.225	0.491***	-0.144	0.469*
7 – 24 months	1.175****	0.999****	0.308	0.495****	0.301	0.495**

Characteristic	Underweight		Stunting		Wasting	
	Severe	Moderate	Severe	Moderate	Severe	Moderate
Size of child at birth:						
Larger then average	-1.609****	-1.113****	-1.218****	-0.660****	-1.613***	-0.652****
Average	-1.188****	-0.540****	-0.760****	-0.332****	-1.001****	-0.437****
Mother's BMI:						
Low (<=18.50kg/m^2)	1.083****	0.717****	0.508****	0.274****	1.558***	0.338**
Desirable (18.51-20.50 kg/m^2)	0.389**	0.351****	0.434****	0.314****	1.030*	-0.139
Mother's height:						
<= 145 cm	0.992****	0.585****	1.209****	0.754****	-0.713*	0.367***
Age of household head:						
> 35 years	-0.471**	-0.243	-0.307*	-0.168		
26 – 35 years	-0.547***	-0.124	-0.544***	-0.156		
Health system						
Measles vaccine:						
No	0.322***	0.184**	0.307***	5.541E-02	0.665**	5.001E-02
Respiratory sickness (RS):						
No	-0.409****	-0.355****			-0.596*	-0.537****
Moderate	-0.210	-0.265***			-0.410	-0.444****
Feeding practice of liquids:						
One of the four liquids	0.865***	0.820****	0.768***	0.182		
At least two of them	0.808***	0.772****	0.639**	8.602E-02		
Feeding practice of solid foods:						
At least three of the five items	-0.429**	-0.112				
One to two of the five items	-0.509****	-0.189				
Community						
Division of residence:						
Barisal	-1.524E-02	-0.173	-0.164	-0.448***	1.478***	0.173
Chittagong	-0.275*	-0.182	-0.261*	-0.319***	0.561	3.743E-03
Dhaka	-0.474***	-0.161	-0.366***	-0.311**	0.477	5.654E-03
Khulna	-0.598***	-0.316**	-0.811****	-0.392***	0.542	0.133
Rajashahi	-0.366**	-0.178	-0.536****	-0.517****	0.537	7.849E-02
Model Fitting Information:	8259.33		8680.76		3367.65	
Chi-square (df)	1415.18 (76)▼		1256.36 (66)▼		316.44 (48)▼	

¶Omitted categories not shown, *p<0.10; **p<0.05; ***p<0.01; ****p<0.001, ▼p<0.0000.

Controls for demographic characteristics affect the nutritional status of children. Measures of birth size showed that, size of child at birth has a significant effect on child nutrition. A significantly (p<0.001) lower percentage of children becomes severely as well as moderately underweight, stunted and wasted, who were larger than average birth size and average birth size compare to the children who were smaller than average birth size. Although the risk of moderate stunting was the highest at the age interval 22-34 months, as like as severe stunting total stunting increases with child age. Children in age groups 12-21 months, 22-34 months and 35-59 months were respectively 6.6 times, 6.3 times and 4.1 times more likely to be severe underweight than children in younger age group. Similar pattern also found in the risk of moderate underweight and also severe and moderate wasting. Children with first birth were 1.2 times and almost 1.3 times more likely to be moderately underweight and stunted than second and higher order births. The risks of severe and moderate underweight were increases with months of breastfeeding; breastfeeding has no significant effect on severe stunting and wasting. Results also indicate that, children who were breastfed for 7-24 months were more vulnerable than those children who were breastfed up to 6 months. The likelihood of the child being severely as well as moderately underweight, stunted and wasted decreases with mother's body mass index (BMI) and mother's height. In particular, children of mothers with low BMI were respectively 3.0 times and 2.1 times, 1.7 times and 1.3 times, 4.6 times and 1.4 times more likely to be severely and moderately underweight, stunted, wasted compare to children of mothers with upper desirable to obese BMI (>20.50 kg/m^2). Age of household head showed a large effect on severe underweight and stunting. Household head aged 26-35 years reduces the likelihood that a child will be severely underweight and stunted by about 42% both. Children with higher age group household head were also less likely to be vulnerable than children with younger age group household head.

