

Regional variation in maternal and childhood undernutrition in Bangladesh: evidence from demographic and health surveys

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ABSTRACT

Background: Undernutrition among mothers and children is currently a major public health and development concern in Bangladesh. In literature relating to nutritional determinants, of particular interest is the geography, as regions with poor nutrition tend to pull down the overall nutritional status of the country. As such, reducing the regional gap can alone reduce overall undernutrition significantly, especially when regional gaps are high. The aim of this study is, therefore, to assess the magnitude of inequalities in undernutrition in children aged under 5 years in Bangladesh and their mothers, and relate this to the administrative divisions of the country.

Methods: The Bangladesh Demographic and Health Surveys (1996–1997, 1999–2000, 2004 and 2007) were the sources of data, and a total of 16 278 mother–child pairs whose records were complete for the required individual and household-level variables were included in the analysis. Maternal nutritional status was measured by the body mass index (BMI). Weight-for-age, height-for-age and weight-for-height z-scores were calculated by use of the World Health Organization (WHO) Child Growth Standards to assess the nutritional status of children aged under 5 years. General linear model, sequential linear and multinomial logistic regression analyses were done to assess the inequalities in maternal and child nutritional status among the six administrative divisions of Bangladesh. Socioeconomic variables that were controlled for were residency, education and occupation of the mothers and their husbands, house type and possession score in the household.

Results: Maternal BMI and prevalence of underweight, stunting and wasting in children aged under 5 years were found to vary significantly according to administrative division. Of the six divisions, Sylhet was found to have highest prevalence of undernourished mothers and children. The trends from 1996 to 2007 also established Sylhet as the poorest-performing region overall.

Conclusion: The Sylhet administrative division needs specially focused attention from policy-makers if the overall performance of the health, nutrition and population sector is to reach the targets set by the country.

Key words: administrative divisions, Bangladesh, undernutrition, WHO Child Growth Standards

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BACKGROUND

Undernutrition among mothers and children is currently a major public health and development concern in Bangladesh.¹ In 2012 the World Food Programme reported that about

2 million, or some 14% of children aged under 5 years in Bangladesh, had acute undernutrition (wasting), close to the World Health Organization's (WHO) "critical" threshold of 15%.² Reproductive health, child health and nutrition are core priorities for any country,³ and more so for Bangladesh, as it

has one of the world's greatest burdens of maternal, newborn and child undernutrition. Understanding the nature and determinants of undernutrition is essential in contemplating the health of populations in the country and in allocating resources appropriately to improve the health of the poor and most vulnerable groups. In literature relating to nutritional determinants, of particular interest is the geography, as regions with poor nutrition tend to pull down the overall nutritional status of the country. As such, reducing the regional gap can alone reduce overall undernutrition significantly, especially when regional gaps are high. According to Simler,⁴ estimates of nutritional status from national surveys for large areas have typically masked the high within-country variability, including pockets of severe undernutrition or "hunger hot spots"; whereas developing policies and programmes to improve nutritional status requires a more disaggregated picture of undernutrition, especially when policies recommend moving to greater levels of decentralization. Earlier evidence has offered strong support for geographic targeting of social programmes and it has documented substantial improvements in programme impact through geographic targeting of needs-based programmes.^{5,6}

The administration of Bangladesh is currently divided into eight major divisions, whereas, during the period (1996–2007) from which the data for these analyses were drawn, there were six administrative divisions: Dhaka, Chittagong, Rajshahi, Barisal, Khulna and Sylhet. As each division has different characteristics in terms of geography, economy and social structure, it tends to offer different opportunity structures for people living there. Opportunity structure, in social science, refers to the societal structure that provides opportunities such as quality education, transportation, community well-being, and income generation for its people to live a successful life.⁷ Biswakarma⁸ anticipated interregional inequality in undernutrition as one of the outcomes of such differential opportunity structures.

Recent mapping of undernutrition in Bangladesh has reported regional concentration of undernutrition, leading to the suggestion of geographic targeting of nutrition interventions, which, in the opinion of the authors, could result in a high pay-off in achieving significant reductions in the number and rate of undernourished children.⁹

The aim of this study is, therefore, to assess the inequalities in nutritional status of mother–child pairs in the six administrative divisions of Bangladesh.

METHODS

Sampling

The Bangladesh Demographic and Health Surveys (BDHS) conducted in 1996–1997, 1999–2000, 2004 and 2007 were the source of data,^{10–13} and they contained information on 9127, 10 544, 11 440 and 10 996 households, respectively. The present study focused on the nutritional status of children aged under 5 years and their mothers. Therefore, only those families with children aged under 5 years were considered for the study, and 5507, 6217, 6612 and 6031 households were selected from the 1996–1997, 1999–2000, 2004 and 2007 surveys, respectively. Children and mothers for whom there were no data on height, weight, age or sex were excluded from the study. Anthropometric measurements of above or below 4 standard deviations (SD) from the mean for the mothers were considered to be outliers and were excluded from the analysis.¹⁴ Nutritional status of the children was measured using *z*-scores, and the cut-off values recommended in the 2006 WHO Child Growth Standards for data exclusion were used; thus, data were excluded if the *z*-score for a child's height-for-age (HAZ) was below -6 or above $+6$, weight-for-age (WAZ) was below -6 or above $+5$, or weight-for-height (WHZ) was below -5 or above $+5$, because these extreme values were most likely to be the result of errors in measurement or data entry.¹⁵ Lastly, children and women for whom information was lacking on the selected socioeconomic and demographic variables of the study were excluded.

