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Factors affecting stunting among children under five years of age in Bangladesh

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A – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

Summary **Background.** Stunting is a major contributor to child morbidity and mortality in developing countries. Knowledge about the risk factors of stunting among children under five years of age is important for devising nutritional intervention programs and strategies.

Objectives. This study attempts to uncover the risk factors associated with stunting status among children under five years of age in Bangladesh.

Material and methods. This study uses Bangladesh Demographic and Health Survey (BDHS) 2014 data collected from an observational study. The ordinal dependent variable, child stunting status (categorized as severely stunted, moderately stunted and normal) is constructed by calculating height-for-age Z scores (HAZ). The bivariate analyses were performed using chi-square test to explore possible associations between stunting status and selected covariates. To know the marginal effects of independent variables, the proportional odds (PO) model was considered.

Results. In bivariate setup, all the selected independent variables were found to be highly significant ($p < 0.01$). However, in multivariate analyses, child age, mother's education, mother's BMI and wealth index were found to be highly significant ($p < 0.01$) factors for the stunting status of children. The risk of having stunted children was found relatively higher in Chittagong (odds ratio = 1.466, $p < 0.05$), Sylhet (odds ratio = 1.345, $p < 0.05$) and Rangpur (odds ratio = 1.276, $p < 0.1$), compared to the Barisal division. Along with this, the birth interval of children ($p < 0.05$) and antenatal care service during pregnancy ($p < 0.1$) were found to be associated with child stunting status.

Conclusions. Child age, mother's education, mother's BMI and wealth index were the most significant determinants in this study. Hence, policy makers should consider these factors while devising child nutrition programs and intervention strategies.

Key words: dwarfism, child, Bangladesh.

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Background

Stunting refers to the reduced or impaired growth of children under five years of age and is often a result of undernutrition and recurrent infections. The World Health Organization (WHO) defines stunting as a condition where the 'height for age' value is less than two standard deviations of the WHO Child Growth Standards median [1]. Undernutrition, more than anything, is considered as the key factor responsible for stunting, as it accounts for one in every three deaths of children under five years of age around the world [2]. Today, more than two million children die due to undernutrition, making it a major health concern for children [3–5]. Stunting is a chronic form of undernutrition, and a significant portion of the population in developing countries suffer from it during early childhood [6].

Stunting is associated with a number of direct and indirect factors which are interlinked with each other [2]. Studies show that both physical and social factors are responsible for chronic undernutrition among children [7, 8]. Stunting often begins in the pre-natal phase and continues to two years (a time period called the '1,000 days') after the birth of a child [9–13]. Furthermore, the volume, frequency and nature of supplementary feeding, birth weight, gender, birth order and disease conditions are all linked with stunting among children [14–16]. Besides this, household facilities such as safe water supply and access to a toilet and sanitation facility are among the factors that increase the risk of stunting [17, 18]. While health care practices, services, dietary and food security issues are direct determinants of stunting, socio-economic determinants like household income, number of family members and educational level work as underlying factors responsible for stunting [19–22]. The influences of both direct and indirect factors have been reviewed by WHO in their Conceptual Framework on Childhood Stunting and were summarized by Dewey and Begum 2011 [23] as well.

Extensive research studies suggest that stunting leads to a number of physical, mental and social problems, including deprived attention, reduced memory, impaired learning, low school enrollment and a low-level of cognitive functioning, resulting in low adult wages, loss of productivity and higher risk of death [23–27]. Children who experience stunting in early childhood have an increased risk of being overweight and may develop chronic forms of illness. WHO [28, 29] also reported on the link between undernutrition and stunting and its long-term consequences. In spite of a decrease in the prevalence of stunting in recent years, the incidence of stunting has been constant due to the increase in the total number of the population [27, 30]. Projections from other studies also indicate that the growth of stunting will possibly remain high in the near future [4, 31].

Proper knowledge about the risk factors associated with stunting in the local context is essential for reducing the stunting rate and to develop prevention strategies [2]. There has been a shortage of research on identifying the socio-demographic factors related to stunting in Bangladesh. The available literature regarding stunting is largely inconsistent, as cohort analyses

are less focused. The present study attempts to investigate the major socio-economic, demographic, health and environmental determinants of stunting among the children under five years of age in Bangladesh, considering its significance. It is recognized that efforts to prevent stunting will improve the outcomes at all levels [12, 27]. The results from this study would help both government and non-government agencies in devising, as well as implementing, appropriate interventions to reduce stunting throughout the country.

