

Progress of Severe, Moderate and Global Acute Malnutrition among Children in Bangladesh

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Although Bangladesh has achieved remarkable economic growth and improved various health indicators, childhood malnutrition still is a big concern in improving child health in Bangladesh. This paper explores the prevalence and trends of severe acute malnutrition, moderate acute malnutrition and global acute malnutrition, as well as their socio-demographic factors and socio-economic differentials using the last seven rounds (1996-97, 1999-2000, 2004, 2007, 2011, 2014 and 2017-18) of Bangladesh Demographic and Health Survey, a nationally representative cross-sectional survey. Results show that the prevalence of all severe acute malnutrition, moderate acute malnutrition and global acute malnutrition has declined from 1996-97 to 2017-18 in Bangladesh: severe acute malnutrition from 6.8 per cent to 1.5 per cent; moderate acute malnutrition from 13.9 per cent to 6.9 per cent; and global acute malnutrition from 20.7 per cent to 8.4 per cent. On the other hand, the overall percentage change in the prevalence of severe, moderate and global acute malnutrition accounts for 78 per cent, 50.3 per cent and 59.4 per cent, respectively. The rate of annual decline of severe acute malnutrition is higher among rural children (7.02 per cent) and lower in those in urban areas (5.04 per cent). Child age (6-12 months), child size at birth (smaller), father's occupation, administrative division and mother's BMI are strongly related to severe, moderate, and global acute malnutrition. This paper also suggests that there is substantial room to upgrade the nutritional status of children aged 6-59 months in Bangladesh.

Keywords: Severe Acute Malnutrition, Moderate Acute Malnutrition, Global Acute Malnutrition, Children, Bangladesh

JEL Classification: C55, E61, I14, I15, Q18

I. INTRODUCTION

Malnutrition is a crucial public health problem worldwide, especially in developing countries like Bangladesh. For millions of survivors, malnutrition causes after-effects in the form of infirmity, chronic vulnerability to disease, and intellectual disability that can affect the human life cycle (WHO, 2001).

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Malnutrition, measured as poor anthropometric status, signifies an imbalance between intake and the need of the body to ensure optimal growth and function. This imbalance over a long period of time leads to chronic malnutrition and undernutrition, whereas acute malnutrition or wasting, reflects an acute imbalance that has occurred recently (Rahman, Chowdhury, & Hossain, 2009). It was estimated that 45 per cent of all deaths in children under the age of 5 years are linked to malnutrition (WHO, 2014). Acute malnutrition (often referred to as wasting) is a major global health problem (Mericq, Martinez-Aguayo, Uauy, Iniguez, Van der Steen, & Hokken-Koelega, 2017; World Bank, 2006). It is the clinical term for undernutrition, a big concern in the health sector. It is defined as a weight-for-height Z-score (WHZ) < -2 (wasting) (Kerac & Seal, 2014).

Acutely malnourished children are categorised into severe acute malnutrition (SAM) and moderate acute malnutrition (MAM) on the basis of body measurements (Langendorf et al., 2014). The World Health Organization (WHO) provides accepted definitions of SAM and MAM. MAM is defined as a weight-for-height z-score (WHZ) between -2 and -3 or mid-upper arm circumference (MUAC) between 115 millimetres and <125 millimetres (Hammer, 1972), and SAM as $WHZ < -3$ or $MUAC < 115$ millimetres, or the presence of bilateral pitting edema, or both (WHO, 2012). Global acute malnutrition (GAM) refers to MAM and SAM together, expressed as a weight-for-height-z-score value below $-2SD$ (WHO, 1986). GAM is used to measure nutritional status at a population level and as an indicator of the severity of an emergency situation (Global Nutrition Cluster, 2017).

Nearly 20 million children suffer from SAM globally; it is one of the top three nutrition-related causes of death in children under five. Children with SAM are 10 times more likely to die than well-nourished children. Estimates of deaths directly attributable to SAM vary from 0.5 to 2 million annually (Uauy, Desjeux, Ahmed, Hossain, Brewster, Forbes, & Kleinman, 2012). The vast majority of children suffering from SAM reside in Africa and Asia. India alone is home to more than 8 million children with SAM (Kapil & Sachdev, 2010), while Africa has 5.6 million children with SAM. Even up to the end of the 20th century, the case fatality rate for SAM among children under five ranged from 20 per cent to 50 per cent in many centres (Uauy et al., 2012).

According to a study, about 33 million among 52 million acutely malnourished children under five years of age, suffered from MAM (McNulty, 2013). Children with MAM face a higher risk of vulnerability to infectious diseases, which, in turn, puts them at three times more risk of death than children with sufficient nutrition (Chang, Trehan, Wang, Thakwalakwa, Maleta, Deitchler, & Manary, 2013;

Lenters et. al., 2013). MAM and SAM together account for roughly 11.5 per cent of total deaths of children under 5 (representing about 875,000 preventable deaths each year) (World Bank, 2006). Approximately one in six children under five years in South Asia suffered from MAM in 2013 (i.e., 17 per cent), followed by West and Central Africa (11 per cent) and the Middle East and North Africa (8 per cent). MAM affects roughly one in ten children under 5 years of age in least developed countries (The State of the World's Children 2014 in Numbers, 2014). MAM prevalence is 10 per cent or higher in 19 out of 80 countries with recent estimates. These children are at increased risk of SAM and, even with MAM, have a roughly three times higher risk of mortality from common communicable diseases than if they were well-nourished (Fernandez, Himes & De Onis 2002; Black et al., 2008).

Almost 15 per cent of South Asian children have acute malnutrition (UNICEF, 2005). According to the World Health Statistics report, a global total of 52 million children under 5 could be classified as having acute malnutrition in 2012 (McNulty, 2013). It is responsible for 8 per cent of child deaths each year globally (Fuchs, Sultana, Ahmed, & Hossain, 2014). Many studies revealed that acute malnutrition leads to more severe infection and higher case fatality in Bangladeshi children (Black, Brown & Becker 1984); it is one of the major causes of morbidity and mortality. Studies from Bangladesh have also revealed the effect of household variables such as wealth, education, and occupation (Bhuya, Susan, & D'Souza, 1986). Different studies have demonstrated that a range of variables, such as maternal variables, that affect fetal growth and birth size are associated with acute malnutrition in children (Rahman, Hawlader, Masud, & Rahman, 1981). A study in the Philippines found that a smaller birth size was the most significant risk factor for acute malnutrition, with age and infectious illness being two other key factors (Rahman, Chowdhury, & Hossain, 2009). The nutritional status of children is a reflection of their overall health. Research suggests that more than 400,000 child deaths can be prevented each year through proper and adequate identification and management of acute malnutrition (Laillou et al., 2014).

Given the above, the prime objective of this study is to explore the trends and prevalence of SAM, MAM, and GAM and assess the impact of associated factors on childhood undernutrition in Bangladesh to develop informed policies. The paper is structured as follows. After the introduction in section I, section II provides the methodology. Section III presents the results, while section IV discusses the results. Section V concludes the paper.

II. METHODOLOGY

2.1 Study Population and Data Source

We extracted data from the Bangladesh Demographic and Health Survey (BDHS), a nationally representative cross-sectional survey. We used the last seven rounds of BDHS survey data (1996-97, 1999-2000, 2004, 2007, 2011, 2014, and 2017-18). The surveys have collected data from 2nd November 1996 to 15th March 2018 as part of the worldwide Demographic and Health Surveys programme to collect information on fertility, family planning, infant and child mortality, maternal and child health, and knowledge of AIDS. The survey was carried out under the authority of the National Institute of Population Research and Training (NIPORT), the Medical Education and Family Welfare Division, and the Ministry of Health and Family Welfare. Detailed survey methodology, sample, and principal findings have been published elsewhere (NIPORT, Mitra and Associates, & ORC Macro, 2001; NIPORT, Mitra and Associates, & ORC Macro, 2005; NIPORT, Mitra and Associates, & Macro International, 2009; NIPORT, Mitra and Associates, & ICF International, 2013; NIPORT, Mitra and Associates, & ICF International, 2016; NIPORT & ICF International, 2020). We have included, in this study, women aged 15 to 49 years with at least one child within the same household as the study population.