Data

Ultimately, a total of 16 278 mother–child pairs, whose records were complete in the required individual and household-level variables, were included in the analysis, of whom 3560 were from the 1996–1997 survey (later referred to as 1996), 4039 were from 1999–2000 (later referred to as 2000), 4731 were from 2004, and 3948 were from the 2007 BDHS (see Table 1).

Table 1: Step-wise process of selecting mother–child pairs with complete information

Steps of selection	Bangladesh Demographic and Health Survey by year			
	1996	2000	2004	2007
Total households	9127	10 544	11 440	10 996
Had a child aged under 5 years in the family	5507	6217	6612	6031
Had child height, weight and age information	3974	4392	4874	4491
Calculation of <i>z</i> -scores of height-for-age, weight-for-age and weight-for-height	3898	4321	4852	4483
Excluded because <i>z</i> -scores were outside WHO cut-off values	3700	4226	4790	4422
Had maternal height and weight information	3687	4214	4773	4412
Were excluded because maternal height and weight outside ± 4 SD	3640	4177	4765	4385
Had socioeconomic and demographic variables	8944	10 211	11 356	10 035
Had all variables	3560	4039	4731	3948
Compliant group total	16 278			

SD: standard deviation.

A cut-off value of -2.00 SD for WAZ, WHZ and HAZ was used to classify a child as underweight, wasted or stunted, respectively.

Maternal nutritional status variables compared overall mean and SD of height, weight and body mass index (BMI). Mothers' BMI values were graded into four groups: underweight (<18.50), normal ($18.50-24.99$), overweight ($25.00-29.99$) and obese (≥ 30.00), using the international WHO cut-off values.¹⁶ Four further categories of BMI were also used, according to recommendations of a WHO expert consultation on cut-off values in Asian populations, where the underweight level was similar to the WHO cut-off value, but the ranges for normal, overweight and obese were lowered to $18.50-22.99$, $23.00-27.49$ and ≥ 27.50 , respectively.¹⁷

Statistical analysis

To assess regional inequalities, six administrative "divisions" were used as the independent variable, namely Dhaka, Chittagong, Barisal, Khulna, Rajshahi and Sylhet.

All continuous data were checked for skewness using the Cox test (coefficient of skewness divided by standard error of skewness) as well as examination of the mean–median difference and the frequency distribution with a normal curve. The general linear model or the multiple regression model was used to analyse continuous outcomes with predictor variables. When the z -scores and maternal BMI values were analysed as categorical variables, logistic regression analyses, binary or multinomial, were undertaken with the explanatory variables.

Analyses were performed with two levels of adjustment: (i) analysis 1: adjusting for the period of the demographic survey and age (considered as both linear and quadratic functions), and accounting for the interaction between the period of the survey and age (considered as both linear and quadratic functions); (ii) analysis 2: in addition to all factors considered in analysis 1, all other explanatory variables in the model were adjusted for – residence (urban/rural); education and occupation of parents; housing condition (type of floor, wall and roof); ownership of assets such as radio, television, bicycle, motorcycle or telephone; availability of electricity, water supply, latrine; and number of family members; further, the effect of administrative division was tested.

IBM SPSS 20 software was used for all data analysis. The level of significance was taken to be $P \leq 0.05$.

RESULTS

Table 2 presents the mean z -scores for children, and prevalence of underweight, stunting and wasting for the six administrative divisions and for the four BDHS of 1996, 2000, 2004 and 2007. It shows that the mean WAZ of children residing in either Chittagong or Dhaka improved between 1996 and 2007, whereas the mean HAZ in all six administrative divisions showed an overall improvement over the study period. The mean WHZ of children in Sylhet, Rajshahi, Barisal and Khulna fell between 1996 and 2007. Overall mean WAZ and

HAZ values were better in children from Khulna, and lowest in children from Sylhet. Table 2 also shows that there were substantial decreases in the percentages of undernourished children over the period of the four surveys: in 1996–1997, half of the children were underweight and almost three fifths of children were stunted, whereas in 2007 almost 60% of children fell into normal categories for both WAZ and HAZ. The rate of stunting showed a decreasing trend in all six administrative divisions throughout the study period, whereas although the number of underweight children declined in all divisions between 1996 and 2000, it did not show an improvement afterwards in any of the divisions except Sylhet. Unexpectedly, the percentage of children with wasting showed an increasing trend in all administrative divisions after 2000. In Sylhet and Barisal, there were higher prevalence rates of underweight and stunting compared with other divisions. The declines in rates of underweight, stunting and wasting were highest in Sylhet, at 13.6%, 19.0% and 7.1%, respectively.