Objectives

This study attempts to uncover the risk factors associated with stunting status among children under five years of age in Bangladesh. It also aims at identifying the marginal effects of factors related to stunting among children under five years of age.

Material and methods

Data and variables

This study extracted necessary information from a cross-sectional secondary data set, the Bangladesh Demographic and Health Survey (BDHS) 2014, which was conducted through a joint effort of the National Institute of Population Research and Training (Bangladesh), ICF International (USA) and Mitra and Associates (Bangladesh). This survey used a two-stage stratified sample of 17,989 chosen households. Among them, interviews were effectively done in 98% of all the occupied households [32]. Since this survey uses a sample from a finite population, for an estimation and test based on this data, it requires adjustment using appropriate sampling weights. In this paper, appropriate sampling weights were used in the analyses so that a statistically valid inference could be made.

To investigate the stunting status of children under five years of age in Bangladesh, the anthropometric index, height-for-age, was used. On the basis of height-for-age Z scores (HAZ), the stunting status of children was divided into three ordinal categories: severely stunted (≤ 3.0 HAZ), moderately stunted (-3.0 to -2.0 HAZ) and normal (≥ -2.01 HAZ). The height-for-age Z scores were calculated by using the WHO AnthroPlus Software (version 3.2.2, 2011) [33]. For final analyses, the anthropometric data was available for 6,965 (weighed) children, and the created ordinal variable was considered to be the main response variable.

To develop a proportional odds (PO) model, a set of socio-economic and demographic covariates were considered. These were: child's age (0–11 months, 12 to 23 months, above 24 months), mother's education (primary or below, secondary, higher), father's education (primary or below, secondary, higher), wealth index (categorized on the basis of terciles), place of residence (urban, rural), division (Barisal, Chittagong, Dhaka, Khulna, Rajshahi, Rangpur, Sylhet), mother's BMI [thin (BMI < 18.5), normal (BMI 18.5 to 24.9), over-weight (BMI > 24.9)], antenatal care service during pregnancy (yes, no) and birth interval (below 24 months, 24 to 47 months, above 48 months).

This study used a secondary data collected by NIPORT, Bangladesh and MEASURE DHS. All procedures performed in this study involving human participants were in accordance with the ethical standards of the national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Statistical analysis

The association between selected covariates and child stunting status was examined in a bivariate and multivariate setup. In the bivariate setup, the chi-square test of independence was considered. The statistic chi-square has the form:

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i},$$

where O_i – denotes observed frequency, E_i – denotes expected frequency under the null hypothesis. The statistic follows a chi-square distribution with (r - 1) (c - 1) degrees of freedom (df), where r and c are the number of categories of the covariates and response variable, respectively.

In a multivariate setup, the PO model was used to assess the marginal effects of selected covariates on the stunting status of children. Let Y_j (j = 1, 2, ..., n) be the ordinal response variable having categories 1, 2, ..., i,... c and $x_j = (x_{j1}, x_{j2}, ..., x_{jp})'$ be the vector of p covariates related to Y_j. The mathematical form of the PO model can be written as:

$$logit[\Pr(Yj \le i)] = \alpha_i + \beta' xj \text{ for } i = 1, 2, ..., c - 1,$$

with $\beta = (\beta_1, \beta_2, ..., \beta_p)'$ being the vector of regression coefficients related to x_j, and α_i being the intercept for i^{th} cumulative logit. In the above model, it should be assumed that the effect of each covariate is the same for any cumulative logits. The validity of this assumption can be checked by using a chi-square test based on deviance. If the test rejects the null hypothesis of common slope, the PO assumption does not hold for the data, and an alternative partial PO model would then be appropriate.

Results

Bivariate analysis

The background characteristics of the selected covariates by stunting status are shown in Table 1. From the table, it is observed that the proportion of severely stunted and moderately stunted children were found to be higher among children with illiterate mothers (14.7% & 27.8%) and those who received no antenatal care service (17.1% & 28.5%), with illiterate fathers (14.2% & 26.8%), born in a poor income family (15.5% & 28.2%), having thin mothers (16.4% & 29.3%) and below 24 months of birth interval (11.7% & 26%). Moreover, severely stunted children were found to be higher in the age group 12–23 months (14%) and in the Sylhet division (15.8%). On the other hand, moderately stunted children were found to be higher among children aged more than 24 months and in the Rangpur division (28.3%). All the selected covariates were found to be significant concerning the children's stunting status (see chi-square statistic and p-values in Table 1).

