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Socio-economic Determinants of Severe and Moderate Stunting among Under-Five Children of Rural Bangladesh

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ABSTRACT

Introduction: Malnutrition among under-five children is a chronic problem in developing countries. This study explores the socio-economic determinants of severe and moderate stunting among under-five children of rural Bangladesh. **Methods:** The study used data from the 2007 Bangladesh Demographic and Health Survey. Cross-sectional and multinomial logistic regression analyses were used to assess the effect of the socio-demographic variables on moderate and severe stunting over normal among the children. **Results:** Findings revealed that over two-fifths of the children were stunted, of which 26.3% were moderately stunted and 15.1% were severely stunted. The multivariate multinomial logistic regression analysis yielded significantly increased risk of severe stunting (OR=2.53, 95% CI=1.34-4.79) and moderate stunting (OR=2.37, 95% CI=1.47-3.83) over normal among children with a thinner mother. Region, father's education, toilet facilities, child's age, birth order of children and wealth index were also important determinants of children's nutritional status. **Conclusion:** Development and poverty alleviation programmes should focus on the disadvantaged rural segments of people to improve their nutritional status.

Keywords: Bangladesh, nutritional status, multinomial regression, rural children

INTRODUCTION

Malnutrition among under-five children is a chronic problem in developing countries like Bangladesh. Worldwide, ten and a half million children of age under-five die every year, with 98% of these deaths reported to occur in developing countries (UNICEF, 2007). In recognition of the burden of malnutrition among under-five children, four of the eight United Nations' Millennium Development Goals (MDGs) are specifically directed towards improving child health outcomes in developing countries. In particular, a reduction in the mortality of children is a key MDG, and a reduction in malnourishment among children is an important indicator of progress towards that goal.

Development efforts have brought major changes in Bangladesh over the last decades (UNDP, 2005), yet the nutritional situation of women and children in the country is still of great concern. Malnutrition contributes to over one-half of child deaths (BBS & UNICEF, 2007). In 2005, 39.7% of the children aged below five years were underweight, 46.2% were stunted, 14.5% were wasted and 1.4% were overweight. According to the criteria of WHO, the

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prevalence of underweight and stunting was 'very high', and the prevalence of wasting indicated a 'critical problem'. Severity of underweight, stunting and wasting was 10.9%, 19.0% and 2.9% respectively in the children (BBS & UNICEF, 2007).

The optimal growth and development of infants and young children are fundamental for their future. Stunting (i.e., low height-for-age) is one of the most important public health problems in developing countries, including Bangladesh. Stunting reflects the poor linear growth accumulated during the prenatal and postnatal periods because of poor nutrition and health. It is related to mental capacity, school performance and working capacity in the adult period (Jukes *et al.*, 2002). It is a major health problem in South Asia where half of the children aged less than five years are stunted. The consequences of stunting in early life include increased susceptibility to infectious diseases, attenuated cognitive ability and increased behavioural problems during childhood (Berkman *et al*., 2002).

Studies consistently show that mother's nutritional status, child's sex, parental education, poverty, socio-economic status, place of residence, child care behaviour, cultural beliefs, access to health care and environmental ecosystems are important factors associated with stunting (Ayaya *et al*., 2004). Most studies conducted on African settings emphasise the importance of maternal education (Wamani *et al*., 2006), provision of household water and sanitation services and household wealth or income (Pongou, Ezzati & Salomon., 2006). Studies on Bangladeshi children show strong inverse relationship between household wealth inequality and children's chronic under-nutrition (Kamal, Manaf & Islam, 2010; Hong & Mishra, 2006). Although a number of studies emphasise household wealth and nutritional status of children, the relationship between economic inequality and a child's nutritional status is not conclusive. For instance, studies conducted elsewhere do not find a consistent relationship between wealth and child malnutrition (Larrea & Kawachi, 2005), while acute under-nutrition among children was reported to be significantly associated with a mother's feeding practices, parent's health-seeking behaviour and personal hygiene (Jacobs & Robert, 2004).