In the pooled data of all four BDHS, the mean prevalence of children aged under 5 years with underweight, stunting or wasting was found to vary significantly according to administrative division. The overall prevalence of stunting ranged from 50.3% in Barisal to 40.4% in Khulna. Sylhet had the highest prevalence of wasting (19.9%) and Barisal had the lowest prevalence (14.7%). The overall prevalence of underweight children ranged from 45.8% in Sylhet to 35.1% in Khulna (data not shown).

Regional heterogeneity was also observed in pooled data: the mean HAZ score was found to be significantly higher in Khulna ($P < 0.001$) and Rajshahi ($P < 0.05$) divisions compared with that in Sylhet (see Table 3). For both WAZ and WHZ, children from Sylhet had the lowest mean values (-1.59 and -0.92 , respectively), whereas those from Khulna and Dhaka had the highest mean values for WAZ and WHZ, respectively (see Table 3). Binary logistic regression analysis in Table 4 shows that children from Dhaka, Rajshahi and Khulna had significantly lower odds of being underweight (odds ratio [OR] 0.86, 0.84 and 0.74, with P values of <0.05 , <0.01 and <0.001 , respectively) compared with Sylhet. Children from Dhaka (OR 0.74, $P < 0.001$) and Rajshahi (OR 0.85, $P < 0.05$) showed less likelihood of being wasted, and those from Khulna (OR 0.76, $P < 0.001$) and Rajshahi (OR 0.79, $P < 0.001$) showed less likelihood of being stunted compared with children from Sylhet.

Regional variation among the administrative divisions was also found to be present in maternal nutritional status; the mean values for maternal height (centimetres), weight (kilograms) and BMI (kilograms per square metre); and the prevalence of underweight, overweight and obese mothers by administrative division for the four survey periods are presented in Table 5.

Mean height, weight and BMI were lowest in Sylhet. Mothers from Khulna and Chittagong were, on average, over 1 kg heavier compared with mothers from Sylhet (see Table 5). The multinomial logistic regression analysis in Table 7 shows that mothers from all the other five divisions had significantly lower odds of being underweight compared with mothers from Sylhet, but not lower odds for being overweight.

Table 2. Mean z-scores and prevalence of underweight, stunting and wasting for children in administrative divisions, from the Bangladesh Demographic and Health Surveys of 1996, 1999, 2004 and 2007

