

## Trends in Body Mass Index and its Determinants among Ever-married Non-pregnant Women in Bangladesh

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### ABSTRACT

**Introduction:** There is increasing prevalence of overweight ever-married non-pregnant women while underweight women of the same category remain common. Thus, this study aimed to identify body mass index (BMI) trends as well as the determinants of nutritional status across urban and rural areas and Bangladesh as a whole over the survey years of Bangladesh Demographic and Health Survey (BDHS) 2007 and 2011. **Methods:** The nationally representative samples of 9,241 and 14,975 ever-married non-pregnant women 15 to 49 years old were extracted from the BDHS 2007 and 2011, respectively. BMI was used as a proxy to measure nutritional status. Binary logistic regression models were fitted separately for urban and rural areas and Bangladesh as a whole to identify the changes in determinants. **Results:** The prevalence of underweight women decreased 5.3% while the prevalence for overweight women increased 3.1% between the survey years of BDHS 2007 and 2011. Women in rural areas were found more likely to be underweight while the percentage of women with normal nutritional status was found to increase in the urban areas. Respondents' age, education, marital status, children ever born, wealth index, age at first birth, husbands' occupation and husbands' education were identified as the most important determinants of nutritional status in both the survey years. **Conclusion:** The burden of underweight, and overweight to obese women in Bangladesh is strongly related to an individual's demographic and socio-economic position. These findings underscore the need for public health efforts aimed at combating underweight among women.

**Key words:** Body mass index, Demographic and Health Survey, ever-married non-pregnant women, nutritional status

### INTRODUCTION

Underweight is a term describing a human whose body weight is considered too low to be healthy. Poor nutrition in adults can cause them to be underweight. Body mass index (BMI) is considered an indirect

measure of nutritional status which is calculated from the person's weight and height. In particular, high mortality, disability, hypertension, heart disease, diabetic mellitus, cardiovascular disease, gall bladder disease and various types of

cancer and poor quality of life are associated with being overweight (Norshafawati, Rosta & Norhaizan, 2014; Rampal *et al.*, 2012; Hossain *et al.*, 2012). Again, being underweight is one of the most common nutritional disorders that can lead to preterm birth and low birth weight (LBW) (Mondal, Hossain & Ali, 2009; Ehrenberg *et al.*, 2003); malnourished children (Rayhan & Khan, 2006); and poor psychological health including high mortality and the higher risk of hip fracture in women (Gnudi, Sitta & Lisi, 2009). It is of particular concern as it is the first and fourth leading causes of death and disability, particularly in the developing countries (Kamal & Islam, 2010) and women in those countries are in a more vulnerable situation (Corsi, Kyu & Subramaniam, 2011; Subramanian, Perkins & Khan, 2009). Menstruation, pregnancy and lactation, low socio-economic status, poverty, socio cultural traditions and disparities of household work pattern contribute to women being more susceptible to underweight (Hossain *et al.*, 2014).

Ever-married women are defined as those who have been married at least once in their lives. The increasing prevalence of underweight ever-married women is a growing public health concern. Like in most developing countries, the nutritional status of women in Bangladesh is poor (Rahman *et al.*, 2015; Haque *et al.*, 2014). Possessing a land area of 147,570 km<sup>2</sup>, Bangladesh is an overpopulated (more than 150 million) country where pervasive poverty is very often the cause of malnutrition. Millions of women suffer from one or more forms of malnutrition including LBW, underweight and anemia (Haque *et al.*, 2014). This is a significant contributor to complicated pregnancies (Mahajan *et al.* 2004) and high maternal and infant mortality rates (Mondal, Hossain & Ali, 2009). It can also be continued from one generation to the next as underweight mothers give birth to infants who struggle to thrive. An underweight woman has a heightened risk

of LBW baby, low quality breast milk, and death from postpartum hemorrhaging. Underweight women also reduce national productivity, have increased susceptibility to infections, recover more slowly from illness, and may experience increased risk of adverse pregnancy outcomes (Mahajan *et al.* 2004).