Despite significant progress in the nutritional status, a large proportion of mother and children are still malnourished in Bangladesh. While studies on nutritional status of under-five children in other developing countries are enormous, little is known on the socio-economic correlates of under-nutrition, particularly of rural children of Bangladesh where the vast majority of people live in. This study aims to explore the socio-economic determinants of severe stunting and moderate stunting among under-five children of rural Bangladesh. The findings may improve understanding of the prevalence and risk factors that are essential in order for better design and implementation of nutritional interventions to reduce child mortality and morbidity in Bangladesh.

METHODS

Data

The study used the data from the 2007 Bangladesh Demographic and Health Survey (BDHS). The 2007 BDHS is a nationally representative survey which gathered information on 10,996 women of reproductive age and 6,058 children aged 0-59 months from 10,500 households located in 361 clusters (134 in urban areas and 227 in rural areas) throughout the country (NIPORT *et al*., 2009). This survey utilised a multistage cluster sampling procedure based on the 2001 Bangladesh Census and the data was collected by trained interviewers from January 24 to August 11, 2007. The survey collected a range of information including background characteristics, such as age, region of residence, place of residence, education, childhood place of residence and

household characteristics, the height and weight of the women as well as children etc. For analytical purposes, the data were restricted only to a weighted sample of 4,139 rural children. The sample size was weighted by the corresponding weighting factor of the subjects as provided in the data set. Due to missing information such as age, height and inconsistencies of anthropometric measurement, a total of 68 children were excluded from the analyses.

Unit of analysis

The units of analyses, i.e., the dependent variables of this study are severe and moderate stunting. The height-for-age measurement status is expressed in Standard Deviation (SD) units (Z-score) from the median of the reference population as recommended by WHO. Children with a measurement of <-2 SD units from the median of the reference population were considered short for their age (moderate stunted) and children with measurement of <-3 SD units from the median of the reference population were considered to be 'severely stunted'.

Independent variables

Based on previous studies that have described risk factors of malnutrition, we constructed a conceptual framework. In our model, we divided the variables into three groups: (i) distal factors which included socio-economic and cultural variables such as administrative regions, mother's level of education, father's level of education, mother's working status, household wealth index, religion, sex of household head; (ii) intermediate factors which included familial variables such as household size, number of children in the household, toilet facilities and sources of drinking water; and (iii) proximal factors which included maternal nutritional status (measured by body mass index, kg/m^2), birth order of child, child's age, child's sex, duration of breastfeeding, maternity care services utilisation including antenatal care (ANC), skilled delivery assistance (SDA) and use of facility place for childbirth. It has been assumed that distal factors influence the intermediate factors and the intermediate factors directly or indirectly affect the proximal factors except for child's age and sex.

Statistical analysis

Data of this study have been analysed by SPSS v17. Along with descriptive statistics, multivariate multinomial logistic regression analyses were used to assess the effect of the socio-economic and demographic factors on the stunting of children. The model fitting process involved three stages of estimation. Model I was fitted for distal factors, Model II included intermediate factors along with distal factors and finally Model III was fitted for the conceptual variables as described earlier. The results of the multinomial regression analyses are presented by odds ratios (ORs) with 95% confidence interval (CI). Statistical significance has been set at $p<0.05$. Multi-colinearity was tested prior to the inclusion of the variables included in the analyses.

