Prevalence and risk factors of underweight among under-5 children in Bangladesh: Evidence from a countrywide cross-sectional study

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Abstract

Background

Underweight is one of the important anthropometric components of malnutrition among under-five children and is a major public health concern in Bangladesh because it contributes to mortality as well as morbidity. In designing suitable health programs and policies with the goal of attaining UN SDG Goals, it is necessary to identify the critical risk factors of under-five malnutrition. It is evident that the quantile regression produces robust estimates in the presence of outliers. However, in the context of Bangladesh, no study has been conducted considering the sequential quantile regression on this topic. Therefore, the authors aimed to find the determinants of underweight among under-5 children in Bangladesh considering the latest country representative dataset.

Methods and materials

The paper considers a weighted sample of size 7762 children are used and data were extracted from the latest Bangladesh Demographic and Health Survey (BDHS) 2017–18 data. Multivariable simultaneous quantile regression models were used to fulfill the objectives of this study.

Results

Findings depict that undernutrition affects the majority of children in the population as compared to the reference population. The WAZ-score of the child increases by 0.202 points at the 10th quantile of the conditional distribution, and by 0.565 points at the 90th quantile as we move from children of underweight to overweight women. Moreover, the WAZ scores of children from the richest families in the 10th, 50th, and 75th quantiles, respectively, are increased by 0.171, 0.016, and 0.084 points.

Conclusion

Quantile regression revealed the results of several socioeconomic and demographic factors acting differently across the WAZ distribution. Therefore, policymakers may consider the identified risk factors to lessen malnutrition among under-5 children in Bangladesh.

Introduction

Malnutrition among under-five children is a major public health concern because it contributes to mortality as well as morbidity, particularly in developing countries like Bangladesh where the rate of malnutrition is relatively high. Underweight is one of the indicators of malnutrition. Underweight indicates a nutritional deficiency that has long-term effects on health and consequences on the overall population's well-being. Underweight is determined by the World Health Organization (WHO) Growth Standard weight-for-age (WAZ), less than minus two standard deviations (SD). Between 1990 and 2019, the global prevalence of underweight children under-5 years declined from 24.8 percent to 13 percent. South Asia has a higher prevalence of underweight children than other parts of the world; for example, in 2019, 13.8 percent of children in South Asia were underweight [1]. The latest Multiple Indicator Cluster Survey (MICS) 2019 highlighted that the prevalence of moderate and severe underweight has decreased from 31.9% in 2012–13 to 22.6 percent in 2019 in Bangladesh [2]. Generally, underweight people have been exposed as a risk factor for several diseases such as anemia, hypotension, osteoporosis, osteoporotic fractures in later life, low bone mineral density, reduced sex hormones, feelings of fatigue, and malaise [3, 4]. Being underweight has the potential to have adverse health implications, such as a larger burden of disease, and it has an impact on how many medical disorders will turn out [5–7]. Children's underweight is a serious health condition with substantial consequences for development, health, and well-being [8]. Underweight and related malnourishment have been shown to be especially hazardous for young females [9] and underweight increases the risk of morbidity as well as mortality [10]. Flegal et al. (2018) have assessed that underweight is associated with raised mortality risk in contrast to normal weight in USA population [11]. Do, et al., (2019) noticed that in the Korean population, being underweight was independently linked to a decline in pulmonary function [12]. Park, et al., (2017) show that underweight population had a 19.7% greater risk of cardiovascular disease (CVD) than the normal-weight [13]. Solis-Soto, et al., (2020) observed that children with incomplete immunisation schedules had a considerably greater prevalence of underweight [14].

Shine and Asegidew (2019) show that the prevalence of underweight among children 6–59 months' years old is 48.7% and the sex of the child, the mother's antenatal care non-attendance, the birth interval of infants younger than 24 months, and breastfeeding for infants younger than 12 months are identified to be significant determinants of underweight [15]. A study emphasized the significance of EBF for newborns up to six months old, as it protects them from diarrhoea and ARI-specific morbidity and mortality [16] and more than 35% of the children aged under 5 years suffered from ARI which negatively impacted their health status [17]. Ochiai, et al. (2017) showed that exercise and eating slowly were linked to underweight among Japanese adolescents [18]. Moreover, several previous studies showed that the child's sex, age, size of child at birth, parental educational status, mother's BMI, family income level, mother's antenatal care visit, household water supply, length of nursing, children's birth order, and status of colostrum feeding were linked to underweight [19–38]. Previous research has

primarily examined the correlates of underweight using binary or linear regression approaches. However, the mean effect may overestimate or underestimate the contribution of the covariates at different points and in the presence of outliers [39]. Outliers impacted the estimates of the mean and variance of a dataset [40, 41]. Other epidemiological and health modeling tools and/or medical statistical approaches may overcome these issues. More specifically, the quantile regression (QR) modeling approach yielded more unbiased estimates for skewed data and in the presence of outliers than other regression models [42]. Moreover, several researchers applied the QR model to examine the core socio-demographic factors of a child's nutritional status [43–47].

In the context of Bangladesh, no study has been conducted considering the sequential quantile regression for finding the correlates of underweight among under-5 children in Bangladesh based on the latest country representative dataset. Moreover, employing relevant and cutting-edge statistical approaches to identify key risk factors for under-five malnutrition can assist in developing appropriate health policies and programmes to meet UN SDG Goal 2 target 2. It is apparent that the study data contain outliers, and the sequential quantile regression approach will provide more robust estimates of risk factors for undernutrition than the ordinary least squares regression estimates in presence of outliers because it estimates conditional median instead of conditional mean. It also helps to estimate different percentile of the target variable which provides a clear picture of variability. In order to uncover important risk factors for chronic malnutrition in children under the age of five, this study aims to construct a simultaneous quantile regression, a detailed health and medical statistical model (i.e., underweight) in Bangladesh using the most recent BDHS-2017/18 data.

Materials and methods

Data and variables

In this study, the secondary data is obtained from a nationally representative survey called the "2017–18 Bangladesh Demographic and Health Survey (BDHS-2017/18)". The BDHS-2017-18 is the complete survey that covers the enumeration areas (EAs) of the entire country. This survey used stratified sampling and selection is made in two stages. Firstly, 675 EAs were chosen with probability proportional to the size of the EA. In the second phase of selection, 30 households per cluster were carefully chosen with a systematic procedure from the list of households. However, due to natural disaster, data were not collected from the three EAs. These three clusters were in Rajshahi (one rural cluster), Rangpur (one rural cluster), and Dhaka (one urban cluster). The full data set is accessible via the following link http://dhsprogram.com/data/available-datasets.cfm. Before starting the analysis, the authors utilise a weighted sample to ensure that the sample is representative of the country. The details of the sampling procedure and methods of the weighted sample (mathematically adjusted) are available in the published report of BDHS-2017/18 in detail [48]. The weight-for-age Z-score (WAZ) is the target variable, and several child characteristics such as sex (male, female), age ($\leq$6 months, 7–12 months, 13–23 months, 24–35 months, 36–47 months, 48–59 months), duration of breastfeeding (never breastfed, $\leq$12 months, 13 or more months), birth order (1st, 2nd -3rd, 4th or higher); maternal attributes such as age ($\leq$18 years, 19–24 years, 25–34 years, $\geq$35 years), educational qualification (no education, primary, secondary or higher) and BMI (underweight ($<$18.5), normal (18.5–24.9), overweight ($\geq$25)); father's education (no education, primary, secondary or higher), and attributes related to child's health are the explanatory variables in this study. The variables included in this study were chosen based on their availability in the dataset, self-efficacy, as well as related existing research [14, 15, 19–38, 43–47].