Measles vaccine had a significant (p<0.05 & p<0.01) association with prevalence of severe and moderate underweight and also with prevalence of severe stunting and wasting. In particular, children who did not received measles vaccine had respectively 1.4 times, 1.4 times and twice more risk to severely underweight, stunted and wasted. In bivariate

analysis, the effect of measles vaccine on severe stunting was positive. Respiratory sickness (RS) had no significant effect on stunting and measure of respiratory sickness showed that, children who had no RS (not cough nor fever in last two weeks) were 1.5 times (34%) and 1.4 times (30%) less likely to be severely and moderately underweight than children who had both cough and fever (severe RS). The risk of severe and moderate wasting was lowest among children had no RS i.e. no RS children were 45% and 42% less likely to be severely and moderately wasted than children who had both cough and fever. The effect of feeding practices of liquids on underweight and stunting was highly significant ($p<0.01$ & $p<0.001$), indicating that, children who drank any one of the four liquids ("plain water", "sugar water", "fresh milk" or "other liquid") and at least two liquids were 2.4 times and 2.2 times more likely to be severely underweight, 2.3 times and 2.2 times more likely to be moderately underweight and also 2.2 times and 1.9 times more likely to be severely stunted than children who did not took any one of the four liquids. Feeding practices of solid foods had highly significant association with only the prevalence of severe underweight. From Table 2, results reveal that, children who took one to two of the five items ("fruits", "dal", "green leafy vegetables", "semi-solid food" and "eggs fish poultry") and at least three items were 1.7 times (40%) and 1.5 times (35%) less likely to be severely underweight than children who did not took any items.

Division of residence showed a large significant effect on child nutrition. Children lived in Chittagong division, Dhaka division, Khulna division and Rajashahi division were respectively 1.3 times (24%) and about 1.3 times (23%), 1.6 times (38%) and 1.4 times (31%), 1.8 times (45%) and 2.3 times (55%) and also 1.4 times and 1.7 times (41%) less likely to be severely underweight and stunted than children who lived in Sylhet division. Residence in Dhaka division, Khulna division, Barisal division and Rajashahi division also reduce the likelihood that a child will be moderately stunted by 27%, 32%, 36% and 40% respectively. Results also indicate that, there exists only one significant difference in the risk of severe wasting among children who resided in the Barisal division (4.4 times higher risk) against children who resided in the Sylhet division.

4. Discussions and Conclusion

Figure 1 represents the selected overall nutritional status of under-5 children in Bangladesh. Findings indicate that about 30% children were stunted and underweight and a major proportion of children were suffered from some degree of Protein Energy Malnutrition (PEM) and it identifying a serious public health problem in the country. Results reveals that, prevalence of malnutrition has declined trends and yet in Bangladesh the fall in prevalence has not been as rapid as the rise in population.

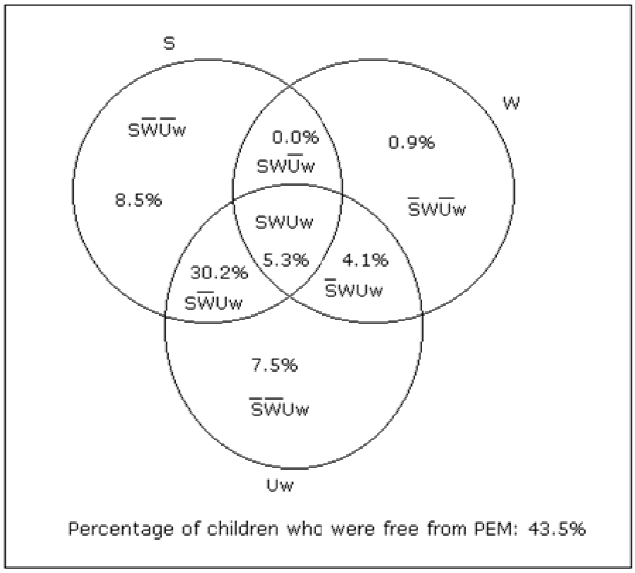

Figure 1. *Selected overall nutritional statuses of children in Bangladesh, 2000.*

Education is the pre-condition of progress. It provides a source of knowledge and it also transforms attitudes[39]. Mother's with little education are less likely to seek health care and they exercise less authority in the home to more educated women[40]. More educated mothers are socially advanced, free from tradition and change her pattern of behaviour and attitude i.e. they make better use of health services, provide better childcare including feeding have increased knowledge of appropriate child rearing, have more hygienic household practices and personal habits, have a higher status in the family, are more assertive, and are more ready to change their beliefs about how, and how much they should invest in each child and they feel in greater control over the lives and become more responsible for their children's survival and also while we lack information about dietary supplementation for children, it should be hypothesized that, they are better able to obtained and prepare clean, nutritionally adequate substitutes for breast milk. Educated women are more likely to identify with aspects of modernization and, thus, to seek modern health care and individuals with little or no education are generally more fatalistic in their attitudes towards illness[13&41]. Uneducated or primary educated mothers children had a higher risk severe underweight and stunting. Lower maternal education was also highlighted as a risk factor for malnutrition[7,8,12&42], for severe malnutrition [7&13]. Father's education may be regarded as a valid proxy of income and wealth status of household. Bairagi et al. (1980)[43] showed that there was an interaction between literacy and increasing income as well as wealth status. Like as mother's education, lower level of father's education had also a higher risk factor of severe as well as moderate underweight and stunting. Stunting is strongly associated with the educational level of both father and mother and with family assets[7&44]. Therefore, education for all should be the goal of nation and it should be needed affective actions to reach this goal.