RESULTS

Characteristics of the study population

Table 1 shows the background characteristics of the children. The highest proportion of children was from the Dhaka division, followed by Rajshahi, Chittagong, Khulna, Sylhet and Barisal divisions respectively. With regard to education of the mothers of the children, more than one-fourth had no formal education, almost one-third had primary education, and about two-fifths had at least secondary level of education. Additionally, over one-third of the fathers of the children had no formal education, while over one-fourth had primary education, one-fourth had secondary education and 8.9% had higher education. Almost three-fourths of the mothers were not working. In terms of wealth

Table 1. Percentage distribution of under-five Bangladeshi children by background characteristics

Characteristics	*N*	*%*	*Mean±SD*
Administrative region			
Barisal	295	7.1	
Chittagong	895	21.6	
Dhaka	1161	28.0	
Khulna	401	9.7	
Rajshahi	995	24.0	
Sylhet	392	9.5	
Mother's education			
No education	1175	28.4	
Primary	1327	32.1	
Secondary	1457	35.2	
Higher	181	4.4	
Father's education			
No education	1553	37.5	
Primary	1192	28.8	
Secondary	1021	24.7	
Higher	370	8.9	
Mother currently working			
No	3023	73.0	
Yes	1116	27.0	
Wealth index			
Poorest	1101	26.6	
Poorer	1032	24.9	
Middle	884	21.4	
Richer	770	18.6	
Richest	351	8.5	
Religion			
Islam	3772	91.1	
Others	367	8.9	
Child's age			29.7±17.3
0-11	837	20.2	
12-23	814	19.7	
24-35	835	20.2	
36-47	798	19.3	
48-59	855	20.7	
Sex of household head			
Male	3752	90.6	
Female	387	9.4	
Household (HH) members			6.3±2.9
<5	1161	28.1	
5-6	1486	35.9	
7-8	823	19.9	
9-40	670	16.2	
Number of children in HH			1.4±0.8
<3	3853	93.1	
3-9	287	6.9	
Toilet facility			
Flush	503	12.2	
Pit latrine	2319	56.0	
Open/other	1317	31.8	

Table 1: Continued

Characteristics	*N*	*%*	*Mean±SD*
Sources of drinking water			
Pipe/Tube well	3562	86.0	
Other	578	14.0	
Birth order			
1st	1342	32.4	
2nd	1048	25.3	
3rd	709	17.1	
4th	467	11.3	
5th+	573	13.8	
Mother's BMI			20.0±4.8
Severely thin (<17.0)	472	11.4	
Moderately thin (17.1-18.4)	900	21.8	
Normal (18.5-24.9)	2554	61.8	
Overweight (25.0+)	205	5.0	
Sex of child			
Male	2014	48.6	
Female	2126	51.4	
Duration of breastfeeding (in months)			22.1±13.5
0-11	1003	24.3	
12-23	1155	28.0	
24-35	1320	31.9	
36+	654	15.8	
Received ANC			
No	2509	60.6	
Yes	1630	39.4	
Place of delivery			
Home	3692	89.2	
Facility place	446	10.8	
Sought skilled assistance			
No	3578	86.4	
Yes	561	13.6	
Total	4139	100.0	

index, more than one-fourth of the children were from the poorest households and 8.5% were from the richest households. The mean age of the children was 29.7±17.3 months. The vast majority of the children were from male-headed households. The number of family members ranged from 3 to 40 with a mean of 6.3±2.9 members. Per household, the average number of children aged below five was 1.4±0.8. About one-third of the children used open field for defecation, while 12.2% used flush toilet and 56.0% used pit latrine. For water, 86.0% used piped or tube well water and 14.0% had no sources of safe water for drinking. Of the children, almost one-third were the first child, one-fourth were the second child, less than one-fifth were the third child, 11.3% were the fourth child and the rest (13.8%) were the fifth or higher order births of their parents. With regard to mother's nutritional status, 11.4% were severely thin, 21.8% were moderately thin, 61.8% were normal and 5.0% were over-weight or obese. Of the children under study, 48.6% were male and 51.4% were female. The mean duration of breastfeeding was 22.1±13.5 months and 72.7% were currently breastfeeding. Among the mothers of the

Table 2. Prevalence of severe stunting, moderate stunting and normal/overweight among under-five children of rural Bangladesh by sex