Of late, a large number of researchers have investigated the relationship between BMI and socio-economic and demographic factors (Rahman *et al.*, 2015; Haque *et al.*, 2014; Corsi *et al.*, 2011; Subramanian *et al.*, 2009). More specifically, for the case of urban areas in Bangladesh, the determinant factors which were significantly associated with being underweight, overweight and obese amongst ever-married non-pregnant women were socio-economic status, education and rural to urban migration (Khan & Kramer, 2009). Under nutrition was related to demographic, economic, social and environmental factors amongst the slum-dwelling adult populations in Dhaka, Bangladesh and a lower BMI amongst females (Pryer & Rogers, 2006). However, after reviewing the literature, trends in the distribution of BMI and its determinants within and across populations over time have not yet been systematically examined. Therefore, this study aimed to provide the trends in BMI and identify the determinant factors of nutritional status among ever-married non-pregnant women for urban areas, rural areas and Bangladesh as a whole. This study also aimed to enrich available information and contribute towards developing appropriate interventions for reducing this health burden.

## METHODS

### Sources of data

This study used two sets of cross-sectional data extracted from the Bangladesh Demographic and Health Survey (BDHS) 2007 (NIPORT, 2009) and BDHS 2011 (NIPORT, 2013), the fifth and sixth national

level demographic and health surveys, respectively. The surveys maintained all the protocols prescribed by the World Health Organisation and written consent was obtained individually from all respondents. The surveys were carried out to provide up-to-date information on the following: fertility and childhood mortality levels; fertility preferences; awareness, approval, and use of family planning methods; maternal and child health; knowledge and attitudes toward sexually transmitted infections; community-level data on accessibility and availability of health and family planning services; and prevalence of non-communicable diseases. The surveys were designed to produce representative results for the country as a whole, for urban and rural areas separately, and for each of the seven administrative divisions (six divisions for BDHS 2007). All ever-married women 12 to 49 years old who were members of the selected households and those who spent the night before the survey in the selected households were eligible to participate in the interviews. The details of the sampling survey design, survey instruments and quality control are reported elsewhere (NIPORT, 2009; NIPORT, 2013). However, a brief description is given in the following subsections.

#### **Sampling and sample size selection**

The samples for the surveys (BDHS 2007; BDHS 2011) were the nationally representative surveys and covered the entire population residing in non-institutional dwelling units. The surveys used the lists of enumeration areas (EAs) prepared for the 2001 (for BDHS 2007) and 2011 (for BDHS 2011) Population and Housing Censuses provided by the Bangladesh Bureau of Statistics as the sampling frames. An EA can include a group of small villages, or a village, or a part of large village. The primary sampling units for the surveys were the EAs that

were created to have an average of about 100 (for BDHS 2007) and 120 (for BDHS 2011) households. The surveys contained location information, type of residence, the number of residential households, and number of males and females in the population. Administratively, Bangladesh has seven divisions: Barisal, Chittagong, Dhaka, Khulna, Rajshahi, Rangpur (only for BDHS 2011) and Sylhet. Each division was subdivided into zilas (districts), and each zila into upazilas (sub-districts). Each urban area in an upazila was divided into wards, and into mohallas (an area of a town or village; a community) within a ward. A rural area in the upazila was divided into Union Parishads (UP) (the smallest rural administrative and local government units) and mouzas (a specific land area within which there may be one or more settlements) within a UP. These divisions allowed the country as a whole to be easily separated into rural and urban areas. The samples were stratified and selected in two stages. Each division was stratified into urban and rural areas. For analytical purposes, the data were restricted to ever-married women, who were not pregnant at the time of survey. Pregnant women were therefore excluded because anthropometric measurements like body weight, increase rapidly during the pregnancy and indicate both nutritional status of the women and growth of the foetus, and reduce the specificity of the indicator. After excluding the women with missing information on height or weight or any of the predictors considered in this study, finally data on 9,241 and 14,975 non-pregnant ever-married women 15 to 49 years old were extracted from BDHS 2007 and BDHS 2011, respectively.