Year	Division (n)	WAZ Mean z-score (SD)	HAZ Mean z-score (SD)	WHZ Mean z-score (SD)	Underweight (≤ -2.00 SD WAZ) n (%)	Stunting (≤ -2.00 SD HAZ) n (%)	Wasting (≤ -2.00 SD WHZ) n (%)	Proportion underweight, stunted, or wasted n (%)
1996	Barisal (369)	-1.97 (1.28)	-2.32 (1.54)	-0.89 (1.44)	193 (52.3)	227 (61.5)	76 (20.6)	268 (72.6)
	Chittagong (599)	-2.05 (1.36)	-2.13 (1.66)	-1.16 (1.42)	308 (51.4)	315 (52.6)	162 (27.0)	413 (68.9)
	Dhaka (1003)	-1.95 (1.26)	-2.22 (1.61)	-0.97 (1.31)	488 (48.7)	582 (58.0)	194 (19.3)	675 (67.3)
	Khulna (382)	-1.82 (1.16)	-1.98 (1.39)	-0.99 (1.36)	171 (44.8)	189 (49.5)	85 (22.3)	250 (65.4)
	Rajshahi (835)	-1.97 (1.18)	-2.13 (1.51)	-1.05 (1.29)	414 (49.6)	477 (57.1)	176 (21.1)	588 (70.4)
	Sylhet (372)	-2.14 (1.40)	-2.40 (1.67)	-1.10 (1.59)	207 (55.6)	228 (61.3)	105 (28.2)	285 (76.6)
	Total (3560)	-1.98 (1.27)	-2.19 (1.58)	-1.03 (1.38)	1781 (50.0)	2018 (56.7)	798 (22.4)	2479 (69.6)
2000	Barisal (347)	-1.64 (1.20)	-1.75 (1.47)	-0.91 (1.09)	133 (38.3)	153 (44.1)	45 (13.0)	181 (52.2)
	Chittagong (839)	-1.65 (1.17)	-1.80 (1.46)	-0.87 (1.08)	323 (38.5)	386 (46.0)	107 (12.8)	465 (55.4)
	Dhaka (1002)	-1.68 (1.15)	-1.90 (1.46)	-0.81 (1.08)	385 (38.4)	481 (48.0)	122 (12.2)	569 (56.8)
	Khulna (621)	-1.51 (1.08)	-1.71 (1.24)	-0.76 (1.07)	198 (31.9)	260 (41.9)	73 (11.8)	312 (50.2)
	Rajshahi (752)	-1.75 (1.13)	-1.86 (1.41)	-0.96 (1.08)	302 (40.2)	343 (45.6)	114 (15.2)	430 (57.2)
	Sylhet (478)	-1.89 (1.20)	-1.99 (1.50)	-1.03 (1.06)	215 (45.0)	242 (50.6)	76 (15.9)	285 (59.6)
	Total (4039)	-1.68 (1.15)	-1.84 (1.43)	-0.88 (1.08)	1556 (38.5)	1865 (46.2)	537 (13.3)	2242 (55.5)
2004	Barisal (547)	-1.69 (1.14)	-2.04 (1.34)	-0.71 (1.05)	215 (39.3)	280 (51.2)	51 (9.3)	310 (56.7)
	Chittagong (978)	-1.75 (1.20)	-1.87 (1.44)	-0.95 (1.16)	415 (42.4)	460 (47.0)	164 (16.8)	563 (57.6)
	Dhaka (1027)	-1.66 (1.15)	-1.85 (1.38)	-0.86 (1.14)	398 (38.8)	483 (47.0)	132 (12.9)	580 (56.5)
	Khulna (662)	-1.55 (1.09)	-1.57 (1.29)	-0.92 (1.15)	222 (33.5)	256 (38.7)	106 (16.0)	341 (51.5)
	Rajshahi (964)	-1.73 (1.14)	-1.77 (1.32)	-1.03 (1.13)	379 (39.3)	423 (43.9)	161 (16.7)	528 (54.8)
	Sylhet (553)	-1.78 (1.15)	-1.88 (1.49)	-0.97 (1.15)	243 (43.9)	270 (48.8)	92 (16.6)	336 (60.8)
	Total (4731)	-1.70 (1.15)	-1.82 (1.38)	-0.92 (1.14)	1872 (39.6)	2172 (45.9)	706 (14.9)	2658 (56.2)
2007	Barisal (537)	-1.79 (1.10)	-1.80 (1.35)	-1.07 (1.09)	233 (43.4)	246 (45.8)	93 (17.3)	317 (59.0)
	Chittagong (768)	-1.74 (1.21)	-1.76 (1.46)	-1.03 (1.12)	317 (41.3)	338 (44.0)	141 (18.4)	420 (54.7)
	Dhaka (847)	-1.59 (1.20)	-1.68 (1.40)	-0.89 (1.13)	325 (38.4)	356 (42.0)	125 (14.8)	452 (53.4)
	Khulna (517)	-1.53 (1.11)	-1.40 (1.39)	-1.04 (1.12)	174 (33.7)	177 (34.2)	92 (17.8)	249 (48.2)
	Rajshahi (676)	-1.72 (1.03)	-1.66 (1.16)	-1.11 (1.05)	280 (41.4)	268 (39.6)	119 (17.6)	370 (54.7)
	Sylhet (603)	-1.81 (1.15)	-1.75 (1.48)	-1.15 (1.16)	253 (42.0)	255 (42.3)	127 (21.1)	350 (58.0)
	Total (3948)	-1.69 (1.14)	-1.68 (1.38)	-1.04 (1.12)	1582 (40.1)	1640 (41.5)	697 (17.7)	2158 (54.7)

SD: standard deviation; HAZ: height-for-age; WAZ: weight-for-age; WHZ: weight-for-height.

Table 3: Relationship between z-scores and the demographic and socioeconomic variables for the pooled data

z-score	Administrative division	Analysis 1 ^a			Analysis 2 ^b		
		Mean	SE	Significance ^c	Mean	SE	Significance ^c
WAZ	Barisal	-1.76	0.03	<0.005	-1.52	0.04	NS
	Chittagong	-1.79	0.02	<0.01	-1.57	0.04	NS
	Dhaka	-1.72	0.02	<0.001	-1.47	0.04	<0.005
	Khulna	-1.57	0.03	<0.001	-1.39	0.04	<0.001
	Rajshahi	-1.79	0.02	<0.005	-1.46	0.04	<0.005
	Sylhet (reference)	-1.91	0.03		-1.59	0.04	
HAZ	Barisal	-1.95	0.03	NS	-1.68	0.05	NS
	Chittagong	-1.91	0.02	NS	-1.67	0.05	NS
	Dhaka	-1.91	0.02	NS	-1.65	0.04	NS
	Khulna	-1.62	0.03	<0.001	-1.45	0.05	<0.001
	Rajshahi	-1.84	0.02	<0.001	-1.51	0.05	<0.05
	Sylhet (reference)	-2.01	0.03		-1.64	0.05	
WHZ	Barisal	-0.90	0.03	<0.001	-0.77	0.05	<0.01
	Chittagong	-0.99	0.02	NS	-0.87	0.04	NS
	Dhaka	-0.88	0.02	<0.001	-0.75	0.04	<0.001
	Khulna	-0.92	0.03	<0.005	-0.80	0.04	<0.05
	Rajshahi	-1.04	0.02	NS	-0.85	0.04	NS
	Sylhet (reference)	-1.06	0.03		-0.92	0.04	

NS: not significant; SE: standard error.

^a Adjustment made for the period of the demographic survey, linear and quadratic effects of age and interaction between the period of the survey, and linear and quadratic effects of age.