2.2 Sampling Method and Sample Size

The BDHS used a two-stage stratified sampling frame to select households, and it utilised a nationally representative sample that covers the entire population. The survey occupied the sampling frame prepared by the Bangladesh Bureau of Statistics (BBS) using population and household information from the population census, which is nationally representative. The complete list of enumeration areas (EA) used for population census by BBS was the sampling frame. The detailed methods and sampling frame have been described in the BDHS report. The survey was designed to obtain 10,000, 10,268, 10,811, 11,485, 18,000, 18,000, and 20,160 fulfilled interviews with ever-married women aged 10-49 for 1996-97, 1999-2000, 2004, 2007, 2011, 2014, and 2017-18 survey years separately; of which 9,099, 9,854, 10,500, 10,819, 17,141, 17,863, and 19,457 ever-married women were interviewed for every particular survey year, respectively (NIPORT, Mitra and Associates, & ORC Macro, 2001; NIPORT, Mitra and Associates, & ORC Macro, 2005; NIPORT, Mitra and Associates, & Macro International, 2009; NIPORT, Mitra and Associates, & ICF International, 2013; NIPORT, Mitra and Associates, & ICF International, 2016; NIPORT & ICF International, 2020). In this current study, we have considered the cohort of ever-married women aged 15-49 years with at least one child of an ever-married woman in the same household. The

number of such women interviewed in the BDHS 1996-97, 1999-2000, 2004, 2007, 2011, 2014 and 2017-18 was 4,879, 5,490, 6,027, 5,268, 7,761, 7,208, and 7,750, respectively.

2.3 Outcome Variables

The outcome variable of the analysis was the children's acute malnutrition status and categorised as severe acute malnutrition (SAM), moderate acute malnutrition (MAM), and global acute malnutrition (GAM). Acute malnutrition status was categorised as SAM if the weight-for-height-z-score value was below $-3SD$, MAM if the weight-for-height-z-score value stayed between $-2SD$ and $-3SD$, and GAM if the weight-for-height-z-score value was below $-2SD$ (WHO, 1986). Children aged up to 59 months were included in this analysis to capture the prevalence of MAM, SAM and GAM and categorised into six age groups. Mother's Body Mass Index (BMI) was calculated by dividing body weight (kg) by height (m^2). It was categorised as normal if the BMI value stayed between 18.5 kg/m^2 and 22.9 kg/m^2 , thin if the BMI value was below 18.5 kg/m^2 , and overweight if the BMI value equated to or was greater than 23 kg/m^2 (Ismail & Tan, 2000).

2.4 Major Explanatory Variables

Studies have identified different socioeconomic and maternal factors that are strongly associated with various forms of malnutrition (Biswas, Rahman, Khanam, Baqui, & Ahmed, 2019; Biswas, Townsend, Magalhaes, Hasan, & Mamun, 2021; Hasan et al., 2017; Kimani-Murage et al., 2015; Mahmood, Ali & Islam, 2013; Nakphong & Beltrán-Sánchez, 2021; Nguyen et al., 2021; Wong et al., 2015). Based on the published literature, we included, in this analysis, child age and sex, child birth order, number of children, maternal and paternal education level, paternal occupation, participant's family size, place of residence, household's administrative division, and wealth index of the households as explanatory variables. Maternal and paternal education levels were classified as: no education, up to primary education, up to secondary education, and higher education; a mother's working status as "yes" if she works and "no" otherwise; fathers' occupation as day labour, agriculture, business, services and others; mothers' BMI as normal weight, underweight, and obese or overweight; participants' family size as small (<4 members), medium (4-6 members), and large (>6 members); and household's administrative division as Dhaka, Chattogram, Rajshahi, Khulna, Barishal, Sylhet, Rangpur, and Mymensingh. DHS measured the household socioeconomic status by calculating the wealth index using principal component analysis (PCA). It was a combined measure of the cumulative living standard and was calculated using selected household assets by generating a factor score as the weight. The procedure includes calculating factor coefficient scores and

standardising indicator variables. Finally, indicator values were multiplied by the factor loadings to generate the index value per household (Rutstein & Johnson, 2004). For this subset analysis, the wealth index was measured following the DHS guidelines and categorised into the ‘poorest’, ‘poorer’, ‘middle’, ‘richer’ and ‘richest’ quintiles (NIPORT, Mitra and Associates, & ICF International, 2016).

2.5 Data Analysis

The percentage changes in the prevalence of SAM, MAM and GAM from 1996-97 to 2017-18 were calculated using the following formula (Sarker et al., 2019).

$$\begin{aligned} & \text{Percentage change} \\ & = \frac{\text{Prevalence at the base year} - \text{Prevalence at the current year}}{\text{Prevalence at the base year}} \times 100 \end{aligned}$$

The base year for this calculation is 1996-97, and the current year is 2017-18. Therefore, the annual percentage change of the prevalence of SAM, MAM and GAM was calculated using the following formula:

$$\begin{aligned} & \text{Annual percentage change} \\ & = \left(\frac{\text{Prevalence at the current year}}{\text{Prevalence at the base year}} \right)^{\frac{1}{\text{No.of years}}} - 1 \times 100 \end{aligned}$$

Multivariate analyses were performed to identify the influential factors associated with MAM, SAM, and GAM prevalence. All of the 44,383 ever-married women who have children under the age of five were included in the descriptive analysis. Sampling weight, provided by the BDHS database, was used to weight the data and thus make the sample more representative of the population at the national level. Descriptive bivariate analysis techniques were used to find out the prevalence of MAM, SAM, and GAM across the place of residence of the participants with 95 per cent confidence intervals. Multivariable logistic regression analysis was performed to investigate the influential factors for MAM, SAM, and GAM and reported as an odds ratio (OR) with 95 per cent confidence intervals for both adjusted models. Adjusted odds ratios were obtained by including all influential variables in the model to consider the effect of all additional confounding variables included in the regression model. The chi-square test of independence was used and measured by P-value. The findings were presented by odds ratios (ORs) with a 95 per cent confidence interval. Finally, a multinomial multivariate logistic regression model was executed, and the results were presented in terms of adjusted RRR (relative risk ratio) with a 95 per cent confidence interval. All statistical analyses were performed using the statistical package STATA (version 14.0) and interpreted the results as statistically significant at a p-value of <0.05.

2.6 Ethical Approval

BDHS is a publicly available dataset and can be downloaded from the DHS Program website. The survey followed standardised data collection procedures and received ethics approval from the National Research Ethics Committee (NREC) of the Bangladesh Ministry of Health and Family Welfare. The study analysed this publicly available DHS data set by taking consent from the MEASURE DHS program office. According to the DHS, they obtained written informed consent from women enrolled in the survey.

III. RESULTS

3.1 Background Characteristics of the Study Participants

The sociodemographic, maternal, and household characteristics of the study participants are presented in Table I. About 40 per cent of children were aged 36-59 months, and about 51 per cent were males. The proportions of male and female children were almost equally distributed in each survey round. About 38 per cent of households had at least three or more children, followed by households with two children (32 per cent). Overall, 35 per cent of mothers had completed secondary education, and their educational attainment (secondary and higher level) increased over the period (17 per cent vs 64 per cent from 1996-97 to 2017-18). Approximately 30 per cent of mothers had primary-level education, and 28 per cent had no formal education. Most mothers (76 per cent) were unemployed and had normal BMI (57 per cent). About 31 per cent of mothers were underweight, followed by overweight (10 per cent) and obese mothers (3 per cent). Approximately 53 per cent of mothers reported that they had their first child before 18 years. Overall, the educational statuses of fathers have increased over the years; their occupations were shifted from agriculture (40 per cent: 1996-97; 20 per cent: 2017-18) to daily workers (33 per cent: 1996-97; 51 per cent: 2017-18). About 56 per cent of families were found medium (4-6 members) in size in the 2017-18 dataset, followed by larger households (31 per cent). Overall, 79 per cent of the children under five belonged to the rural areas; 31 per cent of the study population were selected from the Dhaka division. Around 43 per cent of participants were found poor by their socioeconomic status.