Categories of stunting	*Boys*		*Girls*		*Total*	
	N	*%*	*N*	*%*	*N*	*%*
Severe	316	15.7	310	14.6	626	15.1
Moderate	536	26.6	552	26.0	1087	26.3
Normal	1162	57.7	1264	59.4	2426	58.6
Total	2014	100.0	2126	100.0	4139	100.0

Table 3. Multinomial logistic regression showing the risk of distal factors on severe stunting and moderate stunting versus normal

Characteristics	*Severe stunting vs. normal*	*Moderate stunting vs. normal*
Administrative regions		
Barisal	1.07 (0.71-1.62)	1.10 (0.76-1.58)
Chittagong	1.21 (0.87-1.62)	1.15 (0.86-1.54)
Dhaka	0.70 (0.51-0.97)*	1.03 (0.78-1.36)
Khulna	0.49 (0.32-0.77)***	0.88 (0.63-1.23)
Rajshahi	0.59 (0.42-0.82)***	0.93 (0.70-1.23)
Sylhet	1.00	1.00
Father's education		
No education	2.31 (1.47-3.63)***	2.06 (1.47-2.88)***
Primary	1.85 (1.18-2.91)**	1.93 (1.38-2.69)***
Secondary	1.47 (0.93-2.32)*	1.82 (1.31-2.53)***
Higher	1.00	1.00
Wealth index		
Poorest	4.06 (2.44-6.75)***	2.31 (1.62-3.29)***
Poorer	3.45 (2.08-5.71)***	2.29 (1.62-3.24)***
Medium	2.25 (1.36-3.74)***	1.88 (1.33-2.66)***
Richer	1.92 (1.15-3.20)**	1.75 (1.24-2.47)***
Richest	1.00	1.00

Note: Level of significance *** $p<0.001$; ** $p<0.01$; and * $p<0.05$.

children, 39.4% received antenatal care (ANC) services, 10.8% births were delivered at medical facility places and 13.6% births were delivered by skilled delivery assistants (SBA).

Prevalence of severe stunting, moderate stunting and normal

Table 2 shows that of the study children, the prevalence of severe stunting, moderate stunting and normal was 15.1%, 26.3% and 58.6% respectively, suggesting that two-fifths of the children were <-2SD for height-for-age. Among boys, the prevalence of severe stunting, moderate stunting and normal was 15.7%, 26.6% and 57.7% respectively and the corresponding figures for girls were 14.6%, 26.0% and 59.4% respectively. However, the prevalence and severity of stunting was not statistically significant between boys and girls.

Effect of distal, intermediate and proximate factors on severe and moderate stunting

Table 3 shows the relationship between socio-economic variables and stunting of

children. Multinomial logistic regression analyses were applied to assess the effect of selected variables on severe stunting and moderate stunting over normal. Model I was constructed for distal factors which included seven variables. The model shows that mother's education, mother's working status, religion and sex of household head had no significant effect after controlling for other confounding factors. The results revealed that administrative regions, father's education and wealth index were significantly related to nutritional status of children.

As compared to the children of Sylhet division, the children of Rajshahi, Khulna and Dhaka divisions were less likely to be severely stunted over normal. Although the children of Barisal and Chittagong divisions were more likely to be severely stunted over normal as compared to those of Sylhet division, the effect was found to be insignificant. The multinomial logistic regression further suggests that there was no significant variation in the likelihood of being moderately stunted over normal in the administrative regions of the country.

Father's education showed an inverse relationship with severe stunting and moderate stunting over normal. For instance, as compared to the children whose fathers had higher education, the children whose fathers had a secondary level of education, primary education and no formal education were 1.5 times, 1.9 times and 2.3 times as likely as to be severely stunted respectively. Similarly, the children whose fathers had no formal education or only primary education and secondary level of education as compared to those who had higher education were 2.1 times, 2.0 times and 1.8 times as likely to be moderately stunted, respectively over normal.