^b The socioeconomic and demographic information controlled for in analysis 2 were residence (urban/rural); education and occupation of parents; housing condition (type of floor, wall and roof); ownership of assets such as radio, television, bicycle, motorcycle or telephone; availability of electricity, water supply, and latrine; and number of family members; linear and quadratic terms of age and period of survey and their interactions were also entered into the analysis before testing the effect of administrative division.

^c The mean difference is significant at the 0.05 level and a Bonferroni adjustment was made for multiple comparisons.

Table 4: Binary logistic regression analysis of z-scores by demographic and socioeconomic variables

Variable	Administrative division	Analysis 1 ^a			Analysis 2 ^b		
		OR	95% CI	P value	OR	95% CI	P value
Underweight (≤ -2.00 SD WAZ)	Barisal	0.85	0.74–0.96	<0.001	0.94	0.82–1.08	<0.001
	Chittagong	0.88	0.78–0.98		1.01	0.90–1.14	
	Dhaka	0.77	0.69–0.86		0.86	0.76–0.97	
	Khulna	0.61	0.53–0.69		0.74	0.65–0.85	
	Rajshahi	0.81	0.73–0.91		0.84	0.74–0.95	
	Sylhet (reference)						
Stunting (≤ -2.00 SD HAZ)	Barisal	0.94	0.83–1.08	<0.001	1.04	0.90–1.20	<0.001
	Chittagong	0.87	0.77–0.97		1.01	0.89–1.14	
	Dhaka	0.85	0.76–0.96		0.95	0.84–1.08	
	Khulna	0.60	0.53–0.68		0.76	0.66–0.87	
	Rajshahi	0.77	0.68–0.86		0.79	0.70–0.90	
	Sylhet (reference)						
Wasting (≤ -2.00 SD WHZ)	Barisal	0.71	0.59–0.84	<0.001	0.76	0.63–0.90	<0.001
	Chittagong	0.90	0.78–1.04		0.96	0.83–1.11	
	Dhaka	0.70	0.61–0.81		0.74	0.64–0.86	
	Khulna	0.84	0.72–0.99		0.92	0.78–1.09	
	Rajshahi	0.87	0.75–1.01		0.85	0.73–0.99	
	Sylhet (reference)						

CI: confidence interval; HAZ: height-for-age; OR: odds ratio; SD: standard deviation; WAZ: weight-for-age; WHZ: weight-for-height.

^a Adjustment made for periods of demographic survey, linear and quadratic effects of age and interaction between period of survey, and linear and quadratic effects of age.

^b Socioeconomic and demographic information controlled for in analysis 2 were residence (urban/rural); education and occupation of parents; housing condition (type of floor, wall and roof); ownership of assets such as radio, television, bicycle, motorcycle or telephone; availability of electricity, water supply, latrine; and number of family members; linear and quadratic terms of age and period of survey and their interactions were also entered in the analysis before testing the effect of administrative division.

Table 5: Mean maternal height, weight and BMI, and prevalence of underweight, overweight and obesity, among mothers by administrative division, from the Bangladesh Demographic and Health Surveys of 1996, 1999, 2004 and 2007