TABLE I
BACKGROUND CHARACTERISTICS OF THE STUDY PARTICIPANTS (N=44,383)

Characteristics	1996-97 (n=4,879)	1999-00 (n=5,490)	2004 (n=6,027)	2007 (n=5,268)	2011 (n=7,761)	2014 (n=7,208)	2017-18 (n=7,750)	Overall (n=44,383)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Age in month								
<6 months	488 (10.00)	659 (12.00)	610 (10.11)	456 (8.65)	691 (8.90)	589 (8.17)	841 (10.85)	4333 (9.76)
6-12 months	590 (12.08)	614 (11.18)	670 (11.12)	654 (12.42)	966 (12.45)	976 (13.54)	921 (11.89)	5391 (12.15)
13-23 months	861 (17.65)	1036 (18.88)	1087 (18.04)	1023 (19.42)	1311 (16.89)	1402 (19.45)	1471 (18.98)	8191 (18.46)
24-35 months	969 (19.86)	1050 (19.13)	1207 (20.02)	1062 (20.16)	1446 (18.63)	1428 (19.80)	1536 (19.82)	8697 (19.60)
36-47 months	1002 (20.54)	1015 (18.49)	1244 (20.64)	1023 (19.42)	1720 (22.16)	1407 (19.52)	1474 (19.01)	8884 (20.02)
48-59 months	969 (19.86)	1115 (20.32)	1210 (20.07)	1050 (19.93)	1628 (20.97)	1407 (19.52)	1508 (19.45)	8886 (20.02)
Sex								
Male	2426 (49.71)	2784 (50.70)	3054 (50.68)	2616 (49.65)	3946 (50.84)	3735 (51.82)	4046 (52.20)	22606 (50.93)
Female	2454 (50.29)	2706 (49.30)	2972 (49.32)	2652 (50.35)	3815 (49.16)	3473 (48.18)	3704 (47.80)	21777 (49.07)
Birth order								
First	1259 (25.80)	1547 (28.17)	1725 (28.62)	1734 (32.92)	2691 (34.67)	2763 (38.33)	2959 (38.18)	14678 (33.07)
Second	1152 (23.61)	1398 (25.47)	1552 (25.75)	1393 (26.44)	2255 (29.06)	2167 (30.07)	2511 (32.41)	12428 (28.00)
Third	813 (16.67)	931 (16.96)	1117 (18.53)	904 (17.16)	1356 (17.47)	1177 (16.33)	1318 (17.01)	7617 (17.16)
Fourth or more	1656 (33.93)	1614 (29.40)	1633 (27.09)	1237 (23.48)	1459 (18.80)	1101 (15.28)	961 (12.40)	9660 (21.76)
Number of children								
One child	1127 (23.09)	1326 (24.16)	1471 (24.41)	1511 (28.69)	2365 (30.47)	2502 (34.71)	2652 (34.22)	12954 (29.19)
Two children	1343 (27.52)	1624 (29.57)	1836 (30.47)	1650 (31.32)	2618 (33.73)	2456 (34.07)	2883 (37.20)	14410 (32.47)
3 or more child	2410 (49.39)	2540 (46.27)	2719 (45.12)	2107 (39.99)	2778 (35.79)	2251 (31.23)	2214 (28.57)	17019 (38.35)
Mothers' educational status								
No education	2739 (56.13)	2554 (46.52)	2259 (37.49)	1410 (26.77)	1564 (20.16)	1179 (16.36)	556 (07.18)	12262 (27.63)
Primary education	1335 (27.35)	1599 (29.13)	1886 (31.29)	1667 (31.64)	2384 (30.72)	2017 (27.98)	2224 (28.70)	13112 (29.54)
Secondary education	689 (14.12)	1129 (20.57)	1577 (26.17)	1853 (35.18)	3270 (42.14)	3337 (46.30)	3782 (48.80)	15637 (35.23)
Higher education	117 (02.40)	208 (03.78)	304 (05.05)	338 (06.41)	543 (06.99)	675 (09.36)	1188 (15.32)	3372 (07.60)
Mothers working status								
Not working	3219 (65.97)	4525 (82.42)	4958 (82.27)	3863 (73.33)	7050 (90.84)	5317 (73.77)	4613 (59.52)	33545 (75.58)
Working	1660 (34.03)	965 (17.58)	1069 (17.73)	1405 (26.67)	711 (09.16)	1891 (26.23)	3137 (40.48)	10838 (24.42)

(Contd. Table I)

Characteristics	1996-97	1999-00	2004	2007	2011	2014	2017-18	Overall
	(n=4,879)	(n=5,490)	(n=6,027)	(n=5,268)	(n=7,761)	(n=7,208)	(n=7,750)	(n=44,383)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Mothers BMI								
Underweight	2419 (49.57)	2393 (43.59)	2241 (37.19)	1686 (32.00)	2157 (27.79)	1587 (22.02)	1088 (14.04)	13571 (30.58)
Normal Weight	2260 (46.31)	2830 (51.55)	3433 (56.97)	3166 (60.09)	4665 (60.11)	4282 (59.40)	4660 (60.13)	25296 (56.99)
Overweight	102 (02.09)	183 (03.33)	275 (04.56)	357 (06.77)	769 (09.91)	1098 (15.23)	1582 (20.41)	4364 (09.83)
Obese	99 (02.03)	84 (01.53)	77 (01.28)	60 (01.14)	170 (02.19)	241 (03.35)	420 (05.43)	1153 (02.60)
Mothers age at first birth								
Less than 18 years	3177 (65.12)	3188 (58.06)	3635 (60.31)	2790 (52.96)	3940 (50.77)	3285 (45.57)	3351 (43.24)	23365 (52.65)
18-24	1588 (32.54)	2127 (38.73)	2234 (37.06)	2308 (43.80)	3495 (45.03)	3592 (49.84)	4032 (52.03)	19375 (43.66)
25 or above	114 (02.34)	176 (03.20)	158 (02.63)	170 (03.23)	326 (4.2)	331 (04.59)	367 (04.73)	1642 (03.70)
Fathers' educational status								
No education	2303 (47.20)	2436 (44.37)	2422 (40.18)	1855 (35.21)	2309 (29.75)	1866 (25.89)	1268 (16.36)	14458 (32.58)
Primary education	1277 (26.17)	1343 (24.47)	1644 (27.29)	1477 (28.03)	2258 (29.09)	2167 (30.06)	2643 (34.10)	12809 (28.86)
Secondary education	942 (19.31)	1187 (21.62)	1406 (23.33)	1355 (25.72)	2218 (28.58)	2199 (30.51)	2529 (32.64)	11837 (26.67)
Higher education	357 (07.32)	524 (09.54)	554 (09.20)	581 (11.04)	976 (12.58)	975 (13.53)	1310 (16.91)	5278 (11.89)
Fathers' occupation								
Daily basis worker	1605 (32.89)	2124 (38.69)	2395 (39.75)	2274 (43.17)	3245 (41.81)	3064 (42.51)	3943 (50.88)	18651 (42.02)
Agriculture	1958 (40.13)	1625 (29.59)	1884 (31.26)	1527 (28.99)	2246 (28.94)	1898 (26.34)	1559 (20.12)	12697 (28.61)
Business	1032 (21.15)	1183 (21.55)	1387 (23.01)	1113 (21.13)	1670 (21.51)	1597 (22.16)	1609 (20.76)	9591 (21.61)
Service	204 (04.18)	258 (04.70)	172 (02.85)	187 (03.56)	396 (05.10)	409 (05.68)	411 (05.30)	2037 (04.59)
Others	81 (01.65)	300 (05.47)	189 (03.13)	166 (03.15)	205 (02.64)	239 (03.32)	228 (02.94)	1407 (03.17)
Household size								
Small (<4)	433 (08.87)	433 (07.89)	553 (09.17)	505 (09.58)	779 (10.04)	818 (11.35)	954 (12.31)	4474 (10.08)
Medium (4-6)	2415 (49.49)	2760 (50.28)	3121 (51.80)	2878 (54.62)	4337 (55.88)	4144 (57.49)	4371 (56.40)	24026 (54.13)
Large (6 and more)	2032 (41.64)	2297 (41.84)	2352 (39.03)	1886 (35.80)	2646 (34.09)	2246 (31.16)	2425 (31.29)	15883 (35.79)
Place of residence								
Urban	455 (09.32)	898 (16.36)	1180 (19.58)	1109 (21.05)	1714 (22.09)	1818 (25.23)	2042 (26.35)	9217 (20.77)
Rural	4425 (90.68)	4592 (83.64)	4846 (80.42)	4159 (78.95)	6047 (77.91)	5390 (74.77)	5707 (73.65)	35165 (79.23)

(Contd. Table I)