Ethical approval. Not required because this study considered secondary data which is publicly available. Moreover, the survey was approved by the Ethics Committee of the ICF Macro at Calverton in the USA and by the Ethics Committee in Bangladesh.

Quantile regression

The quantile regression (QR) model was initially introduced by Koenker and Basset in 1978, and nowadays it is extensively applied in various research areas, particularly in Statistics and Econometrics [49]. Nowadays, it is used in public health [43–47, 49–54]. However, the uses of this technique in public health and epidemiology can provide more reliable statistics and help decisionmakers. Suppose, Y be a random (response) variable having cumulative distribution function (CDF) $F_Y(y)$, i.e. $F_Y(y) = P(Y \leq y)$ and X is the p-dimensional vector of predictor variables. Then the τth (quantile level) conditional quantile of Y is described as $Q_\tau(Y|X = x) = \{y: F_\tau(y|x)\}$, where τ varies from 0 to 1.

The QR model portrayed by the conditional τ th quantiles of the outcome Y for considering the values of predictors $x_1, x_2, \ldots, x_P$ can be expressed as

$Q_y\left(\tau|x_1, x_2, \ldots, x_p\right) = \beta_0^{(\tau)} + \beta_1^{(\tau)}x_1 + \ldots + \beta_p^{(\tau)}x_p, 0 < \tau < 1$, where

$\beta^{(\tau)} = \left(\beta_0^{(\tau)}, \beta_1^{(\tau)}, \ldots, \beta_k^{(\tau)}\right)^T$ is the vector of unknown parameters.

For a random sample $\{y_1, y_2, \ldots, Y_n\}$ of Y, it is understood that the sample median minimises the following sum of absolute deviations, $Median = \arg\min_{\xi \in \mathbb{R}} \sum_{i=1}^{n} \rho_\tau(y_t - \xi)$. Likewise, the general τ th sample quantile $\xi(\tau)$, that is the equivalent of $Q(\tau)$, is formulated as the minimiser: $\xi(\tau) = \arg\min_{\xi \in \mathbb{R}} \sum_{i=1}^{n} \rho_\tau(y_t - \xi)$, where $\rho_\tau(Z) = Z(\tau - I(Z < 0))$ for $0 < \tau < 1$ denotes the loss function with an indicator function $I(.)$. The loss function ρ_τ allocates a weight of τ and 1-τ for positive residuals = y_i - ξ and negative residuals respectively. The linear conditional quantile function along with this loss function expands the τ th sample quantile $\xi(\tau)$ to the regression setting in the similar way that the linear conditional mean function expands the sample mean. The OLS estimates is obtained based on the linear conditional mean function

$E(Y|X = x) = x'\beta$, by solving $\hat{\beta} = \arg\min_{\beta \in \mathbb{R}^p} \sum_{i=1}^{n} (y_t - x'\beta_i)^2$ [55].

The estimated parameter minimises the sum of squared residuals as the sample mean minimises the sum of squares $\mu = \arg\min_{\mu \in \mathbb{R}} \sum_{i=1}^{n} (y_t - \mu)^2$. Quantile regression also estimates the linear conditional quantile function, $(\tau|X = x) = x'\beta(\tau)$, by solving

$\hat{\beta}(\tau) = \arg\min_{\beta \in \mathbb{R}^p} \sum_{i=1}^{n} \rho_\tau(y_t - x'\beta_i)^2$. For any quantile $\tau \in (0,1)$ the quantity $\hat{\beta}(\tau)$ is known as the τ th regression quantile. For example, $\tau = 0.5$, which minimises the sum of absolute residuals, and also corresponds to L_1-type or median regression. The set of regression quantiles $\{\beta(\tau): \in (0,1)$ is called the quantile process [55].

The QR model aimed at solving the term $\min_{\beta \in \mathbb{R}^p}\left[\sum_i \tau|e_i| + \sum_i (1-\tau)|e_i|\right]$, where $e_i = y_i - x_i'\beta$ is the i th value of unknown errors, $\sum_i \tau|e_i|$ gives the asymmetric penalties $\tau|e_i|$ for over prediction and $\sum_i (1-\tau)|e_i|$ gives the asymmetric penalties $(1-\tau)|e_i|$ for under prediction

[55]. The τ th quantile regression estimator $\hat{\beta}(\tau)$ is obtained by minimising the following objective function over β_τ

$$Q(\beta_\tau) = \sum_{i \in \{i:y_i \geq x'_i\beta\}}^{N} \tau|y_i - x'_i\beta_\tau| + \sum_{i \in \{i:y_i < x'_i\beta\}}^{N} (1-\tau)|y_i - x'_i\beta_\tau| \text{where}, 0 < \tau < 1, i : y_i \geq x'_i\beta$$

for over prediction, $i : y_i < x'_i\beta$ for under prediction [55].

The authors considered 0.10, 0.25, 0.50, 0.75, and 0.90 quantile levels and the authors motivated to select these quartiles from previous studies [46, 47, 54, 56, 57].

Results

Underweight children are those whose weight-for-age is less than two standard deviations (-2 SD) from the reference population's median. Also, if the weight-for-age Z-score of a child is below three standard deviations of the norm, s/he is considered as severely underweight. This study considers the Z-score of weight-for-age as the dependent variable and several demographic, and socioeconomic variables are considered as the explanatory variables. First of all, characteristics of our main concerned variable i.e., the Z-scores of weight-for-age is observed and it can be seen it has some positive skewness (Skewness: 0.62, Kurtosis: 1.14) with mean -1.29 and SD 1.11. The negative average indicates that undernutrition affects the majority of children in the population as compared to the reference population, and the distribution of an index has changed downward [Fig 1(B)]. The boxplot is also used to identify the distribution of the Z-score and the presence of outliers. Therefore, this paper used quantile regression because it provides more robust estimates of the parameters than the ordinary least squares regression in presence of outliers.

The Box plot presented in Fig 1(A), reveals that the distribution of the Z-score is skewed in some extent and there are several outliers in the data set. The prevalence of underweight among under-five Bangladeshi children by selected background characteristics is presented in Table 1. Results depict that around 22.89 percent of children are underweight, and 3.52 percent are severely underweight in Bangladesh.