Household's wealth index also showed a highly statistical significant inverse association with being severely and moderately stunted over normal. The likelihood of being severely stunted was 4.1 times, 3.5 times, 2.3 times and 1.9 times respectively among children from the poorest, poorer, medium and the richer than those of the richest families. In addition, the comparison of odds ratios revealed that as compared to the children from the richest households, the children from the poorest, poorer, medium and the richer households were 2.3 times, 2.3 times, 1.9 times and 1.8 times as likely as to be moderately stunted over normal than the children who were from the richest households.

The results shown in Table 4 demonstrate the association between distal and intermediate variables and the nutritional status of children. This model included the variables namely household size, number of children in the household, toilet facilities and sources of drinking water along with the distal factors. After adjustment with other factors, the variables namely household size, number of children in the household and sources of drinking water, appeared to have no significant effect on nutritional status of the children. The only variable, 'toilet facilities', showed to have a net significant ($p<0.001$) effect after controlling for other socio-economic and family related factors. As shown in the table, children from the households having flush toilets and pit latrines were 45.0% and 28.0% less likely to be severely stunted over normal than children from the households with no toilet facilities. However, this variable appeared as an insignificant factor for moderate over normal children. After adjustment with other factors, the effect of administrative region and father's education remained almost unchanged. Besides, the effect of wealth index was substantially attenuated for severely stunted, while the likelihood of being moderately stunted over normal appeared to be more strengthened than it was in Model I.

Table 5 shows the results of multinomial logistic regression analysis for the conceptual factors included in the study. Of the proximal factors considered, child's sex and maternity care service related variables were found to have no significant effect on

Table 4. Multinomial logistic regression showing risk of distal and intermediate factors on severe stunting and moderate stunting versus normal

Characteristics	*Severe stunting vs. normal*	*Moderate stunting vs. normal*
Administrative regions		
Barisal	1.07 (0.71-1.62)	1.10 (0.76-1.60)
Chittagong	1.18 (0.84-1.64)	1.15 (0.86-1.54)
Dhaka	0.70 (0.51-0.97)**	1.03 (0.78-1.36)
Khulna	0.51 (0.33-0.79)***	0.88 (0.63-1.24)
Rajshahi	0.59 (0.42-0.83)***	0.93 (0.70-1.24)
Sylhet	1.00	1.00
Father's education		
No education	2.24 (1.43-3.52)***	2.06 (1.48-2.89)***
Primary	1.85 (1.18-2.91)**	1.93 (1.39-2.70)***
Secondary	1.44 (0.91-2.27)	1.83 (1.32-2.53)***
Higher	1.00	1.00
Wealth index		
Poorest	3.13 (1.81-5.41)***	2.36 (1.60-3.48)***
Poorer	2.83 (1.64-4.86)***	2.35 (1.61-3.43)***
Medium	1.86 (1.09-3.20)**	1.93 (1.33-2.79)***
Richer	1.70 (1.00-2.89)*	1.79 (1.25-2.56)***
Richest	1.00	1.00
Toilet facility		
Flush	0.55 (0.36-0.83)***	1.03 (0.77-1.37)
Pit latrine	0.72 (0.59-0.87)***	0.97 (0.83-1.15)
Open	1.00	1.00

Note: Level of significance *** $p<0.001$; ** $p<0.01$; and * $p<0.05$.

stunting among children. The regression analysis revealed that birth order of child, mother's BMI, child's age, duration of breastfeeding and current status of breastfeeding were important factors for nutritional status of children after controlling for distal and intermediate variables.