Year	Administrative division (n)	Maternal height (cm) Mean (SD)	Maternal weight (kg) Mean (SD)	Maternal BMI (kg/m ²) Mean (SD)	Underweight n (%)	Overweight n (%)	Obese n (%)
1996	Barisal (369)	150.05 (5.53)	42.81 (6.57)	18.99 (2.55)	183 (49.6)	23 (6.2) (6.2)	2 (0.5)
	Chittagong (599)	150.65 (5.33)	43.49 (7.36)	19.13 (2.90)	285 (47.6)	44 (7.3)	11 (1.8)
	Dhaka (1003)	150.23 (5.66)	42.89 (6.88)	18.98 (2.67)	495 (49.4)	68 (6.8)	11 (1.1)
	Khulna (382)	150.73 (5.51)	43.23 (6.73)	18.99 (2.50)	184 (48.2)	25 (6.5)	3 (0.8)
	Rajshahi (835)	150.14 (5.72)	42.32 (6.18)	18.75 (2.34)	414 (49.6)	28 (3.4)	7 (0.8)
	Sylhet (372)	149.61 (5.35)	41.76 (6.79)	18.63 (2.62)	208 (55.9)	14 (3.8)	4 (1.1)
	Total (3560)	150.25 (5.56)	42.77 (6.77)	18.92 (2.61)	1769 (49.7)	202 (5.7)	38 (1.1)
2000	Barisal (347)	150.21 (5.18)	43.40 (6.66)	19.21 (2.62)	159 (45.8)	27 (7.8)	5 (1.4)
	Chittagong (839)	150.67 (5.43)	44.99 (7.63)	19.78 (2.93)	312 (37.2)	102 (12.2)	18 (2.1)
	Dhaka (1002)	150.27 (5.35)	44.31 (7.66)	19.59 (2.99)	419 (41.8)	99 (9.9)	23 (2.3)
	Khulna (621)	151.01 (5.37)	45.38 (7.44)	19.87 (2.83)	216 (34.8)	69 (11.1)	13 (2.1)
	Rajshahi (752)	150.19 (5.52)	43.16 (6.51)	19.11 (2.48)	340 (45.2)	43 (5.7)	9 (1.2)
	Sylhet (478)	150.15 (5.24)	42.71 (6.96)	18.91 (2.67)	243 (50.8)	26 (5.4)	7 (1.5)
	Total (4039)	150.43 (5.38)	44.14 (7.31)	19.47 (2.81)	1689 (41.8)	366 (9.1)	75 (1.9)
2004	Barisal (547)	150.41 (5.00)	44.69 (7.44)	19.71 (2.83)	204 (37.3)	53 (9.7)	9 (1.6)
	Chittagong (978)	150.57 (5.33)	45.46 (7.68)	20.02 (3.01)	332 (33.9)	111 (11.3)	28 (2.9)
	Dhaka (1027)	150.28 (5.57)	45.32 (7.96)	20.03 (3.09)	371 (36.1)	126 (12.3)	29 (2.8)
	Khulna (662)	151.09 (5.31)	46.05 (7.63)	20.16 (3.09)	205 (31.0)	97 (14.7)	16 (2.4)
	Rajshahi (964)	150.48 (5.63)	44.74 (7.35)	19.71 (2.72)	338 (35.1)	87 (9.0)	19 (2.0)
	Sylhet (553)	150.19 (5.17)	44.07 (8.18)	19.50 (3.22)	237 (42.9)	63 (11.4)	15 (2.7)
	Total (4731)	150.50 (5.39)	45.11 (7.72)	19.88 (2.99)	1687 (35.7)	537 (11.4)	116 (2.5)
2007	Barisal (537)	150.79 (5.58)	45.31 (7.16)	19.90 (2.82)	180 (33.5)	48 (8.9)	13 (2.4)
	Chittagong (768)	150.68 (5.35)	46.95 (8.55)	20.64 (3.29)	208 (27.1)	118 (15.4)	38 (4.9)
	Dhaka (847)	150.17 (5.40)	46.26 (8.14)	20.49 (3.26)	259 (30.6)	136 (16.1)	34 (4.0)
	Khulna (517)	151.62 (5.17)	47.77 (8.25)	20.73 (3.05)	133 (25.7)	83 (16.1)	20 (3.9)
	Rajshahi (676)	150.28 (5.33)	46.02 (8.38)	20.34 (3.31)	226 (33.4)	93 (13.8)	26 (3.8)
	Sylhet (603)	150.38 (5.36)	44.72 (7.31)	19.75 (2.95)	232 (38.5)	76 (12.6)	13 (2.2)
	Total (3948)	150.59 (5.38)	46.18 (8.08)	20.33 (3.16)	1238 (31.4)	554 (14.0)	144 (3.6)

BMI: body mass index; SD: standard deviation.

Table 6: Relationship between maternal height, weight and BMI and the demographic and socioeconomic variables for the pooled data

Indicator	Administrative division	Analysis 1 ^a			Analysis 2 ^b		
		Mean	SE	Significance ^c	Mean	SE	Significance ^c
Height	Barisal	150.40	0.13	NS	150.70	0.21	NS
	Chittagong	150.62	0.10	<0.05	150.89	0.19	NS
	Dhaka	150.24	0.09	NS	150.66	0.18	NS
	Khulna	151.14	0.12	<0.001	151.22	0.20	<0.005
	Rajshahi	150.32	0.10	NS	150.70	0.18	NS
	Sylhet (reference)	150.11	0.12		150.56	0.20	
Weight	Barisal	44.15	0.18	0.013	46.55	0.26	0.652
	Chittagong	45.23	0.13	0.000	47.20	0.23	0.000
	Dhaka	44.60	0.12	0.000	46.64	0.22	0.065
	Khulna	45.82	0.16	0.000	47.16	0.24	0.000
	Rajshahi	44.15	0.13	0.002	46.89	0.23	0.001
	Sylhet (reference)	43.35	0.17		46.09	0.24	
BMI	Barisal	19.50	0.07	0.051	20.47	0.10	0.873
	Chittagong	19.92	0.05	0.000	20.71	0.09	0.000
	Dhaka	19.73	0.05	0.000	20.52	0.09	0.058
	Khulna	20.03	0.06	0.000	20.60	0.10	0.007
	Rajshahi	19.52	0.05	0.006	20.62	0.09	0.001
	Sylhet (reference)	19.22	0.07		20.30	0.10	

BMI: body mass index; NS: not significant; SE: standard error.

^a Adjustment made for the period of the demographic survey, linear and quadratic effects of age and interaction between the period of the survey, and linear and quadratic effects of age.

^b Socioeconomic and demographic factors controlled for in analysis 2 were residence (urban/rural); education and occupation of parents; housing condition (type of floor, wall and roof); ownership of assets such as radio, television, bicycle, motorcycle or telephone; availability of electricity, water supply; and latrine and number of family members; linear and quadratic terms of age and period of survey and their interactions were also entered into the analysis before testing the effect of region.