Male children are slightly less underweight than female children, according to the results shown in Table 1, despite the fact that the percentage of male children is only slightly higher. Given that the prevalence of underweight increased with age, it appeared that child malnutrition was positively correlated with age in children. The child's birth order demonstrated a positive relationship with underweight and a negative association with the child's birth size and interval. As the prevalence of underweight of children is reduced with the increase in mother's nutrition and education levels, the incidence of underweight is negatively correlated with the mother's nutritional status as evaluated by body mass index (BMI) and educational status. It has been found that children who use modern toilets, drink clean water, and have access to electricity are less likely to be underweight than their counterparts. Additionally crucial to a child's nutritional condition is the place of birth. If a child is born at a health facility, there is a decreased likelihood of malnutrition than if the child is born at home. A kid's nutritional status is also correlated with their current state of health since a youngster who has diarrhoea and fever is more likely to be malnourished than a child who is healthy. According to the findings, one-third of children resided in rural areas, where undernutrition in children is more common. In Bangladesh, household amenities are crucial in determining children's nutritional health. In Bangladesh, the relationship between the wealth index and children's nutritional status is strongly positive. We now carry out quantile regression for various quantiles (0.1, 0.25, 0.5, 0.75, and 0.90).
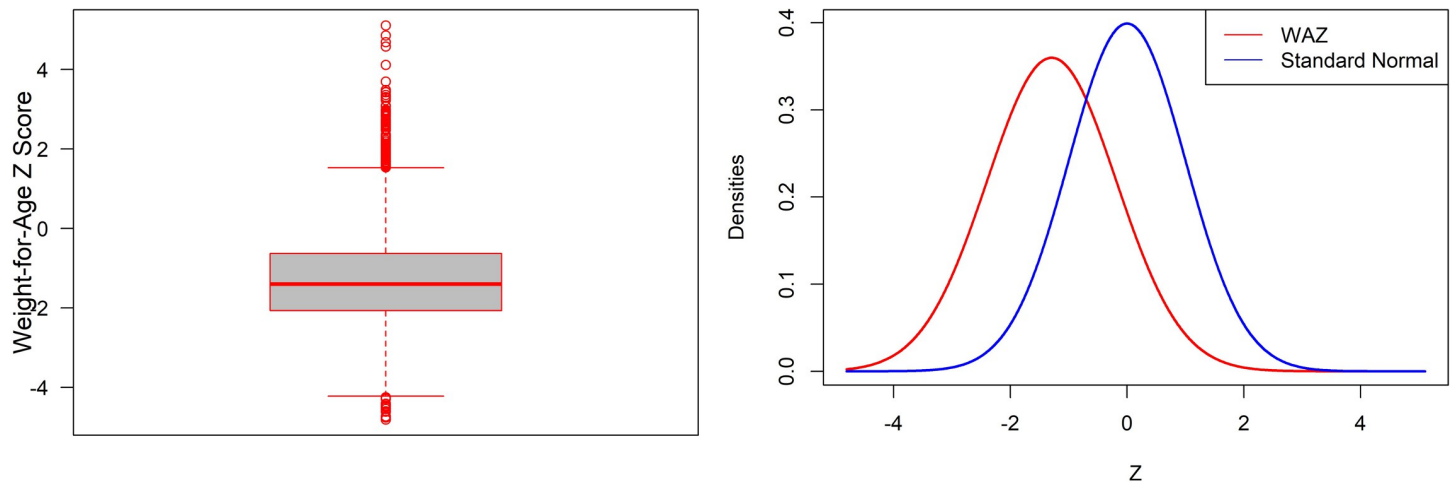
Fig 1. Box plot (a) and normal density (b) of weight-for-age Z-score of children.

Table 2 shows that the factors that determine a child's weight for age z-score in Bangladesh are similar. Based on the Z-score of weight-for-age, the sex, and size of the infant at birth are also significant factors in determining their health status. The mother's age, BMI, and level of education greatly influence the child's weight-for-age Z-score at the bottom tail of the conditional Z-score distribution. For instance, the Z-score for weight-for-age increases by 0.246 and 0.043 points at the 90th quantile of the conditional distribution, respectively, when we move from uneducated women to primary, secondary, and above education levels. Additionally, as we move from children of underweight women to those of women with normal BMI, the WAZ-score of the child increases by 0.202 points at the 10th quantile of the conditional distribution, and by 0.565 points at the 90th quantile as we move from children of underweight to overweight women. The conditional distribution of the weight-for-age Z (WAZ) score's upper tail is significantly influenced by household environmental amenities such as clean drinking water, access to power, and bathroom facilities. Compared to children from the poorest families, children from middle-class, wealthy, and wealthy families have higher WAZ scores. For example, the WAZ scores of children from the richest families in the 10th, 50th, and 75th quantiles, respectively, are increased by 0.171, 0.016, and 0.084 points.

Discussion

Quantile regression analysis was used in this study to identify the crucial risk factors that can help formulate health policies and interventions that will improve child nutritional outcomes and survival. Health is negatively impacted by being underweight; for instance, underweight is associated with a higher mortality risk than people of normal weight [11, 58, 59]. The negative value of WAZ indicates that compared to the reference population, the distribution of an index has changed downward, and the majority of the population's children are undernourished which is consistent with others [50]. Female children are slightly more underweight than their counterparts. Underweight has been shown to be especially hazardous for young females [9]. This might be explained by the fact that in a country like Bangladesh, sons get preference over daughters because they are thought to carry the name and family title of the father and will ensure the future of their parents [60, 61]. A child's age also plays a key role to determine the status of underweight. The proportion of underweight children aged 2–3 years old is more than others. One of the main reason working behind this is that most of the children in

Table 1. Prevalence of child malnutrition according to underweight by background characteristics.