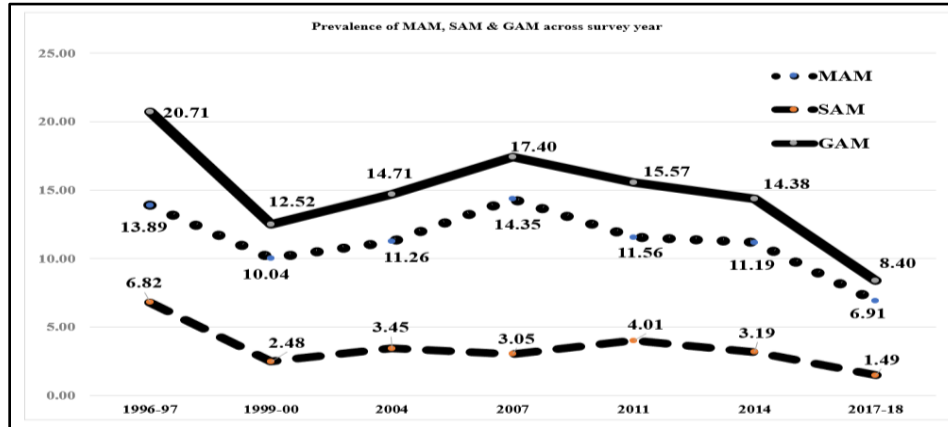
Characteristics	1996-97 (n=4,879)	1999-00 (n=5,490)	2004 (n=6,027)	2007 (n=5,268)	2011 (n=7,761)	2014 (n=7,208)	2017-18 (n=7,750)	Overall (n=44,383)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Division								
Dhaka	1518 (31.11)	1715 (31.25)	1851 (30.72)	1672 (31.73)	2422 (31.21)	2531 (35.12)	1933 (24.95)	13643 (30.74)
Chattogram	1216 (24.91)	1213 (22.09)	1329 (22.05)	1147 (21.77)	1772 (22.83)	1522 (21.12)	1605 (20.71)	9803 (22.09)
Rajshahi	1029 (21.09)	1254 (22.84)	1334 (22.14)	1157 (21.96)	977 (12.59)	755 (10.48)	904 (11.66)	7410 (16.70)
Khulna	484 (09.92)	566 (10.31)	657 (10.90)	507 (09.63)	728 (09.38)	550 (07.63)	730 (09.42)	4223 (09.51)
Barishal	319 (06.53)	339 (06.17)	360 (05.98)	340 (06.46)	420 (05.41)	414 (05.75)	437 (05.64)	2629 (05.92)
Sylhet	315 (06.45)	403 (07.34)	495 (08.22)	445 (08.45)	601 (07.74)	703 (09.75)	645 (08.32)	3607 (08.13)
Rangpur	-	-	-	-	841 (10.83)	732 (10.15)	840 (10.84)	2412 (05.43)
Mymensingh	-	-	-	-	-	-	656 (08.46)	656 (01.48)
Wealth index (n=34,013)								
Poorest	-	-	1518 (25.19)	1180 (22.39)	1831 (23.60)	1642 (22.78)	1687 (21.76)	7858 (23.10)
Poorer	-	-	1239 (20.55)	1141 (21.66)	1589 (20.47)	1358 (18.83)	1587 (20.48)	6913 (20.33)
Middle	-	-	1187 (19.69)	1019 (19.35)	1507 (19.42)	1426 (19.78)	1486 (19.17)	6625 (19.48)
Richer	-	-	1088 (18.05)	991 (18.81)	1476 (19.01)	1431 (19.85)	1559 (20.12)	6545 (19.24)
Richest	-	-	995 (16.51)	937 (17.78)	1358 (17.50)	1352 (18.75)	1431 (18.46)	6072 (17.85)

Source: Authors' estimation.

3.2 Prevalence of SAM, MAM, and GAM across Survey Years

The prevalence of severe, moderate and global acute malnutrition in Bangladesh over the seven survey periods is shown in Figure 1. We observed how the prevalence of SAM, MAM and GAM has declined from 1996-97 to 2017-18. SAM declined from 6.82 per cent in 1996-97 to 1.49 per cent in 2017-18, and MAM was 6.91 per cent in 2017-18 and 13.89 per cent in 1996-97. Similarly, a decreasing trend of childhood global acute malnutrition was also observed, from 20.71 per cent in 1996-97 to 8.40 per cent in 2017-18.

FIGURE 1: Trends of the Prevalence of MAM, SAM and GAM Across Survey Years



3.3 Distribution of SAM, MAM, and GAM across Background Characteristics

The overall change in severe acute malnutrition over the 22 years (1996 to 2018) was about 78.15 per cent. On the other hand, the prevalence of SAM declined at a rate of 6.68 per cent per annum (Table III). The percentage of annual decline was comparatively high for children aged 6 to 12 months (9.91 per cent), which was almost the same among male and female children. Educated mothers contributed more (7.95 per cent) to the deterioration of SAM. As with education, the working status of mothers also contributed positively to the declining SAM of their children over that of the non-working mothers (7.38 per cent vs 6.25 per cent). The percentage of the annual decline was higher among mothers who first gave birth at the age of 25 (9.79 per cent) than younger mothers (6.70 per cent). Like mothers' education, as we observed, the percentage of the annual decline of SAM was higher among children who had fathers with higher education (8.15 per cent) and were employed in service sectors (9.16 per cent). The declining rate was highest (10.09 per cent) among small households than in large households (5.72

per cent). The annual decline of the SAM prevalence rate was higher among rural children (7.02 per cent) than in urban children (5.04 per cent). The percentage of the annual SAM decline was higher in the Rangpur division (15.56 per cent), followed by Rajshahi (8.26 per cent) and Sylhet (7.93 per cent). Regarding the wealth quintiles, the percentage of the annual decline of SAM was high in poorer wealth quintiles (9.10 per cent), followed by middle wealth quintiles (6.30 per cent).

The overall percentage change in the prevalence of moderate acute malnutrition was 50.25 per cent, with a 3.12 per cent annual decline rate (Table II). The percentage of annual change of decline was the highest among children aged 6 to 23 months (9.78 per cent), and females (3.46 per cent) who lived in rural areas (3.31 per cent) and belonged to medium households (3.66 per cent). The higher educational status of mothers (3.98 per cent) and working status of mothers (3.47) played a greater role in declining moderate acute malnutrition among Bangladeshi children. The annual decline rate of MAM was lower among the children who had underweight mothers (1.63 per cent), adult mothers aged 25 and above (0.73 per cent), children from small households (1.77 per cent) and those who belonged to urban households (1.43 per cent) and those living in Sylhet division (1.81 per cent). The annual percentage of change in MAM was high in the Rangpur division (6.49 per cent), followed by the Chattogram division (4.20 per cent) and children of middle wealth quintiles (4.57 per cent).

The prevalence of global acute malnutrition was 8.41 per cent in 2017-18. The overall change in GAM over the 22 years was about 59.39 per cent, while the prevalence of acute malnutrition declined at a rate of 4.01 per cent per annum (Table IV). The percentage of annual decline was comparatively high among children aged 6 to 12 months (6.36 per cent), among females (4.22 per cent) and those who belonged to the medium wealth quintiles (4.95 per cent). The higher educational status of mothers (4.80 per cent) and fathers (4.57 per cent) contributed significantly to declining GAM among Bangladeshi children. The percentage of the annual decline of childhood GAM was higher among the mothers who were employed (4.40 per cent), those who were 18 to 24 years old (4.23 per cent) and those belonging to medium households (4.39 per cent). However, the annual GAM declining rate was lower among uneducated mothers (2.90 per cent), underweight mothers (2.68 per cent), older mothers aged 25 or more (2.86 per cent), and children belonging to urban households (2.43 per cent). Across administrative divisions, the annual percentage of decline was high in the Rangpur division (8.11 per cent), followed by the Chattogram division (4.97 per cent).

TABLE II
DISTRIBUTION OF MAM AMONG UNDER-FIVE CHILDREN IN
BANGLADESH FROM 1996-97 TO 2017-18

Characteristics	Moderate Acute Malnutrition (MAM)								P-value (Base year vs. Current year)	
	1996-97	1999-00	2004	2007	2011	2014	2017-18	Percentage change		Annual Percentage Change
Age in month										
<6 months	14.51	8.95	10.04	13.09	9.60	14.88	6.66	54.10	-3.48	0.081
6-12 months	18.49	15.42	11.97	13.82	10.28	12.89	5.99	67.60	-4.99	0.015
13-23 months	19.88	12.98	15.29	18.72	11.23	10.53	6.75	66.05	-4.79	0.002
24-35 months	11.74	8.74	9.82	13.98	11.50	10.72	5.86	50.09	-3.11	0.074
36-47 months	9.65	7.70	9.77	11.83	11.86	9.83	7.76	19.59	-0.99	0.313
48-59 months	12.02	8.36	10.84	13.80	13.16	10.98	8.02	33.28	-1.82	0.152
Sex										
Male	14.30	10.94	12.18	14.77	11.65	11.34	7.55	47.20	-2.86	0.003
Female	13.49	9.12	10.32	13.94	11.47	11.03	6.21	53.97	-3.46	0.003
Birth order										
First	14.56	9.08	11.02	12.58	10.98	11.14	6.92	52.47	-3.32	0.007
Second	12.49	9.56	11.18	15.40	11.58	11.40	7.08	43.31	-2.55	0.050
Third	14.68	9.64	12.50	15.39	10.94	10.27	6.94	52.72	-3.35	0.039
Fourth or more	13.98	11.62	10.76	14.89	13.19	11.91	6.40	54.22	-3.49	0.054
Number of children										
One child	15.52	9.86	10.91	13.66	11.03	11.68	6.99	54.96	-3.56	0.005
Two children	13.27	9.38	11.71	14.79	11.45	11.20	6.84	48.46	-2.97	0.006
3 or more child	13.49	10.56	11.16	14.50	12.11	10.65	6.92	48.70	-2.99	0.017
Mothers' educational status										
No education	15.58	12.00	12.80	16.24	12.91	11.64	10.13	34.98	-1.94	0.141
Primary education	11.45	9.02	11.12	15.43	13.71	11.73	7.36	35.72	-1.99	0.106
Secondary education	12.15	7.61	9.66	12.38	10.05	11.05	6.74	44.53	-2.64	0.057
Higher education	12.50	7.09	9.14	11.96	7.32	9.55	5.12	59.04	-3.98	0.151
Mothers working status										
Not working	13.11	9.78	10.93	13.60	11.45	10.56	6.79	48.21	-2.95	0.003
Working	15.41	11.29	12.82	16.40	12.63	12.98	7.09	53.99	-3.47	0.002
Mothers BMI										
Underweight	16.47	13.34	14.78	19.07	16.58	14.70	11.47	30.36	-1.63	0.088
Normal Weight	11.05	7.64	9.52	12.83	10.24	11.45	6.44	41.72	-2.42	0.027
Overweight	13.38	5.96	6.74	6.25	6.44	6.37	6.20	53.66	-3.44	0.164
Obese	16.34	5.96	2.83	10.00	7.34	5.45	3.03	81.46	-7.37	0.121