The multivariate analysis suggests that, the odds of being severely stunted was significantly ($p<0.05$) lower for first, third and fourth order births than fifth or higher order births, while the effect of this variable for being moderately stunted was not significant. Mother's BMI was found to be one of the most important determinants related to nutritional status of children. The risk of being severely stunted and moderately stunted consistently decreased with the increase in mother's BMI. For instance, children with thinner mothers (BMI<17.0), moderately thinner (17.1 ≤mother's BMI ≤ 18.4) and normal (18.5 ≤BMI ≤24.9) were at 2.5 times, 2.0 times and 1.9 times as likely as to be moderately stunted over normal than children with overweight (BMI≥25.0) mothers. Besides, as compared to children who had obese or overweight mothers, the children with thinner mothers, moderately thinner and normal were 2.4 times, 2.3 times and 2.1 times likely to be moderately stunted over normal. Child's age was positively related to be severely and moderately stunted over normal. Furthermore, duration of breastfeeding showed a significantly positive association for being moderately stunted, whereas it showed no significant association with severe stunting among

Table 5. Multinomial logistic regression showing the risk of distal, intermediate and proximal factors on severe stunting and moderate stunting versus normal

Characteristics	*Severe stunting vs. normal*	*Moderate stunting vs. normal*
Administrative regions		
Barisal	1.25 (0.81-1.92)	1.14 (0.78-1.67)
Chittagong	1.36 (0.96-1.92)*	1.20 (0.89-1.62)
Dhaka	0.74 (0.53-1.04)*	1.04 (0.78-1.39)
Khulna	0.51 (0.32-0.80)**	0.84 (0.59-1.19)
Rajshahi	0.65 (0.45-0.92)**	0.96 (0.71-1.29)
Sylhet	1.00	1.00
Father's education		
No education	1.94 (1.43-3.52)**	1.87 (1.32-2.64)***
Primary	1.61 (1.18-2.91)*	1.76 (1.26-2.48)***
Secondary	1.41 (0.91-2.27)	1.76 (1.26-2.46)***
Higher	1.00	1.00
Wealth index		
Poorest	2.48 (1.81-5.41)***	1.97 (1.32-2.95)***
Poorer	2.48 (1.64-4.86)***	2.11 (1.43-3.12)***
Medium	1.56 (1.09-3.20)	1.69 (1.15-2.47)**
Richer	1.46 (1.00-2.89)	1.58 (1.10-2.29)**
Richest	1.00	1.00
Toilet facility		
Flush	0.52 (0.36-0.83)***	0.95 (0.71-1.28)
Pit latrine	0.68 (0.59-0.87)***	0.91 (0.77-1.08)
Open	1.00	1.00
Birth order		
First	0.72 (0.54-0.96)**	1.00 (0.78-1.29)
Second	0.79 (0.59-1.07)	0.92 (0.71-1.20)
Third	0.65 (0.47-0.90)**	1.06 (0.81-1.39)
Fourth	0.72 (0.50-1.02)*	1.12 (0.84-1.51)
Fifth+	1.00	1.00
Mother's BMI		
<17.0	2.53 (1.34-4.79)**	2.37 (1.47-3.83)***
17.1-18.4	1.95 (1.05-3.62)*	2.32 (1.47-3.67)***
18.5-24.9	1.88 (1.04-3.41)*	2.14 (1.38-3.30)***
≥25.0	1.00	
Child's age		
0-11 months	0.15 (0.09-0.26)***	0.55 (0.34-0.91)**
12-23 months	0.82 (0.54-1.23)	1.03 (0.73-1.43)
24-35 months	1.47 (1.08-2.02)**	1.39 (1.07-1.80)***
36-47 months	1.67 (1.27-2.21)***	1.17 (0.93-1.48)
48-59 months	1.00	1.00
Duration of breastfeeding		
0-11 months	1.34 (0.84-2.13)	0.55 (0.35-0.87)**
12-23 months	0.74 (0.50-1.08)	0.75 (0.55-1.02)*
24-35 months	0.88 (0.64-1.20)	0.80 (0.62-1.03)*
36+months	1.00	1.00

Note: Level of significance *** $p<0.001$; ** $p<0.01$; and * $p<0.05$.

children. The children who were not currently breastfeeding were at lower risk of being severely stunted over normal children. Additionally, current breastfeeding was found to have no significant relationship to be moderately stunted over normal. With regard to other variables included as distal factors and intermediate factors in the final model, the effect of father's secondary education appeared to be not a significant factor for being severely stunted among children. Overall, the effect of fathers' education and wealth index were substantially attenuated by inclusion of selected proximal factors.