Background characteristics		Percent	Weight-for-Age (underweight) in %		p-value of Chi-square
			Z-score <-3 SD	Z-score <-2 SD	
Child's sex	Male	52.16	3.25	25.42	0.102
	Female	47.84	3.80	27.48	
Age of the child	≤ 6 months	13.14	0.10	3.64	<0.001
	7 months-1 year	9.94	3.58	20.64	
	1–2 years	18.45	5.01	31.53	
	2–3 years	19.87	5.85	32.51	
	3–4 years	19.16	2.57	29.59	
	4–5 years	19.44	2.97	30.85	
Birth order	1st	38.31	3.35	24.31	<0.001
	2nd-3rd	49.22	3.21	25.84	
	4th or higher	12.47	5.22	35.11	
Duration of breastfeeding	Never breastfeed	41.28	2.78	30.00	<0.001
	< = 12 months	2.05	4.82	19.88	
	13 or more	6.97	3.05	28.95	
	Still breastfeeding	49.70	4.14	23.47	
Mother's age	Up to 18 years	7.23	6.38	26.38	<0.001
	19–24	40.24	3.21	25.04	
	25–34	44.67	3.32	26.96	
	35 or more	7.86	3.70	30.59	
Mother's BMI	Underweight (<18.5)	13.61	7.88	39.31	<0.001
	Normal (18.5–24.9)	59.21	3.18	26.43	
	Overweight (> = 25)	27.18	1.97	19.39	
Mother's Education level	No Education	7.15	6.02	39.65	<0.001
	Primary	28.40	4.82	32.64	
	Secondary or above	64.45	2.67	22.16	
Father's Education level	No Education	14.85	5.71	38.01	<0.001
	Primary	34.29	4.25	30.67	
	Secondary or above	50.86	2.42	20.07	
Type of place of residence	Rural	73.04	3.54	27.76	<0.001
	Urban	26.96	3.50	22.69	
Religion	Muslim	91.96	3.48	26.60	<0.001
	Non-Muslim	80.04	3.85	24.19	
Place of delivery	With Health Facility	49.91	2.97	18.99	<0.001
	Respondent's Home	50.09	4.99	29.11	
Number of ANC visits	None	13.13	4.25	25.49	0.026
	1–3	44.66	4.15	25.58	
	4–7	36.18	4.22	22.19	
	8 or more	6.03	1.45	18.55	
Had diarrhea recently	No	95.26	3.49	26.27	0.043
	Yes	4.74	3.98	29.18	
Had fever in last two weeks	No	66.79	3.18	24.75	<0.001
	Yes	33.21	4.18	29.66	
Had cough in last two weeks	No	64.01	3.26	25.55	0.003
	Yes	35.99	3.96	27.89	

(Continued)

Table 1. (Continued)

Background characteristics		Percent	Weight-for-Age (underweight) in %		p-value of Chi-square
			Z-score	Z-score	
			<-3 SD	<-2 SD	
Wealth index	Poorest	21.44			<0.001
	Poorer	20.33	5.13	34.79	
	Middle	18.87	4.59	32.11	
	Richer	19.88	2.91	24.45	
	Richest	19.48	2.66	24.21	

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Bangladesh are breastfed until 24 months and breastfeeding gradually declines with child age [62, 63]. Moreover, as kids become older, their immune systems mature and they learn how to interact with their surroundings more effectively by avoiding germy places and consuming healthy foods, for example [17]. Children who suffered from different childhood morbidities such as fever, diarrhea, and ARI are more underweight than children who do not suffer from them.

Children whose mothers had a secondary or higher education had a lower risk of being underweight than children whose mothers had no education. The results were in line with a study [64]. The reasoning can be that mothers with less education have less experience and understanding with childcare, nutrition, health communication, maintaining a clean environment, nursing, and medical difficulties [17, 65]. Early married women also have fewer opportunities to continue their education, which affects the health of their children [66] and sometimes, wives were physically assaulted by their husbands for neglecting their children [67]. Mother's BMI has an influence on the status of underweight of their children. The WAZ score of a child increases as mother's BMI status shifted from underweight to normal. Moreover, compared to children from wealthy families, those from poorer families were more likely to be underweight. This outcome is consistent with the findings of the WHO indicators study, which found that underweight child prevalence was much lower in families with higher monthly per capita income [19, 68]. Typically, wealthier families can ensure better medical care along with more nutritious food as well as can provide an improved and healthier living environment [37]. Due to inadequate food consumption, a lack of access to basic healthcare, and a higher risk of infection, children from lower-income families were more likely to be underweight than children from higher-income families. Additionally, antenatal care quality is closely related to one's level of wealth. This study supported findings from earlier research conducted in other developing countries, showing that household economic circumstances play a significant role in the nutritional status of children in these countries [63, 69–71].

Strengths and limitations of this study

This study's novelty and use of the most recent country-representative BDHS-2017/18 dataset are its greatest strengths. This is the first study that used quantile regression in order to measure the determinants of underweight among under-five children in Bangladesh. However, there are some limitations of this study. Firstly, the results from this sample are not transferable to other populations with different characteristics, because socioeconomic factors were only assessed at a one-time point. Secondly, it is crucial to remember that simply because this research is cross-sectional, causal inferences cannot be made. Finally, the prevalence of

Table 2. Results of quantile regression analysis for Weight-for-Age Z (WAZ) score for under-5 years Bangladeshi children.