(Contd. Table II)

Characteristics	Moderate Acute Malnutrition (MAM)								P-value (Base year vs. Current year)	
	1996-97	1999-00	2004	2007	2011	2014	2017-18	Percentage change		Annual Percentage Change
Mothers age at first birth										
Less than 18 years	14.10	10.00	12.30	14.49	12.26	11.50	7.42	47.38	-2.88	0.004
18-24	14.01	9.94	9.61	14.02	11.11	11.26	6.60	52.89	-3.36	0.003
25 or above	6.71	12.09	10.89	16.49	7.95	7.43	5.71	14.90	-0.73	0.460
Fathers' educational status										
No education	14.80	11.75	11.96	14.83	12.03	11.85	7.97	46.15	-2.77	0.038
Primary education	14.78	9.45	10.72	14.57	12.85	11.19	7.06	52.23	-3.30	0.008
Secondary education	11.70	8.97	12.20	14.29	11.54	9.88	7.07	39.57	-2.26	0.089
Higher education	10.65	6.06	7.46	12.36	7.50	12.90	5.29	50.33	-3.13	0.152
Fathers' occupation										
Daily basis worker	14.21	11.58	11.16	12.71	11.44	10.65	7.66	46.09	-2.77	0.007
Agriculture	14.23	10.33	11.28	17.28	12.23	12.49	7.74	45.61	-2.73	0.035
Business	12.75	7.84	11.63	14.96	11.36	11.46	5.07	60.24	-4.11	0.033
Service	14.56	5.24	5.37	11.22	8.80	9.92	4.79	67.10	-4.93	0.136
Others	12.33	10.41	15.07	9.22	12.95	8.40	5.15	58.23	-3.89	0.273
Household size										
Small (<4)	13.62	12.24	9.50	14.02	12.32	10.06	9.19	32.53	-1.77	0.200
Medium (4-6)	15.26	10.57	12.53	14.84	11.97	11.42	6.72	55.96	-3.66	0.000
Large (6 and more)	12.34	8.99	9.99	13.68	10.66	11.19	6.35	48.54	-2.97	0.026
Place of residence										
Urban	9.84	8.74	10.54	11.61	10.29	9.07	7.17	27.13	-1.43	0.279
Rural	14.31	10.30	11.44	15.08	11.92	11.91	6.82	52.34	-3.31	0.000
Division										
Dhaka	12.88	9.52	10.00	12.54	11.26	9.93	7.52	41.61	-2.42	0.144
Chattogram	16.05	10.22	11.53	14.02	12.07	11.66	6.25	61.06	-4.20	0.073
Rajshahi	13.30	10.78	12.95	16.67	11.13	13.94	6.65	50.00	-3.10	0.180
Khulna	15.17	8.98	12.50	15.38	11.08	10.23	6.34	58.21	-3.89	0.205
Barishal	11.37	10.40	7.49	14.55	12.06	13.67	6.03	46.97	-2.84	0.281
Sylhet	12.99	10.64	11.84	14.61	14.14	9.68	8.69	33.10	-1.81	0.268
Rangpur	-	-	-	-	10.17	12.56	6.36	37.46	-6.49	0.329
Mymensingh	-	-	-	-	-	-	7.27	0.00	0.00	0.500
Wealth index (n=3,675)										
Poorest	-	-	13.97	16.72	13.11	13.21	8.21	41.23	-3.73	0.051
Poorer	-	-	11.40	14.58	12.05	13.05	7.00	38.60	-3.42	0.118
Middle	-	-	11.84	14.36	13.44	9.94	6.15	48.06	-4.57	0.076
Richer	-	-	9.09	14.53	10.21	10.47	7.26	20.13	-1.59	0.313
Richest	-	-	8.67	10.87	8.27	8.97	5.70	34.26	-2.95	0.229
Overall	13.89	10.04	11.26	14.35	11.56	11.19	6.91	50.25	-3.12	0.000

TABLE III
DISTRIBUTION OF SAM AMONG UNDER-FIVE CHILDREN IN BANGLADESH FROM 1996-97 TO 2017-18

Characteristics	Severe Acute Malnutrition (SAM)							Percentage change	Annual Percentage Change	<i>P-value</i> (Base year vs. Current year)
	1996-97	1999-00	2004	2007	2011	2014	2017-18			
Age in month										
<6 months	11.79	3.91	5.21	4.55	6.18	5.30	2.52	78.63	-6.77	0.105
6-12 months	12.11	5.05	6.18	4.42	4.37	6.58	1.22	89.93	-9.91	0.138
13-23 months	9.20	3.44	4.30	4.06	4.21	3.08	1.62	82.39	-7.59	0.108
24-35 months	5.93	1.69	4.06	2.50	3.23	2.39	2.24	62.23	-4.33	0.207
36-47 months	3.80	1.39	1.41	2.71	4.12	1.74	1.05	72.37	-5.68	0.294
48-59 months	2.98	1.08	1.79	1.42	3.30	2.36	0.64	78.52	-6.75	0.338
Sex										
Male	7.73	2.41	3.77	3.39	4.22	3.88	1.66	78.53	-6.75	0.038
Female	5.92	2.56	3.13	2.71	3.80	2.46	1.31	77.87	-6.63	0.095
Birth order										
First	5.88	2.36	3.33	3.13	3.71	2.92	1.54	73.81	-5.91	0.125
Second	5.90	2.37	2.38	2.70	3.30	3.53	1.25	78.81	-6.81	0.145
Third	7.09	2.63	3.24	2.58	3.97	3.84	1.83	74.19	-5.97	0.172
Fourth or more	8.04	2.61	4.75	3.67	5.72	2.53	1.52	81.09	-7.29	0.180
Number of children										
One child	7.23	3.12	3.58	3.11	3.69	3.00	1.80	75.10	-6.12	0.090
Two children	5.86	2.02	2.85	3.02	3.56	3.51	1.02	82.59	-7.64	0.139
3 or more child	7.16	2.45	3.79	3.01	4.71	3.06	1.75	75.56	-6.20	0.102
Mothers' educational status										
No education	7.19	2.62	3.89	3.11	4.87	2.94	1.79	75.10	-6.12	0.256
Primary education	6.62	2.65	3.27	3.66	4.26	3.61	1.57	76.28	-6.33	0.127
Secondary education	6.04	2.11	3.34	2.71	3.51	3.00	1.62	73.18	-5.81	0.113
Higher education	5.01	1.55	1.94	1.60	3.46	3.36	0.81	83.83	-7.95	0.297
Mothers working status										
Not working	6.57	2.39	3.41	2.95	4.19	3.20	1.59	75.80	-6.25	0.050
Working	7.30	2.90	3.66	3.30	2.29	3.18	1.35	81.51	-7.38	0.077
Mothers BMI										
Underweight	8.23	3.37	5.11	4.48	4.49	4.05	2.13	74.12	-5.96	0.148
Normal Weight	5.45	1.93	2.54	2.47	4.06	3.07	1.51	72.29	-5.67	0.089
Overweight	4.39	0.51	2.13	1.31	2.94	2.63	1.03	76.54	-6.38	0.312
Obese	6.03	0.00	0.59	3.46	1.39	2.42	1.37	77.28	-6.51	0.335

(Contd. Table III)