DISCUSSION AND CONCLUSION

In Bangladesh, as in other developing countries, nutritional status of children is a major public health concern (Hien & Kam, 2008). The findings of this study reveal that more than two out of five children were at least moderately stunted. Further, at least one out of seven was severely stunted. These statistics indicate that malnutrition among under-five children is chronic in rural Bangladesh. According to the 2005 Child and Mother Nutrition Survey of Bangladesh, 48.8% were stunted, 42.2% were underweight and 12.2% were wasted while 1.3% was overweight in rural children. The prevalence of stunting, underweight, wasting and overweight in urban areas was 35.9%, 29.9%, 12.2% and 1.6% respectively (BBS & UNICEF, 2007). These comparisons indicate that rural children were lagging behind urban children in terms of nutrition, and chronic growth retardation is the major effect of malnutrition in rural children.

The multivariate multinomial logistic regression analyses identified several variables as important determinants of severe stunting and moderate stunting over normal among the rural children. The factors related to malnutrition are administrative region, father's education, toilet facilities, child's age and birth order of child, duration of breastfeeding and current status of breastfeeding. Wealth index and mother's BMI are the most important determinants of stunting. The regional variations in nutritional status of children may be attributed to differences in socio-economic status, cultural values, social security and poor accessibility of education and health services for mother and child. It is surprising that while many studies showed that maternal education is a crucial factor for nutritional status of children in developing countries (Hien & Kam, 2008; Amsalu & Tigabu, 2008; Hong & Mishra, 2006), our finding showed that father's education is an important factor rather than mother's education for child nutrition. Probably, the effect of mother's education has been captured by father's education. An earlier study showed that, in Bangladesh, increasing paternal education was associated with greater decreases in the odds of stunting than was maternal education (Semba *et al.*, 2008). Thus, the relative importance of maternal and paternal education might vary in different settings. A study that involved over 5,000 pre-school children in Bangladesh found a strong and significant relationship between paternal education level, but not maternal education and child stunting (Rahman & Chowdhury, 2006). Another study on 18,544 children from Metro Cebu, Philippines showed that father's education was a more consistent determinant of child stunting than was maternal education in families in urban and rural areas (Ricci & Becker, 1996). The level of paternal education is usually related to household income, since more educated fathers usually earn more money and marry women of a comparable level of education (Semba *et al*, 2008).

In the recent past, the literacy rate among females has increased due to special efforts on behalf of the government to foster female education in Bangladesh. In contrast, substantial employment opportunities have not been created for them, resulting in only a small proportion of women being engaged in prestigious jobs in the formal sector while

many women are still engaged in low paid or blue collar jobs in the informal sector. Such working status of women does not make significant difference in health care for mother as well as child. Besides, in patriarchal settings like Bangladesh, men are the principal decision makers and women being the weaker sex are subjugated, which may also affect the feeding and dietary behaviour of a child as well as other family members of a household. Although the pathways through which paternal education may influence stunting have been less frequently investigated, work from Indonesia and Bangladesh suggests that these may include health-promoting behaviours such as childhood vaccination, family planning, attendance at the local health clinic and vitamin A supplementation (Semba *et al*., 2008). Extensive research from developing countries on the role of maternal education suggests that it may influence child growth and health through better feeding practices (Ramli *et al.*, 2009; Semba *et al*., 2008).

The findings of the present study reveal that after controlling for other socio-economic and demographic factors, the poorest and the poor of the wealth categories were significantly related to severe stunting of the children, while all categories of this factor were found to have a significant net effect of moderate stunting among children. This implies that the poor have a limited range of food sources. Probably, they are not capable of providing for their children nutritional and balanced food for childhood growth, resulting in higher risk of being severe and moderately stunted over normal children. The association between poverty and under-nutrition is a manifestation of the somatic development pattern of children who live in poorer conditions with insufficient food intake, greater exposure to infections, and lack of access to basic health services. These findings are consistent with those of previous studies conducted in other developing countries and provide further evidence that household economic status is an important determinant of childhood under-nutrition in developing countries (Kamal *et al*., 2010; Hong & Mishra, 2006).