Characteristics	Labels	Q10 Coefficient (95% CI)	Q25 Coefficient (95% CI)	Q50 Coefficient (95% CI)	Q75 Coefficient (95% CI)	Q90 Coefficient (95% CI)
Child's sex	Male (Ref.)					
	Female	0.077 (-0.024,0.178)	0.081* (-0.006,0.168)	0.025* (-0.003,0.052)	0.021** (0.006,0.036)	0.008* (-0.002,0.018)
Age of the child	< = 6 months (Ref.)					
	7 months-1 year	-0.068*** (-0.094,-0.042)	-0.243* (-0.528,0.042)	-0.255* (-0.525,0.015)	-0.062*** (-0.086,-0.037)	-0.772** (-0.183,0.276)
	1–2 years	-0.505*** (-0.797,-0.212)	-0.698*** (-0.994,-0.402)	-0.707*** (-1.091,-0.324)	-0.47*** (-0.719,-0.222)	-0.062* (-0.126,0.001)
	2–3 years	-0.439** (-0.72,-0.158)	-0.704*** (-1,-0.408)	-0.777*** (-1.119,-0.434)	-0.652*** (-0.859,-0.444)	-0.206* (-0.449,0.037)
	3–4 years	0.317** (0.022,0.612)	0.168** (0.028,0.307)	0.141* (-0.018,0.3)	0.227** (-0.007,0.462)	0.165** (0.001,0.329)
	4–5 years	-0.195 (-0.539,0.148)	-0.216** (-0.395,-0.036)	-0.208* (-0.435,0.018)	-0.194* (-0.42,0.031)	-0.182** (-0.342,-0.022)
Birth order	1st (Ref.)					
	2nd-3rd	0.005 (-0.004,0.014)	-0.015 (-0.092,0.061)	-0.071** (-0.134,-0.008)	-0.117** (-0.202,-0.032)	-0.198** (-0.382,-0.013)
	4th and higher	0.044* (-0.007,0.096)	0.003 (-0.121,0.127)	-0.128* (-0.284,0.028)	-0.233** (-0.443,-0.023)	-0.508** (-0.857,-0.158)
Duration of breastfeeding	Never breastfeed (Ref.)					
	< = 12 months	-0.023 (-1.183,1.137)	-0.003 (-0.111,0.104)	0.098* (-0.003,0.199)	-0.204 (-1.509,1.101)	-0.943** (-1.689,-0.197)
	13 or more	-0.112** (-0.213,-0.01)	-0.026* (-0.056,0.004)	-0.175*** (-0.271,-0.08)	-0.438 (-1.673,0.796)	-0.353 (-1.077,0.371)
	Still breastfeeding	-0.243** (-0.473,-0.012)	-0.095* (-0.201,0.011)	-0.095** (-0.189,0)	-0.281 (-1.494,0.933)	-0.568* (-1.19,0.055)
Religion	Muslim (Ref.)					
	Non-Muslim	-0.006 (-0.13,0.119)	0.053 (-0.069,0.174)	-0.047 (-0.176,0.082)	-0.081 (-0.264,0.102)	-0.208** (-0.411,-0.006)
Mother's age	Up to 18 years (Ref.)					
	19–24	0.192* (-0.009,0.394)	0.044 (-0.109,0.197)	0.013* (-0.002,0.028)	0.036** (0.004,0.068)	0.124 (-0.06,0.308)
	25–34	0.129** (0.028,0.229)	-0.034* (-0.071,0.002)	0.023** (0.003,0.044)	0.028* (-0.003,0.06)	0.139* (-0.03,0.307)
	35 or more	0.075*** (0.052,0.098)	-0.127* (-0.266,0.012)	-0.049* (-0.103,0.005)	-0.063** (-0.126,0)	0.993** (0.192,1.794)
Mother's Education level	No Education (Ref.)					
	Primary	-0.062** (-0.12,-0.003)	-0.001 (-0.004,0.001)	0.055* (-0.007,0.117)	0.101** (0.004,0.198)	0.246* (-0.04,0.533)
	Secondary and above	-0.017* (-0.037,0.003)	0.048** (0.01,0.086)	0.119* (-0.013,0.251)	0.071* (-0.001,0.143)	0.043** (0,0.086)
Mother's BMI	Underweight (<18.5) (Ref.)					
	Normal (18.5–24.9)	0.202*** (0.098,0.305)	0.303*** (0.22,0.387)	0.321*** (0.249,0.393)	0.326*** (0.2,0.452)	0.565*** (0.303,0.828)
	Overweight (> = 25)	0.338*** (0.229,0.448)	0.407*** (0.314,0.499)	0.403*** (0.308,0.497)	0.584*** (0.45,0.718)	0.819*** (0.538,1.1)
Father's Education level	No Education (Ref.)					
	Primary	0.089* (-0.003,0.181)	-0.036** (-0.072,-0.001)	-0.043* (-0.09,0.003)	-0.006 (-0.02,0.008)	0.025** (0.003,0.048)
	Secondary and above	0.092* (-0.005,0.188)	0.044** (0,0.088)	0.002* (0,0.005)	0.046* (-0.005,0.096)	0.074* (-0.011,0.158)

(*Continued*)

Table 2. (Continued)

Characteristics	Labels	Q10 Coefficient (95% CI)	Q25 Coefficient (95% CI)	Q50 Coefficient (95% CI)	Q75 Coefficient (95% CI)	Q90 Coefficient (95% CI)
Type of place of residence	Rural (Ref.)					
	Urban	-0.071 (-0.162,0.021)	0.015 (-0.093,0.122)	0.043** (0,0.086)	0.077* (-0.003,0.157)	-0.069 (-0.291,0.153)
Place of delivery	With Health Facility (Ref.)					
	Respondent's Home	-0.001 (-0.113,0.111)	-0.014 (-0.097,0.07)	-0.022 (-0.094,0.05)	-0.076* (-0.16,0.009)	-0.111* (-0.245,0.023)
Number of ANC visits	None (Ref.)					
	1–3	-0.108** (-0.175,-0.04)	-0.045* (-0.094,0.003)	-0.029 (-0.134,0.077)	-0.098* (-0.215,0.019)	-0.4** (-0.803,0.004)
	4–7	-0.108** (-0.182,-0.035)	-0.036** (-0.066,-0.005)	-0.038 (-0.161,0.085)	-0.102* (-0.215,0.01)	-0.406* (-0.881,0.069)
	8 or more	-0.082** (-0.153,-0.011)	0.024** (0.004,0.043)	-0.039 (-0.152,0.074)	-0.034 (-0.321,0.252)	0.049* (-0.006,0.104)
Had diarrhea recently	No (Ref.)					
	Yes	-0.021 (-0.215,0.172)	-0.002 (-0.17,0.167)	-0.014 (-0.136,0.107)	-0.057 (-0.283,0.169)	-0.118 (-0.559,0.323)
Had fever in last two weeks	No (Ref.)					
	Yes	-0.219*** (-0.308,-0.13)	-0.215*** (-0.312,-0.119)	-0.21*** (-0.307,-0.113)	-0.208*** (-0.32,-0.095)	-0.103* (-0.224,0.017)
Had cough in last two weeks	No (Ref.)					
	Yes	-0.015 (-0.114,0.084)	0.047** (0.005,0.089)	0.055** (0.008,0.103)	0.114** (0.004,0.223)	-0.002 (-0.033,0.028)
Received BCG	No (Ref.)					
	Yes	0.02 (-0.197,0.236)	-0.059 (-0.286,0.169)	-0.157** (-0.31,-0.005)	-0.278** (-0.506,-0.05)	-0.653** (-1.235,-0.07)
Received Vitamin A	No (Ref.)					
	Yes	-0.153*** (-0.244,-0.061)	-0.133*** (-0.203,-0.063)	-0.204*** (-0.294,-0.114)	-0.312*** (-0.438,-0.187)	-0.529*** (-0.781,-0.276)
Wealth index	Poorest (Ref.)					
	Poorer	0.152** (0.029,0.274)	0.071** (0.021,0.12)	-0.066* (-0.136,0.003)	-0.052 (-0.12,0.017)	-0.365** (-0.708,-0.022)
	Middle	0.17** (0.012,0.329)	0.119** (0.014,0.225)	0.072* (-0.012,0.156)	-0.011* (-0.024,0.002)	-0.248** (-0.479,-0.018)
	Richer	0.12** (0.005,0.234)	0.058** (0.005,0.11)	0.051* (-0.001,0.103)	0.02** (0,0.041)	-0.129* (-0.269,0.01)
	Richest	0.171** (0.01,0.332)	0.019* (-0.01,0.048)	0.016** (0.001,0.032)	0.084* (-0.01,0.177)	-0.021* (-0.045,0.003)
Constant		-1.486** (-2.619,-0.353)	-0.791 (-1.871,0.29)	0.097 (-0.994,1.189)	1.05 (-0.426,2.526)	1.936 (-0.805,4.677)

Notes: *** refers p-value <0.001,

** refers p-value <0.05 and

* refers p-value <0.1.

underweight may also vary across time and space, however, the investigators did not take this into consideration in this study.