#### **Outcome variables**

Nutritional status (i.e., BMI of the respondents) was considered as the outcome variable. The anthropometric measurement of weight and height was

used to calculate BMI. The BMI is a simple index of weight-for-height and an indicator of body composition, which is defined as the weight in kilograms divided by the square of the height in meters ( $\text{kg}/\text{m}^2$ ) (WHO, 2004) as shown below:

$$\text{BMI} = \frac{\text{Weight of the adult in kilogram}}{(\text{Height of the adult in meter})^2}$$

The cut-off points adopted for this study were as follows:

- (i) underweight
- (ii) normal weight
- (iii) overweight
- (iv) obese

### Explanatory variables

This study's ten explanatory variables were: age ( $X_1$ ); education ( $X_2$ ); working status ( $X_3$ ); marital status ( $X_4$ ); children ever born (CEB) ( $X_5$ ); wealth index ( $X_6$ ); residence region ( $X_7$ ); age at first birth ( $X_8$ ); husband's occupation ( $X_9$ ); and husband's education ( $X_{10}$ ). The categories and coding systems of the variables were modeled on the previous studies (Mondal *et al.*, 2015; Mondal *et al.*, 2012).

### Statistical analysis

Univariate analysis of the data was performed to describe the variables in a list. Binary logistic regression analysis of the data was performed to determine the relative risks of the independent variables to the dependent variable (nutritional status). Six binary logistic regression models were fitted for urban areas, rural areas and Bangladesh as a whole to identify the determinant factors of nutritional status for the two consecutive survey years (BDHS 2007 and BDHS 2011). In the logistic regression analysis, nutritional status ( $Y$ ) was treated as the dependent variable and other variables were selected as independent variables ( $X_i$ ,  $i=1, 2, \dots, 10$ ). The dependent variables ( ${}_k Y_j$ ,  $j=1$  (urban), 2 (rural), 3 (Bangladesh as a whole); and  $k = 1$  (BDHS 2007), 2 (BDHS 2011)) were classified in the following manner:

$${}_k Y_j = \begin{cases} 0; & \text{if the woman was underweight (BMI} < 18.5 \text{ kg/m}^2\text{);} \\ 1; & \text{nourished} \end{cases}$$

The multicollinearity in this binary regression analysis was checked by examining the standard error (SE) for the regression coefficients ( $\beta_j$ ). However, there is no exact method to detect the multicollinearity problem in logistic regression analysis. In this study, the magnitude of SE was used to detect the multicollinearity problem. If the magnitude of SE was between 0.001 and 0.5, it could be considered as no evidence of multicollinearity (Chan, 2004). In this study, the magnitudes of SE were less than 0.10, indicating an absence of multicollinearity. Statistical significance was accepted at  $p < 0.05$ . The results of regression analysis are presented by odds ratios (ORs) with a 95% confidence interval (CI) for easy understanding of the effects of the corresponding factors, net of other confounders. Statistical Package for Social Sciences (SPSS) version 17.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis.

## RESULTS

### Univariate analysis

A total of 9,241 (3,510 urban and 5,731 rural) from BDHS 2007, and 14,975 (5,200 urban and 9,775 rural) from BDHS 2011 ever-married non-pregnant women 15-49 years old were included in this study. The distribution of respondents who were underweight, normal weight, overweight and obese relative to their socio-demographic characteristics are presented in Table 1.

The results revealed a decrease in the number of underweight women (5.3%) while those who were normal weight (1.3%), overweight (3.1%), and obese (1.0%) increased over the survey years (see Figure 1). For both the survey years, a higher percentages of underweight women were seen amongst women with the following characteristics: younger; illiterate or less

Table 1. Sociodemographic characteristics by prevalence of body mass index categories over the surveys