Characteristics	Severe Acute Malnutrition (SAM)								Percentage change	Annual Percentage Change	P-value (Base year vs. Current year)
	1996-97	1999-00	2004	2007	2011	2014	2017-18				
Mothers age at first birth											
Less than 18 years	6.67	2.45	3.47	2.95	4.16	3.64	1.45	78.26	-6.70	0.078	
18-24	7.24	2.66	3.39	3.20	3.96	2.49	1.62	77.62	-6.58	0.052	
25 or above	5.11	0.83	3.93	2.62	2.83	6.45	0.53	89.63	-9.79	0.387	
Fathers' educational status											
No education	7.69	2.79	3.43	4.02	4.85	2.85	1.49	80.62	-7.19	0.159	
Primary education	5.89	2.35	3.72	2.58	4.20	4.14	1.41	76.06	-6.29	0.139	
Secondary education	5.74	2.56	3.90	2.55	3.35	2.83	1.77	69.16	-5.21	0.156	
Higher education	7.34	1.24	1.62	2.27	3.13	2.59	1.13	84.60	-8.15	0.191	
Fathers' occupation											
Daily basis worker	5.98	2.53	3.38	3.16	3.55	3.60	1.49	75.08	-6.12	0.090	
Agriculture	7.65	2.81	3.79	3.58	5.36	3.25	1.76	76.99	-6.46	0.131	
Business	5.73	2.19	3.54	2.50	3.39	2.89	1.11	80.63	-7.19	0.208	
Service	7.86	1.98	0.80	0.76	3.79	2.52	0.95	87.91	-9.16	0.308	
Others	14.71	2.00	2.90	2.83	2.10	0.73	3.51	76.14	-6.31	0.209	
Household size											
Small (<4)	8.52	3.42	4.54	2.43	3.98	2.70	0.82	90.38	-10.09	0.222	
Medium (4-6)	6.84	2.38	3.26	3.26	3.97	3.46	1.49	78.22	-6.69	0.052	
Large (6 and more)	6.43	2.42	3.46	2.89	4.09	2.89	1.76	72.63	-5.72	0.117	
Place of residence											
Urban	5.52	2.21	3.24	2.87	3.61	3.35	1.77	67.93	-5.04	0.210	
Rural	6.95	2.53	3.50	3.09	4.13	3.14	1.40	79.86	-7.02	0.029	
Division											
Dhaka	5.45	2.44	3.07	2.91	4.18	2.08	1.38	74.68	-6.05	0.274	
Chattogram	8.52	2.19	4.39	3.58	3.71	3.90	1.75	79.46	-6.94	0.259	
Rajshahi	6.40	2.90	3.33	2.09	5.34	3.52	0.96	85.00	-8.26	0.311	
Khulna	5.92	1.89	3.83	3.56	3.64	3.61	1.36	77.03	-6.47	0.367	
Barishal	6.15	2.73	1.89	3.76	3.34	4.26	2.88	53.17	-3.39	0.430	
Sylhet	10.28	2.87	3.36	3.53	4.50	2.23	1.67	83.75	-7.93	0.331	
Rangpur	-	-	-	-	2.94	5.26	0.90	69.39	-15.56	0.421	
Mymensingh	-	-	-	-	-	-	1.74	0.00	0.00	0.500	
Wealth index (n=3,675)											
Poorest	-	-	3.85	3.99	4.76	3.78	1.75	54.55	-5.48	0.299	
Poorer	-	-	4.07	3.08	3.81	3.66	1.07	73.71	-9.10	0.275	
Middle	-	-	3.68	2.66	4.03	2.71	1.48	59.78	-6.30	0.309	
Richer	-	-	2.76	3.05	3.25	2.74	1.57	43.12	-3.95	0.383	
Richest	-	-	2.57	2.22	4.06	3.01	1.59	38.13	-3.37	0.406	
Overall	6.82	2.48	3.45	3.05	4.01	3.19	1.49	78.15	-6.68	0.015	

TABLE IV
DISTRIBUTION OF GAM AMONG UNDER-FIVE CHILDREN IN BANGLADESH FROM 1996-97 TO 2017-18

Characteristics	Global Acute Malnutrition (GAM)							Percentage change	Annual Percentage Change	P-value (Base year vs. Current year)
	1996-97	1999-00	2004	2007	2011	2014	2017-18			
Age in month										
<6 months	26.30	12.860	15.25	17.64	15.78	20.18	9.18	65.10	-4.67	0.002
6-12 months	30.60	20.470	18.15	18.24	14.65	19.47	7.21	76.44	-6.36	0.000
13-23 months	29.08	16.420	19.60	22.78	15.43	13.61	8.37	71.22	-5.50	0.000
24-35 months	17.67	10.430	13.88	16.48	14.73	13.11	8.10	54.16	-3.48	0.009
36-47 months	13.45	9.090	11.18	14.54	15.98	11.58	8.81	34.50	-1.90	0.115
48-59 months	15.00	9.440	12.63	15.22	16.46	13.33	8.66	42.27	-2.47	0.053
Sex										
Male	22.03	13.350	15.95	18.15	15.87	15.22	9.22	58.15	-3.88	0.000
Female	19.41	11.680	13.45	16.65	15.27	13.49	7.52	61.26	-4.22	0.000
Birth order										
First	20.43	11.440	14.34	15.70	14.69	14.06	8.47	58.54	-3.92	0.000
Second	18.39	11.930	13.57	18.10	14.87	14.94	8.33	54.70	-3.54	0.001
Third	21.77	12.280	15.74	17.96	14.91	14.11	8.77	59.72	-4.05	0.002
Fourth or more	22.02	14.220	15.51	18.56	18.91	14.44	7.92	64.03	-4.54	0.002
Number of children										
One child	22.75	12.980	14.48	16.77	14.72	14.68	8.78	61.41	-4.24	0.000
Two children	19.12	11.400	14.56	17.82	15.02	14.72	7.86	58.89	-3.96	0.000
3 or more child	20.65	13.010	14.95	17.51	16.82	13.72	8.67	58.01	-3.87	0.000
Mothers' educational status										
No education	22.77	14.620	16.68	19.35	17.78	14.59	11.92	47.65	-2.90	0.021
Primary education	18.07	11.670	14.39	19.08	17.98	15.34	8.92	50.64	-3.16	0.003
Secondary education	18.19	9.720	13.00	15.09	13.56	14.05	8.36	54.04	-3.47	0.002
Higher education	17.51	8.640	11.08	13.56	10.78	12.90	5.93	66.13	-4.80	0.049
Mothers working status										
Not working	19.68	12.170	14.34	16.56	15.64	13.76	8.39	57.37	-3.80	0.000
Working	22.71	14.190	16.48	19.70	14.91	16.16	8.44	62.84	-4.40	0.000
Mothers BMI										
Underweight	24.70	16.720	19.89	23.55	21.07	18.75	13.60	44.94	-2.68	0.002
Normal Weight	16.50	9.570	12.06	15.30	14.30	14.52	7.95	51.82	-3.26	0.000
Overweight	17.77	6.470	8.87	7.56	9.39	9.00	7.23	59.31	-4.01	0.070
Obese	22.37	5.960	3.42	13.46	8.74	7.87	4.40	80.33	-7.12	0.049

(Contd. Table III)