Conclusions

Age, and child's size at birth, mother's educational level and BMI, and income quantile all play significant roles in determining a child's WAZ score. It is necessary to focus on children aged less than three years to reduce the burden of underweight in Bangladesh. Improved mothers' education and health status will be helpful to lessen the prevalence of underweight among under-five children because a healthy mother may give birth to healthy children. Moreover, special attention is needed for children who lived in poor families. It seems vital to include information on ways of determining optimal weight in health promotion campaigns because underweight can have a range of harmful implications. Therefore, it would seem necessary to describe the effects of underweight in campaigns for health promotion. The authors would like to suggest that Bangladesh's educational system incorporate advice and guidance concerning nutrition and health education. Moreover, the authors believe that these findings will be helpful to the policymakers to ensure the SDGs goal-3. Furthermore, to observe the trend and get an in-depth scenario temporal and spatial variability should be incorporated into a further study.

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References

1. UNICEF, WHO, World Bank. Levels and trends in child malnutrition: Key findings of the 2020 Edition of the Joint Child Malnutrition Estimates. Geneva WHO. 2020. Available: https://www.unicef.org/media/69816/file/Joint-malnutrition-estimates-2020.pdf

2. UNICEF Bangladesh. Bangladesh sees sharp decline in child malnutrition, while violent disciplining of children rises, new survey reveals. In: UNICEF Bangladesh [Internet]. 2020 [cited 15 Apr 2022]. Available: https://www.unicef.org/bangladesh/en/press-releases/bangladesh-sees-sharp-decline-child-malnutrition-while-violent-disciplining-children

3. Kodama H. Problems of underweight in young females and pregnant women in Japan. Japan Med Assoc J. 2010; 53: 285–289. Available: https://www.cabdirect.org/cabdirect/abstract/20113069912

4. Tatsumi Y, Nakao YM, Masuda I, Higashiyama A, Takegami M, Nishimura K, et al. Risk for metabolic diseases in normal weight individuals with visceral fat accumulation: a cross-sectional study in Japan. BMJ Open. 2017; 7: e013831. https://doi.org/10.1136/bmjopen-2016-013831 PMID: 28093438

5. Andersen KK, Olsen TS. The obesity paradox in stroke: lower mortality and lower risk of readmission for recurrent stroke in obese stroke patients. Int J stroke. 2015; 10: 99–104. https://doi.org/10.1111/ijs.12016 PMID: 25635277

6. Bucholz EM, Krumholz HA, Krumholz HM. Underweight, Markers of Cachexia, and Mortality in Acute Myocardial Infarction: A Prospective Cohort Study of Elderly Medicare Beneficiaries. PLoS Med. 2016; 13: e1001998. https://doi.org/10.1371/journal.pmed.1001998 PMID: 27093615

7. Doleman B, Mills KT, Lim S, Zelhart MD, Gagliardi G. Body mass index and colorectal cancer prognosis: a systematic review and meta-analysis. Tech Coloproctol. 2016; 20: 517–535. https://doi.org/10.1007/s10151-016-1498-3 PMID: 27343117

8. Schönbeck Y, van Dommelen P, Sing RAH, van Buuren S. Thinness in the era of obesity: trends in children and adolescents in The Netherlands since 1980. Eur J Public Health. 2015; 25: 268–273. https://doi.org/10.1093/eurpub/cku130 PMID: 25125574

9. Pawlińska-Chmara R, Wronka I, Suliga E, Broczek K. Socio-economic factors and prevalence of underweight and overweight among female students in Poland. Homo. 2007; 58: 309–318. https://doi.org/10.1016/j.jchb.2006.10.002 PMID: 17574555

10. Bråbäck L, Hjern A, Rasmussen F. Body mass index, asthma and allergic rhinoconjunctivitis in Swedish conscripts—a national cohort study over three decades. Respir Med. 2005; 99: 1010–1014. https://doi.org/10.1016/j.rmed.2005.02.004 PMID: 15950142

11. Flegal KM, Graubard BI, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity: an evaluation of potential bias. Vital Heal Stat. 2018; 3: 1–21. https://doi.org/10.1001/JAMA.293.15.1861 PMID: 30216148

12. Do JG, Park CH, Lee YT, Yoon KJ. Association between underweight and pulmonary function in 282,135 healthy adults: A cross-sectional study in Korean population. Sci Rep. 2019; 9: 14308. https://doi.org/10.1038/s41598-019-50488-3 PMID: 31586079

13. Park D, Lee JH, Han S. Underweight: another risk factor for cardiovascular disease?: A cross-sectional 2013 Behavioral Risk Factor Surveillance System (BRFSS) study of 491,773 individuals in the USA. Medicine (Baltimore). 2017; 96: e8769. https://doi.org/10.1097/MD.0000000000008769 PMID: 29310352

14. Solis-Soto T, Paudel D, Nicoli F. Relationship between vaccination and nutritional status in children: Analysis of recent demographic and health surveys. Demogr Res. 2020; 42: 1–14. https://doi.org/10.4054/DEMRES.2020.42.1

15. Shine S, Asegidew W. Prevalence of Underweight and Associated Factors among Children Aged Six to Fifty-Nine Months in the Pastoral Community of Korahay Zone, Somali Regional State. 2019; 9: 53–59. https://doi.org/10.5923/j.fph.20190902.03

16. Abdulla F, Hossain MM, Karimuzzaman M, Ali M, Rahman A. Likelihood of infectious diseases due to lack of exclusive breastfeeding among infants in Bangladesh. PLoS One. 2022; 17: e0263890. https://doi.org/10.1371/journal.pone.0263890 PMID: 35171952

17. Rahman A, Hossain MM. Prevalence and determinants of fever, ARI and diarrhea among children aged 6–59 months in Bangladesh. BMC Pediatr. 2022; 22: 117. https://doi.org/10.1186/S12887-022-03166-9 PMID: 35248016

18. Ochiai H, Shirasawa T, Nanri H, Nishimura R, Nomoto S, Hoshino H, et al. Lifestyle factors associated with underweight among Japanese adolescents: a cross-sectional study. Arch public Heal. 2017; 75: 45. https://doi.org/10.1186/s13690-017-0213-9 PMID: 29075484

19. Tosheno D, Adinew YM, Thangavel T, Workie SB. Risk Factors of Underweight in Children Aged 6–59 Months in Ethiopia. J Nutr Metab. 2017; 2017: 6368746. https://doi.org/10.1155/2017/6368746 PMID: 29259827

20. Gamecha R, Demissie T, Admasie A. The Magnitude of Nutritional Underweight and Associated Factors Among Children Aged 6–59 Months in Wonsho Woreda, Sidama Zone Southern Ethiopia. Open Public Health J. 2017; 10: 7–16. https://doi.org/10.2174/1874944501610010007

21. Kassa ZY, Behailu T, Mekonnen A, Teshome M, Yeshitila S. Malnutrition and associated factors among under five children (6–59 Months) at Shashemene Referral Hospital, West Arsi Zone, Oromia, Ethiopia. Curr Pediatr Res. 2017; 21: 172–180. Available: https://www.alliedacademies.org/articles/malnutrition-and-associated-factors-among-under-five-children-659-months-at-shashemene-referral-hospital-west-arsi-zone-oromia-eth.html