In Bangladeshi children the risk of malnutrition increases

with age and studies generally show a peak in the prevalence of severe and moderate underweight and wasting during the 2nd year of life. Prevalence tends downward thereafter. By contrast, the prevalence of severe stunting as like as total stunting increases during the 2nd year of life and remains stable thereafter. This opinion is similar with the findings in other study[7&8].

Negative effects of artificial feeding have been reported in the United States[45]. The findings suggest that exclusive breastfeeding up to about 6 months, avoid feeding practice of liquids (only fresh milk has somewhat positive effect on child nutrition) and introduction of solid foods appear to contribute significantly to improve nutritional status of children. After about six months of age the nutrients provided by breast milk become inadequate to sustain growth and the addition of supplementation necessary[12&46]. The Bangladeshi children in general are breastfed for a long period of time and although introduction of supplemental food of liquids is fairly early, solid food is introduced quite late[7,13&47]. Unmodified non-human milks and liquids may not provide optimal nutrient balance, especially for the malnourished[48]. In addition, the use of plain water or sugar water can become a source of diarrhoea as in most rural areas of developing countries water supply is poor[8,12&49], also use of bottles can result in bacterial contamination due to improper sterilization[13&50], and yet with the supplementation of liquids other than breast milk, the risk of diarrhea and malnutrition increases[51]. Thus careful introduction of adequate, healthy and hygienic supplements of fresh milk and solid foods after the first 4-6 months is an appropriate thought.

Most of the Bangladeshi children delivered at home under traditional delivery system without medical facility and they have higher risk of malnutrition than children delivered in hospital under medical care and its mother gather different knowledge of complications, child nutrition, breastfeeding practices and childcare that may have positive effects on child health and negative effects on maternal and child mortality.

A person's occupation is the reflection of the physical environment, his social milieu, his educational background, his income and his life style[7,8,12&52]. Since skilled worker are economically better than unskilled worker, children of skilled worker fathers were less likely to be severely underweight, and severely as well as moderately wasted than children whose fathers were unskilled worker. Children lived with household head at age 26-35 had lowest risk of severe stunting and severe underweight. Higher age group household had also lower risk of severe stunting and moderate stunting than younger aged household head. In Bangladesh household head is the main earner of a household. Different ages household head were different occupations and income level is also vary by their age and skill. Household head is also the main decision maker in a family and effectives and efficient decision for child nutrition depends on nutritional knowledge, income (that ensure household food security, health care facilities and maternal care etc.), awareness, loving attachment to children, all may depends on age of household head and his occupation. So, household head should make aware to select proper age to expect newcomer in his family.

Our findings showed that, children whose mothers did not expose any mass media (newspapers, radio & TV) had higher risk of becoming malnourished. Children who lived in lower economic class, who did not received measles vaccine and who had both cough and fever (severe RS) had a significantly higher risk of developing malnutrition. Vaccination against diseases such as measles is more important to child health[7,13&53]. Gastro-intestinal disease and acute respiratory infections are the primary causes of childhood mortality as well as malnutrition and these types of diseases are heavily influenced by living conditions[54], also improving ventilation in houses reduces the risk of respiratory infections[12&15] and both may depend on household economic status.

Surprisingly, this study's results that households with only one under-5 year children had a higher risk (2.1 times more) of severely wasted children than household with more than one child. This surprising finding may be occurs due to the fact that these children were mainly dependent on breastfeeding for lovely affection and were not given properly supplementations at due time to their overall preference. Furthermore, children lived in household having one child had lower risk of severely underweight and severely as well as moderately stunted than children lived in household heaving two or more. Families with fewer children had a lower proportion of severely malnourished children than the families with more children[8,13&21].