^c The mean difference is significant at the 0.05 level and a Bonferroni adjustment was made for multiple comparisons.

Table 7: Multinomial logistic regression analysis of maternal BMI by demographic and socioeconomic variables

BMI	Analysis ^a	Division	Underweight		Overweight		Obese		P value
			OR	95% CI	OR	95% CI	OR	95% CI	
WHO cut-off value	1	Barisal	0.79	0.69–0.90	0.89	0.65–1.22	0.66	0.26–1.72	<0.001
		Chittagong	0.65	0.58–0.73	1.27	0.98–1.64	1.83	0.92–3.64	
		Dhaka	0.75	0.67–0.84	1.31	1.02–1.70	1.70	0.86–3.39	
		Khulna	0.60	0.52–0.68	1.33	1.01–1.77	1.26	0.57–2.76	
		Rajshahi	0.75	0.67–0.85	1.07	0.81–1.42	1.23	0.58–2.60	
	Sylhet (reference)								
	2	Barisal	0.85	0.73–0.97	0.97	0.69–1.37	0.86	0.31–2.38	
		Chittagong	0.72	0.63–0.81	1.12	0.84–1.48	1.55	0.74–3.22	
		Dhaka	0.81	0.72–0.91	1.03	0.77–1.37	0.99	0.46–2.10	
		Khulna	0.67	0.58–0.77	0.97	0.71–1.32	0.84	0.36–1.96	
Rajshahi		0.72	0.64–0.82	1.08	0.79–1.46	1.18	0.52–2.64		
Sylhet (reference)									
Asian cut-off value	1	Barisal	0.77	0.67–0.89	0.86	0.68–1.09	0.77	0.47–1.26	<0.001
		Chittagong	0.67	0.59–0.76	1.25	1.03–1.53	1.53	1.04–2.25	
		Dhaka	0.77	0.68–0.86	1.31	1.07–1.59	1.44	0.98–2.12	
		Khulna	0.62	0.54–0.70	1.37	1.11–1.69	1.30	0.85–1.99	
		Rajshahi	0.74	0.66–0.84	0.91	0.74–1.13	1.11	0.74–1.68	
	Sylhet (reference)								
	2	Barisal	0.83	0.72–0.96	0.90	0.69–1.16	0.79	0.46–1.36	
		Chittagong	0.72	0.64–0.82	1.12	0.91–1.39	1.26	0.83–1.91	
		Dhaka	0.82	0.72–0.93	1.11	0.89–1.38	0.96	0.62–1.47	
		Khulna	0.67	0.58–0.77	1.03	0.82–1.30	0.84	0.52–1.34	
Rajshahi		0.71	0.63–0.81	0.93	0.73–1.17	1.01	0.64–1.59		
Sylhet (reference)									

BMI: body mass index; CI: confidence interval; OR: odds ratio.

^a Analysis 1: adjustment was made for the period of the demographic survey, linear and quadratic effects of age and interaction between the period of survey, and linear and quadratic effects of age; analysis 2: socioeconomic and demographic factors controlled for in analysis 2 were residence (urban/rural); education and occupation of parents; housing condition (type of floor, wall and roof); ownership of assets such as radio, television, bicycle, motorcycle or telephone; availability of electricity, water supply, and latrine; and number of family members; linear and quadratic terms of age and the period of the survey and their interactions were also entered into the analysis before testing the effect of region.

Over the four survey periods, there were linear increases in maternal mean height, weight and BMI. Height, although showing a significant overall increase (0.34 cm, $P < 0.05$) within each administrative division over the study period, remained at a constant level (data not shown), whereas BMI significantly increased within each administrative division across the period of the four surveys (see Table 5). The rates of the increase in weight and BMI were somewhat less among mothers from Sylhet (3 kg and 1.14 kg/m²), whereas the rate was highest among mothers from Khulna (4.5 kg and 1.77 kg/m²). In 2007, the prevalence of underweight mothers ranged from 38.5% in Sylhet to 25.7% in Khulna. Over the four BDHS survey periods, the decrease in the number of underweight mothers was least in Barisal (16.1%, $P < 0.001$), whereas it decreased 22.5% ($P < 0.001$) in Khulna and 20.5% in Chittagong ($P < 0.001$) (see Table 5).

DISCUSSION

Previous research in Bangladesh has reported that women living in the Sylhet region are more likely to be underweight compared with the reference region of Barisal, and women from Chittagong, Rajshahi, and Khulna are less likely to be underweight compared with those in Sylhet.¹⁸ In the present study, regional heterogeneity in maternal mean BMI and weight was observed, with the lowest mean in both these indicators in Sylhet, after controlling for all socioeconomic and demographic variables.