22. Amare D, Negesse A, Tsegaye B, Assefa B, Ayenie B. Prevalence of Undernutrition and Its Associated Factors among Children below Five Years of Age in Bure Town, West Gojjam Zone, Amhara National Regional State, Northwest Ethiopia. Adv Public Heal. 2016; 2016: 1–8. https://doi.org/10.1155/2016/7145708

23. Asfaw M, Wondaferash M, Taha M, Dube L. Prevalence of undernutrition and associated factors among children aged between six to fifty nine months in Bule Hora district, South Ethiopia. BMC Public Health. 2015; 15: 41. https://doi.org/10.1186/s12889-015-1370-9 PMID: 25636688

24. Yisak H, Gobena T, Mesfin F. Prevalence and risk factors for under nutrition among children under five at Haramaya district, Eastern Ethiopia. BMC Pediatr. 2015; 15: 212. https://doi.org/10.1186/s12887-015-0535-0 PMID: 26675579

25. Ma'alin A, Birhanu D, Melaku S, Tolossa D, Mohammed Y, Gebremicheal K. Magnitude and factors associated with malnutrition in children 6–59 months of age in Shinille Woreda, Ethiopian Somali regional state: a cross-sectional study. BMC Nutr. 2016; 2: 44. https://doi.org/10.1186/S40795-016-0079-1

26. Kumar R, Abbas F, Mahmood T, Somrongthong R. Prevalence and factors associated with underweight children: a population-based subnational analysis from Pakistan. BMJ Open. 2019; 9: e028972. https://doi.org/10.1136/bmjopen-2019-028972 PMID: 31366654

27. Adhikari D, Khatri RB, Paudel YR, Poudyal AK. Factors Associated with Underweight among Under-Five Children in Eastern Nepal: Community-Based Cross-sectional Study. Front Public Heal. 2017; 5: 350. https://doi.org/10.3389/fpubh.2017.00350 PMID: 29312920

28. Hong SA, Peltzer K, Lwin KT, Aung LS. The prevalence of underweight, overweight and obesity and their related socio-demographic and lifestyle factors among adult women in Myanmar, 2015–16. PLoS One. 2018; 13: e0194454. https://doi.org/10.1371/journal.pone.0194454 PMID: 29547655

29. John JM, John JS. Prevalence and risk factors associated with underweight among under-five children in a rural area of Puducherry. Muller J Med Sci Res. 2018; 9: 11. https://doi.org/10.4103/MJMSR.MJMSR_16_17

30. Poda GG, Hsu CY, Chao JC. Factors associated with malnutrition among children. Int J Qual Heal care. 2017; 29: 901–908. https://doi.org/10.1093/INTQHC/MZX129 PMID: 29045661

31. Martínez JI, Román EM, Alfaro EL, Grandi C, Dipierri JE. Geographic altitude and prevalence of under-weight, stunting and wasting in newborns with the INTERGROWTH-21st standard. J Pediatr. 2019; 95: 366–373. https://doi.org/10.1016/j.jped.2018.03.007 PMID: 29859133

32. Rahman S, Islam MT, Alam DS. Obesity and overweight in Bangladeshi children and adolescents: a scoping review. BMC Public Health. 2014; 14: 70. https://doi.org/10.1186/1471-2458-14-70 PMID: 24450958

33. Das S, Gulshan J. Different forms of malnutrition among under five children in Bangladesh: A cross sec-tional study on prevalence and determinants. BMC Nutr. 2017; 3: 1. https://doi.org/10.1186/s40795-016-0122-2

34. Chowdhury TR, Chakrabarty S, Rakib M, Saltmarsh S, Davis KA. Socio-economic risk factors for early childhood underweight in Bangladesh. Global Health. 2018; 14: 1–12. https://doi.org/10.1186/s12992-018-0372-7 PMID: 29848359

35. Hossain S, Chowdhury PB, Biswas RK, Hossain MA. Malnutrition status of children under 5 years in Bangladesh: A sociodemographic assessment. Child Youth Serv Rev. 2020; 117: 105291. https://doi.org/10.1016/J.CHILDYOUTH.2020.105291

36. Sultana N, Afroz S, Tomalika N, Momtaz H, Kabir MH. Prevalence of childhood obesity and undernutri-tion among urban school children in Bangladesh. J Biosoc Sci. 2019; 51: 244–253. https://doi.org/10.1017/S0021932018000093 PMID: 29633670

37. Rahman A, Chowdhury S. Determinants of chronic malnutrition among preschool children in Bangla-desh. J Biosoc Sci. 2007; 39: 161–173. https://doi.org/10.1017/S0021932006001295 PMID: 16566847

38. Rahman A, Chowdhury S, Hossain D. Acute malnutrition in Bangladeshi children: Levels and determi-nants. Asia-Pacific J Public Heal. 2009; 21: 294–302. https://doi.org/10.1177/1010539509335399 PMID: 19403548

39. Yeh CC, Wang KM, Suen YB. Quantile analyzing the dynamic linkage between inflation uncertainty and inflation. Probl Perspect Manag. 2009; 7: 21–28.

40. Hossain MM. Proposed Mean (Robust) in the Presence of Outlier. J Stat Appl Probab Lett. 2016; 3: 103–107. https://doi.org/10.18576/jsapl/030301

41. Hossain MM. Variance in the Presence of Outlier: Weighted Variance. J Stat Appl Probab Lett. 2017; 4: 57–59. https://doi.org/10.18576/jsapl/040203

42. Olsen CS, Clark AE, Thomas AM, Cook LJ. Comparing least-squares and quantile regression approaches to analyzing median hospital charges. Acad Emerg Med. 2012; 19: 866–875. https://doi.org/10.1111/j.1553-2712.2012.01388.x PMID: 22805633

43. Borooah VK. The height-for-age of Indian children. Econ Hum Biol. 2005; 3: 45–65. https://doi.org/10.1016/j.ehb.2004.12.001 PMID: 15722262

44. Aturupane H, Deolalikar AB, Gunewardena D. Determinants of Child Weight and Height in Sri Lanka: A Quantile Regression Approach. In: McGillivray M, Dutta I, Lawson D, editors. Health Inequality and Development. Studies in Development Economics and Policy, Palgrave Macmillan, London; 2011. https://doi.org/10.1057/9780230304673_4

45. Fenske N, Burns J, Hothorn T, Rehfuess EA. Understanding child stunting in India: A comprehensive analysis of socio-economic, nutritional and environmental determinants using additive quantile regression. PLoS One. 2013; 8: e78692. https://doi.org/10.1371/journal.pone.0078692 PMID: 24223839