Regression analysis

The effects of the selected covariates were estimated by utilizing the proportional odds (PO) model. Note that the deviance-based chi-square test provided evidence that the data satisfied the parallel lines assumption (χ^2 statistic = 20.885, df = 20, p-value = 0.404), which indicates that for each of the chosen covariates, a single parameter can be used to model separate logits of cumulative probabilities. The estimated effects are displayed in Table 2. From the table, it is observed that the odds of staying in a worse state (severely stunted and moderately stunted) of stunting status is [exp (0.454) - 1] = 57% higher for the children belonging to age group 12–23 months (p < 0.01) compared to infants. These odds are almost similar for children more than 24 months of age (odds ratio = 1.578, p < 0.01). The risk of staying in a worse stunting state is significantly lower for children with secondary and higher educated mothers (26% and 48% lower odds for secondary and higher educated mothers, respectively, with p < 0.01). Compared to children from poor income families, the odds of switching status from better to worse stunting status were 20% and 38% lower for children from middle income families (p < 0.01) and wealthy families

Table 1. Cross-classification of stunting status of children under five years of age by socio-demographic factors					
Covariates	Stunting status			Chi-square	*p*
	Severely stunted *n* (%)	Moderately stunted *n* (%)	Normal *n* (%)		
Child's age (months)					
0–11	115 (8.2)	298 (21.2)	994 (70.6)	43.518	< 0.001
12–23	216 (14)	380 (24.7)	945 (61.3)		
Above 24	482 (11.4)	1088 (25.8)	2654 (62.8)		
Mother's education					
Primary or below	466 (14.7)	884 (27.8)	1828 (57.7)	134.075	< 0.001
Secondary	308 (9.3)	761 (22.9)	2255 (67.8)		
Higher	39 (5.8)	122 (18.2)	511 (76.0)		
Father's education					
Primary or below	568 (14.2)	1073 (26.8)	2368 (59.1)	130.716	< 0.001
Secondary	192 (8.8)	504 (23.0)	1495 (68.2)		
Higher	53 (5.5)	189 (19.5)	728 (75.1)		
Wealth index					
Poor	377 (15.5)	685 (28.2)	1370 (56.3)	156.280	< 0.001
Middle	260 (10.7)	630 (26.0)	1537 (63.3)		
Rich	176 (7.6)	451 (19.5)	1686 (72.9)		
Place of residence					
Urban	179 (9.9)	383 (21.2)	1244 (68.9)	24.513	< 0.001
Rural	633 (11.8)	1383 (25.8)	3349 (62.4)		
Division					
Barisal	42 (10.2)	99 (24.1)	270 (65.7)	52.746	< 0.001
Chittagong	210 (13.9)	370 (24.4)	936 (61.7)		
Dhaka	235 (9.3)	574 (22.8)	1709 (67.9)		
Khulna	52 (9.5)	141 (25.8)	353 (64.7)		
Rajshahi	80 (10.6)	202 (26.8)	473 (62.6)		
Rangpur	83 (11.4)	206 (28.3)	439 (60.3)		
Sylhet	110 (15.8)	175 (25.1)	413 (59.2)		
Mother's BMI					
Thin	261 (16.4)	466 (29.3)	862 (54.2)	133.265	< 0.001
Normal	455 (10.8)	1023 (24.3)	2729 (64.9)		
Overweight	91 (6.7)	267 (19.8)	993 (73.5)		
Antenatal care service					
No	150 (17.1)	250 (28.5)	478 (54.4)	58.708	< 0.001
Yes	329 (9.9)	752 (22.7)	2232 (67.4)		
Birth interval (months)					
Below 24	530 (11.7)	1182 (26.0)	2833 (62.3)	20.114	< 0.001
24–47	179 (10.2)	387 (22.0)	1194 (67.8)		
Above 48	98 (12.3)	176 (22.1)	523 (65.6)		