A recent study found that children from the Sylhet division were more likely to be severely stunted in their growth compared with children from Rajshahi, Khulna and Dhaka administrative divisions.¹⁹ Similarly, Rahman and Chowdhury²⁰ analysed the

data from BDHS 2004 and showed that children in the Sylhet division were more likely, and in the Khulna division less likely, to be chronically undernourished than children in other divisions. However, Das et al.²¹ observed the highest level of stunting in the Barisal administrative division, where about one fifth of children were severely stunted and 30% moderately stunted, while a better picture was observed in the Khulna division, where only 8.2% and 23.1% were severely and moderately stunted, respectively. The World Bank²² reported that Sylhet had the highest prevalence of underweight children in 1996–1997 (64%) and showed the slowest relative decline (11%) in numbers of underweight children between 1996–1997 and 1999–2000. Helen Keller International (HKI)²³ also reported on the large regional differences in undernutrition in Bangladesh and that over 12 years, the numbers of underweight children had reduced by 20.3% in Sylhet, but by only 14.6% in Rajshahi. Additionally, HKI²⁴ stated that the administrative divisions most in need of attention were Barisal, Sylhet and Rajshahi.²⁴ Results from the Child and Mother Nutrition Survey of Bangladesh in 2012 and the undernutrition mapping exercise by the World Food Programme⁹ showed that both stunting and underweight rates at administrative division level were highest in Sylhet, followed by Chittagong. The present study concurred with this, and also the HKI²³ finding, with Sylhet mostly, and Barisal as well, needing the most attention from the policy-makers to decrease interregional disparity.

There were, however, paradoxes within the broad inequalities found in this study. Sylhet is the home of most Bangladeshis that migrate to other countries, mostly to the United Kingdom of Great Britain and Northern Ireland. This administrative division receives a major flow of foreign currency from nonresident Bangladeshis: in 2005, 16% of households in Sylhet received remittances, compared with less than 5% of households in Rajshahi, Khulna and Barisal. Previous research in Bangladesh has shown that the poverty rate among households receiving remittances from abroad is 17%, compared with 42% among the rest.¹² Like many other developing countries, most surveys indicate that in Bangladesh the majority of remittances are used for consumption of food and clothing, and national food-security data have also placed Sylhet as a relatively food-secure region;²⁵ it is therefore startling that the region has the poorest nutritional status.

However, Sylhet is also reported to be a poor-performing region for other social indicators. According to the Bangladesh Bureau of Statistics,²⁵ the overall literacy rate in Sylhet division was the lowest in the country, at 39.2% in 2007, with an even lower female literacy rate of 35.1%. Sylhet has the highest mortality rates for all-mortality indicators (for example, neonatal mortality, postneonatal mortality and infant mortality) except child mortality.²⁶ Moreover, this division has a much lower demand for family planning and, as a result, registered a lower contraceptive prevalence rate and higher total fertility rate than other divisions.¹³

It has been reported that, although remittances have brought improvement in overall earnings in households in Sylhet, they are seen mostly as important financial means for housing and land purchase. Investment in education, business or traditional productive uses, and in savings, was reported to be

rather small.²⁷ As such, amid economic improvement, social indicators have lagged behind in this area when compared with national standards.

A recent report by Save the Children²⁸ predicted that the stunting rate in 2030 would be 25%, if the trend from 1997 to 2011 continued to 2030; this is four percentage points higher than the target set by the Sustainable Development Goals (SDGs) for 2025. The report assumed that only the top 10% richest by wealth of the population will meet the target of halving the rate of stunting. The Khulna administrative division is also likely to get close to this target. However, the Sylhet division, the poorest quintile, and urban areas of Bangladesh, will remain some distance from the target if current trends continue. The current study concurred with these findings.

Although there has been overall development during the past four decades, Bangladesh has also experienced marginalization and social exclusion. Inequality in social and economic outcomes exists among the geographic regions. Haors and tea estates were two significantly different geographical locations in Sylhet where housing, transportation and livelihoods were significantly worse than in other parts of the administrative division and the country. Seasonal variations have also been reported in Sylhet.²⁹ Overall, life in these areas was poor and risky. Economic deprivation due to geographical difference and isolation has created social inequality. The children in these areas are unable to undergo continuous education, mainly owing to economic deprivation and social inequalities arising from their geographical isolation.

Limitations of this study included lack of information on consumption of energy intake and macro and micronutrients, and physical activity, which are important components in estimating nutritional status. The cross-sectional nature of the surveys does not allow causal inferences to be drawn. Information on, for example, childcare practices, food taboos and management of illness was not collected.

Conclusion

There can be no doubt that special, focused efforts must be made in the Sylhet administrative division of the country if the overall performance of the health, nutrition and population sector is to reach the targets set by SDG 2 of zero hunger and ending all forms of malnutrition. A recent report by Save the Children commented that Bangladesh has done well in reducing chronic malnutrition relative to other countries, but progress still needs to accelerate to meet targets, and looking below country level has revealed that, in particular groups, there are still sizeable numbers of children who need to progress at a faster rate.²⁸ More in-depth data collection by breaking down the divisions into smaller administrative units (that is, upazila/union/village) is recommended to identify the worst-performing areas and the interventions needed. A holistic approach to development is required to improve the situation in these areas. Considering the variations among the administrative divisions, a needs-based household-centric integrated development approach may be suitable for addressing marginalization and exclusion.

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