Characteristics	Global Acute Malnutrition (GAM)								Percentage change	Annual Percentage Change	P-value (Base year vs. Current year)
	1996-97	1999-00	2004	2007	2011	2014	2017-18				
Mothers age at first birth											
Less than 18 years	20.76	12.450	15.77	17.44	16.42	15.14	8.87	57.27	-3.79	0.000	
18-24	21.25	12.610	13.00	17.22	15.06	13.75	8.22	61.32	-4.23	0.000	
25 or above	11.82	12.920	14.82	19.11	10.78	13.88	6.24	47.21	-2.86	0.276	
Fathers' educational status											
No education	22.49	14.530	15.39	18.86	16.88	14.70	9.47	57.89	-3.86	0.001	
Primary education	20.68	11.800	14.45	17.15	17.05	15.33	8.47	59.04	-3.98	0.000	
Secondary education	17.44	11.530	16.10	16.85	14.89	12.71	8.84	49.31	-3.04	0.006	
Higher education	17.98	7.300	9.09	14.62	10.63	15.49	6.42	64.29	-4.57	0.014	
Fathers' occupation											
Daily basis worker	20.19	14.110	14.53	15.87	15.00	14.25	9.15	54.68	-3.53	0.000	
Agriculture	21.88	13.140	15.07	20.86	17.59	15.74	9.50	56.58	-3.72	0.000	
Business	18.48	10.030	15.17	17.46	14.75	14.35	6.18	66.56	-4.86	0.002	
Service	22.43	7.220	6.17	11.98	12.59	12.44	5.73	74.45	-6.01	0.038	
Others	27.04	12.410	17.97	12.06	15.06	9.14	8.66	67.97	-5.04	0.062	
Household size											
Small (<4)	22.15	15.670	14.04	16.45	16.30	12.76	10.02	54.76	-3.54	0.011	
Medium (4-6)	22.09	12.960	15.79	18.10	15.95	14.88	8.22	62.79	-4.39	0.000	
Large (6 and more)	18.77	11.410	13.45	16.57	14.75	14.08	8.11	56.79	-3.74	0.000	
Place of residence											
Urban	15.36	10.960	13.78	14.48	13.91	12.42	8.94	41.80	-2.43	0.070	
Rural	21.26	12.830	14.94	18.17	16.05	15.05	8.21	61.38	-4.23	0.000	
Division											
Dhaka	18.33	11.960	13.07	15.46	15.43	12.01	8.90	51.45	-3.23	0.035	
Chattogram	24.57	12.410	15.91	17.59	15.79	15.56	8.00	67.44	-4.97	0.014	
Rajshahi	19.70	13.670	16.28	18.76	16.48	17.47	7.61	61.37	-4.23	0.053	
Khulna	21.09	10.870	16.33	18.95	14.71	13.84	7.70	63.49	-4.48	0.111	
Barishal	17.52	13.130	9.39	18.31	15.40	17.92	8.92	49.09	-3.02	0.217	
Sylhet	23.27	13.510	15.20	18.14	18.64	11.91	10.36	55.48	-3.61	0.119	
Rangpur	-	-	-	-	13.12	17.81	7.26	44.66	-8.11	0.251	
Mymensingh	-	-	-	-	-	-	9.01	0.00	0.00	0.500	
Wealth index (n=3,675)											
Poorest	-	-	17.81	20.71	17.87	16.99	9.95	44.13	-4.07	0.012	
Poorer	-	-	15.47	17.66	15.86	16.71	8.08	47.77	-4.53	0.025	
Middle	-	-	15.52	17.02	17.47	12.65	7.63	50.84	-4.95	0.023	
Richer	-	-	11.85	17.58	13.46	13.21	8.83	25.49	-2.08	0.209	
Richest	-	-	11.24	13.08	12.33	11.98	7.29	35.14	-3.05	0.159	
Overall	20.71	12.52	14.72	17.39	15.57	14.39	8.41	59.39	-4.01	0.000	

3.5 Factors associated with SAM, MAM, and GAM among Children in Bangladesh

Risk factors associated with SAM, MAM, and GAM are described in Table V. The VIF test indicated that no evidence of multicollinearity was present in the regression models. We found that child age, sex, birth order, number of children in households, mothers' BMI, mothers' education and occupational status, fathers' education, occupations, and administrative divisions were significantly associated with the presence of MAM, SAM, and GAM. We observed that the odds of having childhood SAM were significantly high among children aged less than 6 months (OR = 2.49; 95% CI: 1.88-3.28), followed by children aged 6 to 12 months (OR = 2.30; 95% CI: 1.73-3.06) and those ages 13 to 23 months (OR = 1.70; 95% CI: 1.32-2.20). Such a significant relationship was not observed in terms of MAM. However, children below six years were 1.17 times more susceptible to having GAM compared to the reference age group and were statistically significant ($p=0.05$). Male children were significantly more likely to suffer from SAM (OR = 1.26; 95% CI: 1.09-1.46), MAM (OR = 1.10; 95% CI: 1.01-1.19), and GAM (OR = 1.14; 95% CI: 1.06-1.23) compared to female children. In terms of birth order, the first and second children suffered significantly from MAM, while no such connection was observed in terms of SAM. Single children were however 1.36 ($p=0.01$) times more prone to having MAM and 1.30 times more susceptible to having GAM ($p=0.01$) than the reference group. The odds of having MAM (1.53) and GAM (1.51) were significantly higher among the children of uneducated mothers compared to the children of higher educated mothers. Children of underweight mothers were significantly more likely to suffer from SAM (OR = 1.51; 95% CI: 1.30-1.77), MAM (OR = 1.63; 95% CI: 1.50-1.79), and GAM (OR = 1.66; 95% CI: 1.53-1.79) compared to those of mothers with normal BMI. However, we observed a significant negative relationship between SAM, MAM and GAM with the overweight status of mothers. We observed that children with fathers involved in agriculture, were more prone to SAM, MAM and GAM ($p=0.05$). The odds of having SAM (1.31), MAM (1.14) and GAM (1.19) were highest for those children who lived in the Chattogram division compared to the reference divisions. However, no significant differences were observed in regards to household size, mothers' age at first birth, urbanity, and wealth status of the households.

TABLE V
DETERMINANTS / RISK FACTORS OF MAM, SAM AND GAM

Characteristics	Moderate Acute Malnutrition (MAM)	Severe Acute Malnutrition (SAM)	Global Acute Malnutrition (GAM)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age in month			
<6 months	0.91 (0.77, 1.08)	2.49*** (1.88, 3.28)	1.17* (1.01, 1.36)
6-12 months	0.89 (0.77, 1.04)	2.30*** (1.73, 3.05)	1.12 (0.98, 1.28)
13-23 months	1.00 (0.88, 1.14)	1.70*** (1.32, 2.20)	1.12* (1.00, 1.26)
24-35 months	0.86* (0.76, 0.99)	1.47** (1.14, 1.89)	0.96 (0.85, 1.08)
36-47 months	0.89 (0.78, 1.01)	1.17 (0.89, 1.53)	0.93 (0.83, 1.05)
48-59 months (ref.)			
Child sex			
Male	1.10** (1.01, 1.19)	1.26*** (1.09, 1.46)	1.14*** (1.06, 1.23)
Female (ref.)			
Birth order			
First (ref.)			
Second	1.19** (1.02, 1.40)	0.88 (0.61, 1.27)	1.13 (0.97, 1.31)
Third	1.27* (1.02, 1.58)	1.11 (0.73, 1.69)	1.25** (1.03, 1.52)
Fourth or more	1.26* (1.00, 1.59)	1.37 (0.88, 2.13)	1.31** (1.06, 1.62)
Number of children			
One child	1.36** (1.08, 1.71)	1.06 (0.68, 1.65)	1.30** (1.06, 1.61)
Two children	1.19* (1.01, 1.4)	1.13 (0.85, 1.50)	1.18** (1.02, 1.37)
3 or more child (ref.)			
Mothers' educational status			
No education	1.53*** (1.21, 1.94)	1.30 (0.89, 1.92)	1.51*** (1.22, 1.86)
Primary education	1.39** (1.11, 1.74)	1.29 (0.90, 1.83)	1.39*** (1.14, 1.69)
Secondary education	1.16 (0.94, 1.42)	1.20 (0.86, 1.66)	1.18 (0.98, 1.41)
Higher education (ref.)			
Mothers working status			
Not working (ref.)			
Working	1.07 (0.97, 1.18)	0.82* (0.68, 0.98)	1.01 (0.92, 1.11)
Mothers BMI			
Underweight	1.63*** (1.50, 1.79)	1.51*** (1.30, 1.77)	1.66*** (1.53, 1.79)
Normal Weight (ref.)			
Overweight	0.65*** (0.56, 0.76)	0.76* (0.57, 1.01)	0.67*** (0.58, 0.77)
Obese	0.50*** (0.35, 0.70)	0.67 (0.39, 1.14)	0.52*** (0.39, 0.70)
Mothers age at first birth			
Less than 18 years (ref.)			
18-24	0.96 (0.88, 1.05)	0.99 (0.84, 1.15)	0.97 (0.89, 1.04)
25 or above	0.95 (0.76, 1.19)	1.43 (0.94, 2.17)	1.06 (0.86, 1.30)

(Contd. Table V)