Children of first birth order had higher risk of moderate stunting and underweight than 2nd to higher birth order children. It is well dominant that, the primary providers of care for young children in all cultures are mothers, and therefore care of the child is inextricably linked with the situation of household and mother. All of the first order birth faced inexperienced adolescent mother (cause of early marriage) most of them don't know proper child care and adequate nutrition practices. Child care affects the child's calorie intake and therefore nutritional status in different ways; through parental nutrition and calorie intake expenditure, breastfeeding and child feeding behaviors, timely feeding, frequency of feeding, both quality and quantity of food and also amount of food per meal.

The findings of this research indicate that both mothers' body mass index and mother's height (two indicators of mother's nutritional status) have a strong link with child nutritional status. Results showed that the risk of severe as well as moderate stunting, wasting and underweight decreases with increases mother's body mass index and also mother's height.

The problem of maternal malnutrition in a country like Bangladesh is a complex one with several underlying causes. Poverty is a direct cause of maternal under-nutrition because mothers from poor families are nutritionally deprived during childhood and adolescence, and this does not improve when they are married. Social causes, like early marriage, frequent childbirth, lack of proper birth spacing, and discrimination of inter household food distribution in a male dominated family all exacerbate the state of maternal undernutrition[7,55&56], and

the preferential treatment of male children is common in many Asian cultures[8,13&57]. Also other studies showed that, undernourished mothers had little or no education and mostly come from poor families[7,12&26]. This result is an agreement with the 1999-2000 BDHS report. Undernourished mothers probably could not breast feed their children adequately, which could have contributed to the poor nutrition of their children[7,8&58] and they usually give birth to low birth-weight babies. Half of the total newborns in Bangladesh have low birth weight[1&12].

This study also suggests that, increases birth size reduce the risk of severe as well as moderate malnutrition of children assessed by all three indices. But size of child at birth depends on various maternal and socio-economic factors such as food intake during pregnancy, mothers' health and nutritional condition, mothers' education that provides a source of womb and carrying knowledge, mothers' age, household economic status, maternal checkup during pregnancy etc. Only a few percentages of children in this country born at larger than average birth size and they have lower risk of severe and moderate malnutrition, and therefore special attention should be given to increase birth size of child and ensure all requirements for do this.

Community variations were marked with respect to child nutritional status. Children lived in Khulna division had low risk of severe and moderate malnutrition and children lived in Sylhet division had high risk of malnutrition. Figure 2 shows stunted rate of children by division of residence for three class of household economic status.

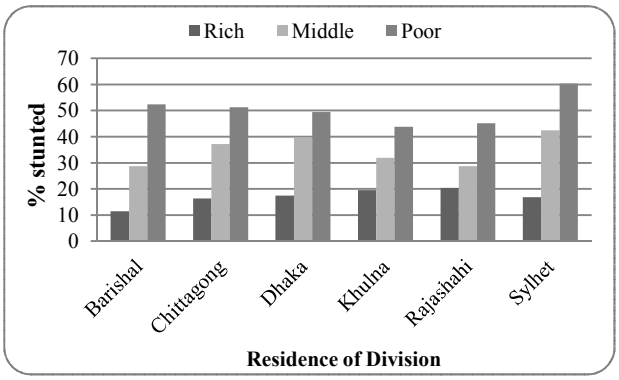

Figure 2. *Percentage of stunted children by level of economic status and division of residence.*

Children in Khulna division, the economic differentials in stunting rate were relatively small. In Barisal and Sylhet division, children from rich households have lower stunting rate than those of other class households as well as divisions but within poor class they were higher stunting rate and also highest in Sylhet division. In different divisions, however, the differentials widen and a gradual of stunting rates in accordance with different class of household status comes into view. Most of the households in the Sylhet, Rajashahi and Barisal divisions are in poor class and the educational condition is poor in Sylhet and Rajashahi division, also in the Sylhet division other socioeconomic conditions (more unskilled worker, less media exposure, and higher delivered at home without medical facilities etc.), maternal condition (more undernourished mother) and immunization and sickness conditions (higher rate of children 'not received measles vaccine' and 'suffered severe RS') are poor. These nutritional differences may be associated with cultural, religious and political factors. This may equally true, for government organizations, such as public health center, club, women's co-operatives, vocational training centers etc. Special effort thus will have to be given to remove these resided differences.

In conclusion, the present research provided information that severe and moderate malnutrition constitutes a violent public health problem among children under-5 years in Bangladesh. Low socio-economic condition, poor maternal as well as demographic situations, poor feeding and immunization practices and also high rate of respiratory and divisional differences are the most important factors associated with higher prevalence of severe as well as moderate malnutrition. The specific set of determinants of severe and moderate malnutrition and maternal health & childcare practices deserve further more careful investigation, since maternal health and behaviour are evidently not the same for all communities as like as socio-economic situations.

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