46. Sharaf MF, Mansour EI, Rashad AS. Child nutritional status in Egypt: a comprehensive analysis of socio-economic determinants using a quantile regression approach. J Biosoc Sci. 2019; 51: 1–17. https://doi.org/10.1017/S0021932017000633 PMID: 29316992

47. Abdulla F, Rahman A, Hossain MM. Prevalence and risk predictors of childhood stunting in Bangladesh. PLoS One. 2023; 18: e0279901. https://doi.org/10.1371/journal.pone.0279901 PMID: 36701381

48. National Institute of Population Research and Training (NIPORT), ICF. Bangladesh Demographic and Health Survey 2017–18. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT and ICF; 2020. Available: https://dhsprogram.com/pubs/pdf/FR344/FR344.pdf

49. Koenker R, Bassett G. Regression Quantiles. Econometrica. 1978; 46: 33–50. https://doi.org/10.2307/1913643

50. Rahman A, Hossain MM. Quantile regression approach to estimating prevalence and determinants of child malnutrition. J Public Health (Bangkok). 2022; 30: 323–339. https://doi.org/10.1007/S10389-020-01277-0

51. Hossain MM, Majumder AK. Determinants of the age of mother at first birth in Bangladesh: quantile regression approach. J Public Health (Bangkok). 2019; 27: 419–424. https://doi.org/10.1007/s10389-018-0977-6

52. Hossain MM, Abdulla F, Rahman A. Prevalence and determinants of wasting of under-5 children in Bangladesh: Quantile regression approach. PLoS One. 2022; 17: e0278097. https://doi.org/10.1371/journal.pone.0278097 PMID: 36417416

53. Abdulla F, El-Raouf MMA, Rahman A, Aldallal R, Mohamed MS, Hossain MM. Prevalence and determinants of wasting among under-5 Egyptian children: Application of quantile regression. Food Sci Nutr. 2022; 1–11. https://doi.org/10.1002/fsn3.3144 PMID: 36789038

54. Hossain S, Hossain MM, Yeasmin S, Bhuiyea MSH, Chowdhury PB, Khan MTF. Assessing the Determinants of Women's Age at First Marriage in Rural and Urban Areas of Bangladesh: Insights From Quantile Regression (QR) Approaches. J Popul Soc Stud. 2022; 30: 602–624.

55. Yirga AA, Ayele DG, Melesse SF. Application of Quantile Regression: Modeling Body Mass Index in Ethiopia. Open Public Health J. 2018; 11: 221–233. https://doi.org/10.2174/1874944501811010221

56. Hossain S, Biswas RK, Hossain AA. Body mass index of women in Bangladesh: comparing Multiple Linear Regression and Quantile Regression. J Biosoc Sci. 2021; 53: 247–265. https://doi.org/10.1017/S0021932020000176 PMID: 32252838

57. Islam T, Hossain MM. Application of Text Mining on the Editorial of a Newspaper of Bangladesh. Int J Comput Appl. 2019; 178: 23–29. https://doi.org/10.5120/ijca2019918837

58. Pawlińska-Chmara R, Wronka I, Suliga E, Broczek K. Socio-economic factors and prevalence of underweight and overweight among female students in Poland. Homo. 2007; 58: 309–318. https://doi.org/10.1016/j.jchb.2006.10.002 PMID: 17574555

59. Flegal KM, Graubard BI, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity. J Am Med Assoc. 2005; 293: 1861–1867. https://doi.org/10.1001/jama.293.15.1861 PMID: 15840860

60. Huq MN, Hossain MM, Abdulla F, Yeasmin S. Intergenerational educational mobility in Bangladesh. Khan HTA, editor. PLoS One. 2021; 16: e0255426. https://doi.org/10.1371/JOURNAL.PONE.0255426 PMID: 34329343

61. Torche F. Educational mobility in developing countries. UNU-WIDER; 2019. https://doi.org/10.35188/UNU-WIDER/2019/724-8

62. Dhungana GP. Nutritional Status and the Associated Factors in Under Five Years Children of Lamjung, Gorkha and Tanahun Districts of Nepal. Nepal J Stat. 2017; 1: 15–18. https://doi.org/10.3126/NJS.V1I0.18814

63. Chowdhury TR, Chakrabarty S, Rakib M, Afrin S, Saltmarsh S, Winn S. Factors associated with stunting and wasting in children under 2 years in Bangladesh. Heliyon. 2020; 6: e04849. https://doi.org/10.1016/j.heliyon.2020.e04849 PMID: 32984587

64. Tosheno D, Adinew Y, Thangavel T, Workie S. Risk Factors of Underweight in Children Aged 6–59 Months in Ethiopia. J Nutr Metab. 2017; 2017: 6368746. https://doi.org/10.1155/2017/6368746 PMID: 29259827

65. Mahumud RA, Alam K, Renzaho AMN, Sarker AR, Sultana M, Sheikh N, et al. Changes in inequality of childhood morbidity in Bangladesh 1993–2014: A decomposition analysis. PLoS One. 2019; 14: e0218515. https://doi.org/10.1371/journal.pone.0218515 PMID: 31216352

66. Hossain MM, Abdulla F, Banik R, Yeasmin S, Rahmanid A. Child marriage and its association with morbidity and mortality of under-5 years old children in Bangladesh. Goli S, editor. PLoS One. 2022; 17: e0262927. https://doi.org/10.1371/JOURNAL.PONE.0262927 PMID: 35139075

67. Hossain MM, Abdulla F, Rahman A, Khan HTA. Prevalence and determinants of wife-beating in Bangladesh: evidence from a nationwide survey. BMC Psychiatry. 2022; 22: 9. https://doi.org/10.1186/s12888-021-03652-x PMID: 34983457

68. Imdad A, Yakoob MY, Bhutta ZA. Impact of maternal education about complementary feeding and provision of complementary foods on child growth in developing countries. BMC Public Health. 2011; 11 Suppl 3: S25–S25. https://doi.org/10.1186/1471-2458-11-S3-S25 PMID: 21501443

69. Meshram II, Arlappa N, Balakrishna N, Laxmaiah A, Rao KM, Gal Reddy C, et al. Prevalence and determinants of undernutrition and its trends among pre-school tribal children of maharashtra state, India. J Trop Pediatr. 2012; 58: 125–132. https://doi.org/10.1093/tropej/fmr035 PMID: 21543411

70. Hong R, Mishra V. Effect of wealth inequality on chronic under-nutrition in Cambodian children. J Heal Popul Nutr. 2006; 24: 89–99. https://doi.org/10.3329/JHPN.V24I1.751 PMID: 16796155

71. Kien VD, Lee H-Y, Nam Y-S, Oh J, Giang KB, Minh H Van. Trends in socioeconomic inequalities in child malnutrition in Vietnam: findings from the Multiple Indicator Cluster Surveys, 2000–2011. Glob Health Action. 2016; 9: 29263. https://doi.org/10.3402/gha.v9.29263 PMID: 26950558