Variables	Sample size (n)		Underweight (BMI<18.5kg/m <sup>2</sup> )		Normal weight (BMI=18.5-24.5 kg/m <sup>2</sup> )		Overweight (BMI=24.5-29.9 kg/m <sup>2</sup> )		Obese (BMI>30 kg/m <sup>2</sup> )	
	2007	2011	2007	2011	2007	2011	2007	2011	2007	2011
<b>Total</b>	9,241	14,975	2635(28.5)	3467(23.2)	5312(57.5)	8798(58.8)	1085(11.7)	2220(14.8)	209(2.3)	490(3.3)
<b>Age (years)</b>										
15-19	688(7.4)	952(6.4)	257(37.4)	353(37.1)	410(59.6)	561(58.9)	20(2.9)	36(3.8)	1(0.1)	2(0.2)
20-24	1674(18.1)	2657(17.7)	529(31.6)	736(27.7)	1027(61.4)	1638(61.6)	105(6.3)	240(9.0)	13(0.8)	43(1.6)
25-29	1684(18.2)	2938(19.6)	448(26.6)	628(21.4)	986(58.6)	1790(60.9)	212(12.6)	436(14.8)	38(2.3)	84(2.9)
30-34	1514(16.4)	2457(16.4)	360(23.8)	478(19.5)	900(59.4)	1432(58.3)	213(14.1)	455(18.5)	41(2.7)	92(3.7)
35-39	1515(16.4)	2165(14.5)	385(25.4)	420(19.4)	813(53.7)	1276(58.9)	259(17.1)	368(17.0)	58(3.8)	101(4.7)
40-44	1162(12.6)	2062(13.8)	331(28.5)	426(20.7)	648(55.8)	1165(56.5)	154(13.3)	393(19.1)	29(2.9)	78(3.8)
45-49	1004(10.9)	1744(11.6)	325(32.4)	426(24.4)	528(52.6)	936(53.7)	122(12.2)	292(16.7)	29(2.9)	90(5.2)
<b>Education</b>										
Illiterate	3166(34.3)	4215(28.1)	1183(37.4)	1255(29.8)	1765(55.7)	2464(58.5)	191(6.0)	421(10.0)	27(0.9)	75(1.8)
Primary <sup>1</sup>	2800(30.3)	4589(30.6)	849(30.3)	1189(25.9)	1650(58.9)	2743(59.8)	261(9.3)	560(12.2)	40(1.4)	97(2.1)
Secondary <sup>2</sup>	2608(28.2)	5103(34.1)	556(21.3)	947(18.6)	1543(59.2)	3024(59.3)	412(15.8)	905(17.7)	97(3.7)	227(4.4)
Higher	667(7.2)	1068(7.1)	47(7.0)	76(7.1)	354(53.1)	567(53.1)	221(33.1)	334(31.3)	45(6.7)	91(8.5)
<b>Religion</b>										
Islam	8350(90.4)	13,252(88.5)	2358(28.2)	3061(23.1)	4802(57.5)	7798(58.8)	992(11.9)	1961(14.8)	198(2.4)	432(3.3)
Others	891(9.6)	1723(11.5)	277(31.1)	406(23.6)	510(57.2)	1000(58.0)	93(10.4)	259(15.0)	11(1.2)	58(3.4)
<b>Working status</b>										
No	6402(69.3)	12,950(86.5)	1775(27.7)	2999(23.2)	3596(56.2)	7626(58.9)	855(13.4)	1897(14.6)	176(2.7)	428(3.3)
Yes	2839(30.7)	2025(13.5)	860(30.3)	468(23.1)	1716(60.4)	1172(57.9)	230(8.1)	323(16.0)	33(1.2)	62(3.1)
<b>Marital status</b>										
Married	8533(92.3)	14,039(93.7)	2377(27.9)	3185(22.7)	4938(57.9)	8299(59.1)	1027(12.0)	2092(14.9)	191(2.2)	463(3.3)
Others <sup>a</sup>	708(7.7)	936(6.3)	258(36.4)	282(30.1)	374(52.8)	499(53.3)	58(8.2)	128(13.7)	18(2.5)	27(2.9)
<b>Children ever born</b>										
≤2	4270(46.2)	7496(50.1)	1108(25.9)	1636(21.8)	2519(59.0)	4460(59.5)	543(12.7)	1160(15.5)	100(2.3)	240(3.2)
3-4	3025(32.7)	5072(33.9)	839(27.7)	1120(22.1)	1733(57.3)	2983(58.8)	377(12.5)	782(15.4)	76(2.5)	187(3.7)
>4	1946(21.1)	2407(16.1)	688(35.4)	711(29.5)	1060(54.5)	1355(56.3)	165(8.5)	278(11.5)	33(1.7)	63(2.6)