Characteristics	Moderate Acute Malnutrition (MAM)	Severe Acute Malnutrition (SAM)	Global Acute Malnutrition (GAM)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Fathers' educational status			
No education (ref.)			
Primary education	1.04 (0.93, 1.16)	0.98 (0.81, 1.18)	1.03 (0.93, 1.13)
Secondary education	1.17** (1.03, 1.32)	0.92 (0.73, 1.15)	1.11 (0.99, 1.24)
Higher education	1.23 (0.98, 1.55)	0.79 (0.55, 1.12)	1.12 (0.92, 1.37)
Fathers' occupation			
Daily basis worker (ref.)			
Agriculture	1.11* (1.00, 1.23)	1.22* (1.02, 1.45)	1.14** (1.04, 1.25)
Business	1.13* (1.01, 1.26)	0.98 (0.80, 1.19)	1.10 (0.99, 1.21)
Service	1.01 (0.78, 1.30)	0.93 (0.58, 1.48)	0.99 (0.78, 1.24)
Others	0.96 (0.75, 1.23)	0.83 (0.52, 1.34)	0.93 (0.74, 1.17)
Household size			
Small (<4)	1.05 (0.90, 1.23)	1.04 (0.79, 1.38)	1.06 (0.92, 1.21)
Medium (4-6)	1.08 (0.99, 1.19)	1.08 (0.92, 1.27)	1.09* (1.00, 1.18)
Large (6 and more) (ref.)			
Place of residence			
Urban (ref.)			
Rural	1.02 (0.91, 1.13)	0.90 (0.75, 1.08)	0.99 (0.90, 1.09)
Division			
Dhaka (ref.)			
Chattogram	1.14* (1.00, 1.29)	1.31** (1.06, 1.63)	1.19** (1.06, 1.33)
Rajshahi	1.17** (1.02, 1.34)	1.13 (0.89, 1.43)	1.17** (1.03, 1.32)
Khulna	1.09 (0.94, 1.26)	1.24 (0.97, 1.59)	1.13 (0.99, 1.29)
Barishal	1.02 (0.88, 1.18)	1.22 (0.94, 1.57)	1.06 (0.93, 1.22)
Sylhet	1.08 (0.94, 1.24)	0.99 (0.77, 1.26)	1.06 (0.94, 1.20)
Rangpur	0.90 (0.75, 1.08)	1.15 (0.80, 1.64)	0.95 (0.81, 1.13)
Mymensingh	0.70** (0.52, 0.93)	0.71 (0.42, 1.20)	0.69** (0.53, 0.89)
Wealth index (n=3,675)			
Poorest	1.14 (0.95, 1.35)	0.88 (0.66, 1.17)	1.07 (0.92, 1.25)
Poorer	1.06 (0.90, 1.26)	0.81 (0.61, 1.07)	0.99 (0.86, 1.15)
Middle	1.07 (0.91, 1.25)	0.81 (0.62, 1.06)	1.00 (0.87, 1.15)
Richer	1.05 (0.90, 1.23)	0.81 (0.62, 1.06)	0.99 (0.86, 1.13)
Richest (ref.)			
Constant	0.05*** (0.03, 0.07)	0.01*** (0.01, 0.03)	0.06*** (0.05, 0.09)
N	33,783	33,783	33,783
Log pseudo-likelihood	-11,411	-4,478	-13,357
Prob > chi2	0.00	0.00	0.00
Pseudo R2	0.020	0.027	0.022
Wald chi2 (41)	347.17	227.68	440.1
Mean VIF	2.59	2.59	2.59

V. DISCUSSION

Although childhood undernutrition prevalence has declined substantially over the last few decades, it still is a big concern in improving child health in Bangladesh. Using nationally representative data from Bangladesh, this study explores the prevalence of SAM, MAM, and GAM and their socio-demographic factors and socioeconomic differentials. This study finds decreasing trends of childhood global acute malnutrition, from 20.71 per cent in 1996-97 to 8.41 per cent in 2017-18. In particular, SAM declined from 6.82 per cent in 1996-97 to 1.49 per cent in 2017-18, while the MAM was 6.91 per cent in 2017-18. From 1996 to 1997, the MAM was 13.89 per cent. The study identifies factors such as child age, sex, birth order, number of children in households, mother's BMI, mother's education and occupational status, father's occupation, and administrative divisions to be significantly associated with the prevalence of SAM, MAM, and GAM.

We observed a significant positive relationship between the increasing age of the children and SAM. However, such a pattern was not observed regarding MAM and GAM among Bangladeshi children. Studies also reported a higher prevalence of acute malnutrition in the younger age group (Bezatu Mengiste, 2014; Legason & Dricile, 2018). The insufficiency of appropriate supplementary food for children above six months of age may be one of the reasons for inadequate energy and protein intake (Mittal, Singh, & Ahluwalia, 2007). It was often discussed that only mother's milk is not sufficient to maintain adequate nutrition after six months of age (Akram et al., 2018). These statements are also reflected in earlier studies in this country's context, as higher age groups were positively associated with stunting and wasting (Legason & Dricile, 2018). Although this study found male children were prone to SAM, MAM, and GAM, the logic behind this gender divergence is not well defined. Because it is believed that boys are more influenced by environmental stress than girls, and male children may be related to a higher growth rate requiring a greater need for nutrients not supplied by diet (Wamani, Åström, Peterson, Tumwine, & Tylleskär, 2007). Our findings are consistent with previous studies that mothers' education and BMI are crucial contributing factors to childhood undernutrition (Sarker, Sultana, & Sheikh, 2019). It was observed that educated mothers could ensure children's minimum acceptable diets (MAD) due to being well-informed about the deleterious effect of malnutrition on child development (Arimond & Ruel, 2004). Also, educated mothers can often show more concern through improved knowledge of healthy behaviours and sanitation

habits while nurturing their children (Ntenda & Chuang, 2018). Therefore, more intensive community-based educational programmes are required to reduce the inequality of childhood nutritional status. In line with other studies, we also observed that underweight mothers played a significant role in SAM, MAM and GAM, as underweight mothers had a higher likelihood of their child being underweight (Tigga & Sen, 2016; Akram et al., 2018; Rahman, Halder, Rahman, & Parvez, 2021).

This study also documented that birth order and the number of children in the households are vital factors for childhood undernutrition. A similar study focusing on childhood stunting observed that a child with a higher birth order had a significantly higher risk of malnutrition (Akram et al., 2018). It can be explained by the fact that additional care and nutritious food are often required for larger households, which leads to higher consumption of resources and thus undernutrition (Horton, 1988). Some other studies documented that multiple births are associated with premature births, low birth weight, and even inadequate breastfeeding, which can impede childhood growth and development (Kabubo-Mariara, Ndenge, & Mwabu, 2009; Khanam, Shimul, & Sarker, 2019). Although we did not observe a significant relationship between SAM, MAM, and GAM with the wealth status of households, children from disadvantaged households often bear the greatest burden of childhood morbidity directly linked with childhood undernutrition (Mahumud et al., 2019). The findings of this study reveal that the father's occupation is a significant determinant of childhood malnutrition because the children of agricultural workers have a greater chance to develop both SAM and MAM, and even GAM. We are not sure of the logic behind this; however, healthcare-seeking habits and food intake are often lower than in other occupations due to affordability issues. We found children who lived in the Chattogram division were at a significantly higher risk of MAM, SAM, and GAM. The Chattogram division is frequently affected by natural disasters such as cyclones, floods, and rainstorms. The Rajshahi division is exposed to drought, and the Mymensingh division is at a lower risk of natural disasters.

The current study has used high-quality, nationally representative household survey data from both the urban and rural areas, which is the strength of this study. Therefore, the findings can be representative of the entire country. Despite this strength, this study has some limitations. First, it was based on cross-sectional data, which failed to establish causal relationships. Second, all information related to the prevalence and determinants of SAM, MAM, and GAM was provided by mothers and thus subjective. Third, the measurement of wealth status was based on

household assets because of the lack of data on household income and expenditures. Therefore, using such a wealth index rather than income quintiles is a limitation of this study. Also, Mymensingh is a new division created from the Dhaka division and this information is not available in the previous BDHS surveys. Fourthly, the definition of urban and rural areas in Bangladesh has changed, over time, with the most rapid growth in urbanisation. As a result, some areas earlier classified as rural in the previous BDHSs were considered urban in the more recent BDHSs, which may bring in some errors in urban-rural calculations. The terms SAM, MAM and GAM that we used in this study were defined by the WHO flag limits, and, to some extent, may lead to arbitrary results. This, in turn, may present outcomes that are higher or lower than the reported prevalence. As determinants such as dietary intake, physical activity, caregiving practices, cultural influences, and smoking behaviours of the parents were not explained, further exploration is required to ascertain the contribution of these potential determinants to the development of various forms of acute malnutrition in Bangladesh.

V. CONCLUSIONS

Bangladesh has achieved remarkable economic growth and improved various health indicators. However, the study concludes that there is substantial room to upgrade the nutritional status of children aged 6-59 months in Bangladesh. Child age (6-12 months), child-size at birth (smaller), father's occupation, administrative division and mother's BMI are strongly related to the SAM, MAM, and GAM. Interventions should focus on supporting and educating mothers because only a healthy mother can give birth to a healthy child. Interventions should also emphasise educating household heads about low-cost but nutritious, locally available foods and child-care, including feeding and immunisation practices. Easier access to health facilities and nutrition-related information needs to be ensured to improve the mother's health status and educate the parents about malnutrition. A concerted effort could be made by the government, non-governmental organisations, private sector organisations, and the community to reduce the burden of acute malnutrition among children under-5 in Bangladesh. In addition, the government may wish to develop a targeted nutritional intervention strategy for different target groups to reduce acute childhood malnutrition.

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