Table 2. Proportional odds model-based parameter estimates of selected covariates to determine the factors of stunting			
Covariates	Estimate	Odds ratio (95% CI)	*p*
Intercept (α_1)	-1.622	–	< 0.01
Intercept (α_2)	-0.159	–	< 0.01
Child's age (months)			
0–11 (Ref.)	–	–	–
12–23	0.454	1.575 (1.341, 1.849)	< 0.01
Above 24	0.456	1.578 (1.337, 1.863)	< 0.01
Mother's education			
Primary or below (Ref.)	–	–	–
Secondary	-0.295	0.744 (0.636, 0.871)	< 0.01
Higher	-0.645	0.525 (0.386, 0.712)	< 0.01
Father's education			
Primary or below (Ref.)	–	–	–
Secondary	-0.096	0.908 (0.769, 1.072)	0.256
Higher	0.108	1.115 (0.860, 1.443)	0.411

Table 2. Proportional odds model-based parameter estimates of selected covariates to determine the factors of stunting

Covariates	Estimate	Odds ratio (95% CI)	*p*
Wealth index			
Poor (Ref.)	–	–	–
Middle	-0.217	0.805 (0.683, 0.949)	< 0.01
Rich	-0.482	0.617 (0.499, 0.763)	< 0.01
Place of residence			
Urban (Ref.)	–	–	–
Rural	0.021	1.021 (0.873, 1.195)	0.792
Division			
Barisal (Ref.)	–	–	–
Chittagong	0.383	1.466 (1.148, 1.873)	< 0.01
Dhaka	0.097	1.102 (0.854, 1.422)	0.453
Khulna	0.168	1.183 (0.899, 1.554)	0.229
Rajshahi	0.145	1.156 (0.883, 1.512)	0.291
Rangpur	0.244	1.276 (0.980, 1.661)	0.070
Sylhet	0.297	1.345 (1.041, 1.739)	0.023
Mother's BMI			
Thin (Ref.)	–	–	–
Normal	-0.443	0.642 (0.552, 0.746)	< 0.01
Overweight	-0.667	0.513 (0.410, 0.642)	< 0.01
Antenatal care service			
No (Ref.)	–	–	–
Yes	-0.142	0.868 (0.736, 1.023)	< 0.10
Birth interval (months)			
Below 24 (Ref.)	–	–	–
24–47	-0.174	0.840 (0.719, 0.982)	0.028
Above 48	-0.048	0.954 (0.772, 1.178)	0.659

CI – confidence interval.

($p < 0.01$), respectively. Among the divisions, the risk of having stunted children was relatively higher in Chittagong (odds ratio = 1.466, $p < 0.05$), Sylhet (odds ratio = 1.345, $p < 0.05$) and Rangpur (odds ratio = 1.276, $p < 0.1$) compared to Barisal. Children with normal weight mothers had 36% lower odds of staying in the worst state of stunting status. It was also observed that children with overweight mothers had a lower risk of having a poor stunting status. Mothers receiving antenatal care service during pregnancy had a lower risk of having a stunted child (odds ratio = 0.868, $p < 0.10$). Moreover, children having a birth interval of 24–47 months had less chance of staying in the worst state of stunting status (odds ratio = 0.840, $p < 0.05$) compared with children having less than 24 months birth interval. However, the father's education and place of residence had no significant effect on the stunting status of children.

Discussion

This study was conducted with the data extracted from the Bangladesh Demographic and Health Survey 2014. Based on this secondary data source, the study attempted to identify the factors that influence the stunting status of children aged between 0 to 59 months. Although a great deal of literature could be identified that dealt with the same issue and revealed a number of factors that are associated with stunting, the number of studies on Bangladesh is very limited. Upon addressing this issue, the findings of the study exhibit that a number of factors affect the stunting status of children, which includes age of the child, mother's education, wealth index of families, body mass index of the mother, access and propensities to antenatal care services, division and birth interval.

It is evident from existing literature that with age, the odds of being stunted for a child increases significantly [34–37]. This study finds similar result, where children aged between 12 to 23 months and children aged more than 24 months had a higher probability of being stunted compared to infants, although children are supposed to have more nutritional food over time. Moreover, the volume of food intake increases significantly for a child who is at his/her early stage of development than an infant. Hence, the probability of being stunted is supposed to be much lower for a child older than an infant. Previous research on stunting suggests that children older than infant age have higher odds of being stunted, which should be further investigated.