Types of toilet facility in this study emerged as an important factor for severe stunting over normal under-five children, while this variable was found to be insignificant for moderate stunting. It is not surprising that access to hygienic sanitation is an indicator of socio-economic status. Thus, it is expected that that the nutritional status of children from households that have access to a hygienic sanitation is better than their counterparts that do not have such facility. Our findings reveal that better community environmental status positively affects nutritional status after other factors were adjusted, suggesting that community hygiene affects health irrespective of individual or household characteristics. This result of the study is concurrent with recent studies from Brazil and South Africa (Monteiro *et al.,* 2010; Willey *et al.,* 2009). Although birth order appeared as an important factor for severe stunting, it was found to be insignificant for moderate stunting. Probably, mothers with many children have overall lesser time to extend care equally to each of the children than those who have fewer children. A study from Vietnam reported that children from families with three or more children were more likely to be underweight, stunted and wasted than children from families with two or less children (Hien & Kam, 2008).

The present study revealed no evidence of son preference in the indicator of children's nutritional status, suggesting the diminishing preference for male children in rural Bangladesh. This finding is also concordant with several earlier studies (Miller & Rodgers, 2009; Fuse, 2008). Consistent with many other studies, the multivariate analysis of this study revealed that mother's BMI is positively associated with nutritional status of children. The higher the mother's BMI, the lower the risk of being severely stunted and moderately stunted over normal BMI, which is consistent

with previous studies conducted elsewhere (Bell *et al*., 2007).

Breastfeeding is a norm and nearly universal in Bangladesh. According to 2007 BDHS, 98.0% children were breastfed at some point. Overall, 43% of children are breastfed within one hour of birth, and 89% are breastfed within one day after delivery. WHO recommends the introduction of solid or semi-solid food to children around the age of six months because by that age, breast milk alone is no longer sufficient to maintain a child's optimal growth. The results of the present study support these updated recommendations. The finding of this study indicate that the risk of being severely and moderately stunted over normal children increases significantly with age. These findings are similar to the results from other studies conducted elsewhere (Ramli *et al*., 2009; Teshome *et al*., 2009; Pongou *et al*., 2006; Kumar *et al*., 2006) where children aged two years and above were found to be at greater risk of being severely or moderately stunted.

Stunting is a cumulative process and continues to about three years after birth. This low risk of being severely stunted and moderately stunted may be due to the protective effect of breastfeeding, since almost all children in Bangladesh continue to be breastfed throughout the first year of their life. Besides, the high rates of severe and moderate stunting observed in the age group 24-35 months may be linked to inappropriate food supplementation during the weaning period (Hien & Kam, 2008). Furthermore, the positive association of a longer duration of moderate stunting may be the result of the lack of inappropriate food supply among children aged more than one year.

In conclusion, this paper highlights the existence of significant differences in child malnutrition (severe stunting and moderate stunting), which is still an important health problem among children under-five years of age in rural Bangladesh. Malnutrition affects child survival negatively. It may also adversely affect health status and productivity in later adult life. Thus, the repercussions of socio-economic inequalities in child nutritional status are likely to be self-perpetuating. Furthermore, malnutrition was found to be a result of familial, socio-economic and environmental factors. These findings are of great importance because they identify potential actions that can be taken to improve the nutritional status of children. Mothers' health status is also associated with child's health –indicating that a healthy mother may produce a healthy child. Thus, programmes should be undertaken to ensure better health among the mothers. Development and poverty alleviation programme must focus on the vulnerable rural segments of societies to improve their economic status and thereby the health conditions for under-five children as well as mothers to achieve the MDG goals.

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