This study also reveals that level of the mother's education has an inverse relationship to children's stunting status. The higher the mother's years of schooling, the lower the odds for a child of being stunted. The children of mothers having no education are more exposed to being stunted than children of mothers having secondary and higher education. This finding complies with other studies that suggest that children with mothers having higher education have lower odds of being stunted than those with mothers having no education [20, 38]. As an educated mother possesses better understanding of the needs of her newborn baby, she would generally have greater opportunity of learning the essentials of rearing a child at an institutional level than an uneducated mother. This finding, particularly, calls for greater attention on the part of the government for framing policies to facilitate education at an institutional level for females. Besides this, the relationship between a mother's BMI and the odds of giving birth to a child exposed to being stunted was found to be significant in this study, which is supported by previous work [39]. A contribution to the existing body of knowledge is the finding of this study, which reveals that children of both normal weight and overweight mothers have a lower probability of being stunted.

Children from families with a greater income and resources tend to have better diets and improved nutritional status, leading to lesser odds of having stunted children [40]. Studies reveal that children of undernourished mothers are more likely to be

stunted [41, 42]. The findings of this study confirm this argument in the sense that due to inadequate income, children from poor income families have higher odds in terms of switching from better to worse stunting status in comparison to children from middle income and wealthy families. Although literature suggests that the prevalence of stunting in the urban area was higher than in the rural area, the findings in this study reveal that the place of residence had no significant effect on the stunting status of children [43, 44]. Why this finding is the way it is goes beyond plausible explanation and demands further investigation. The same can be said for the district-wise stunting status of children. Why the prevalence of stunted children is higher in Chittagong, Sylhet or Rangpur compared to Barisal needs further research, which is beyond the scope of this study.

Whether antenatal care is being made use of or not has been an important factor on determining the stunting status of children. Literature exhibits the idea that non-use of antenatal care is associated with a prevalence of stunting [45], and children whose mother received antenatal care are less likely to be stunted [46, 47]. From this perspective, a key policy suggestion for the government would be expansion of antenatal care services to the far-reaching corners of the country. Bangladesh, having a majority of the population living in villages, needs to work on growing consciousness of the situation among the rural females so that they become aware of the positive implications of making use of antenatal care services as prescribed.

Although both short and long birth intervals may result in adverse pregnancy outcome [48], stunting has a relationship with the short-term birth interval. There is evidence of an association between birth interval and odds of stunting [49, 50], and this study confirms this, where it was found that children having a birth interval of 24–47 months had lower odds of being stunted compared to children having less than 24 months of a birth interval.

Limitations of the study

As this study is based on the data of the Bangladesh Demographic and Health Survey 2014, the limitations of that survey are applicable for this study as well. One of the limitations mentioned in the report was the difficulty of accurately determining each child's date of birth, which might have affected the reporting of the age of children. Another limitation is that this study particularly focused on some selected factors. Studies suggest that there can be other factors, such as duration of breast feeding, gender of the child, household size, use of iodized salt, mother's height, blood relations of parents, etc., that may affect the stunting status of children, which is subject to further investigation in the Bangladesh context [20, 44, 51].

Generalizability

The Bangladesh Demographic and Health Survey 2014 was the seventh Demographic and Health Survey conducted in Bangladesh, and the sample used for the 2014 BDHS is nationally representative. The survey was based on a two-stage stratified sampling of households and was designed to generate representative results for the country as a whole, for the urban and the rural areas separately and for each of the seven administrative divisions.

Conclusions

Stunting is an issue that is being studied intensely around the world. The prevalence of stunting can incorporate a number of factors. This study, using secondary data sources, identified some of the important factors that have higher probabilities of being associated with the stunting status of children in Bangladesh. Further research might be initiated to make sense of exactly why these particular factors influence the stunting status of children and why other factors, for instance rural urban division or the father's educational level, which were thought to have an influence, could not be found influential. Moreover, as a growing concern among the governments of both developing and underdeveloped countries, the study sheds light upon some probable policy responses in dealing with stunting that might positively affect the odds of stunting of children, including the role of education for females and expansion of care services for safe motherhood. Research on stunting, from the Bangladesh perspective, can also be conducted for seeking explanations of why the stunting status of children varies across different divisions within Bangladesh.

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