Variables	Sample size (n)		Underweight (BMI<18.5kg/m <sup>2</sup> )		Normal weight (BMI=18.5-24.5 kg/m <sup>2</sup> )		Overweight (BMI=24.5-29.9 kg/m <sup>2</sup> )		Obese (BMI>30 kg/m <sup>2</sup> )	
	2007	2011	2007	2011	2007	2011	2007	2011	2007	2011
<b>Wealth index</b>										
Poorest	1543(16.7)	2657(17.7)	682(44.2)	1060(39.9)	811(52.6)	1465(55.1)	47(3.0)	124(4.7)	3(0.2)	8(0.3)
Poorer	1671(18.1)	2777(18.5)	605(36.2)	828(29.8)	995(59.5)	1764(63.5)	67(4.0)	167(6.0)	4(0.2)	18(0.6)
Middle	1741(18.8)	2884(19.3)	573(32.9)	705(24.4)	1046(60.1)	1836(63.7)	110(6.3)	305(10.6)	12(0.7)	38(1.3)
Richer	1858(20.1)	3153(21.1)	483(26.0)	593(18.8)	1161(62.5)	1897(60.2)	189(10.2)	562(17.8)	25(1.3)	101(3.2)
Richest	2428(26.3)	3504(23.4)	292(12.0)	281(8.0)	1299(53.5)	1836(52.4)	672(27.7)	1062(30.3)	165(6.8)	325(9.3)
<b>Living area</b>										
Urban	3510(38.0)	5200(34.7)	706(20.1)	784(15.1)	1965(56.0)	2902(55.8)	667(19.0)	1184(22.8)	172(4.9)	330(6.3)
Rural	5731(62.0)	9775(65.3)	1929(33.7)	2683(27.4)	3347(58.4)	5896(60.3)	418(7.3)	1036(10.6)	37(0.6)	160(1.6)
<b>Residence region</b>										
Barisal	1211(13.1)	1830(11.2)	375(31.0)	451(24.6)	705(58.2)	1098(60.0)	11(9.7)	235(12.8)	13(1.1)	46(2.5)
Chittagong	1628(17.6)	2619(16.0)	429(26.4)	562(21.5)	961(59.0)	1557(59.5)	194(11.9)	403(15.4)	44(2.7)	97(3.7)
Dhaka	1990(21.5)	2812(17.2)	527(26.5)	649(23.1)	1127(56.6)	1635(58.1)	283(14.2)	418(14.9)	53(2.7)	110(3.9)
Khulna	1443(15.6)	2498(15.3)	340(23.6)	464(18.6)	894(62.)	1498(60.0)	182(12.6)	444(17.8)	27(1.9)	92(3.7)
Rajshahi	1765(19.1)	2407(14.7)	508(28.8)	542(22.5)	998(56.5)	1424(59.2)	205(11.6)	368(15.3)	54(3.1)	73(3.0)
Rangpur	NA	2314(14.2)	NA	586(25.3)	NA	1439(62.2)	NA	248(10.7)	NA	41(1.8)
Sylhet	1204(13.0)	1849(11.3)	456(37.9)	591(32.0)	627(52.1)	957(51.8)	103(8.6)	247(13.4)	18(1.5)	54(2.9)
<b>Age at first birth</b>										
<18	6038(65.3)	7843(52.4)	1828(30.3)	1931(24.6)	3512(58.2)	4730(60.3)	597(9.9)	975(12.4)	101(1.7)	207(2.6)
18-22	2432(26.3)	5824(38.9)	652(26.8)	1309(22.5)	1383(56.9)	3353(57.6)	326(13.4)	960(16.5)	71(2.9)	202(3.5)
>22	771(8.3)	1308(8.7)	155(20.1)	227(17.4)	417(54.1)	715(54.7)	162(21.0)	285(21.8)	37(4.8)	81(6.2)
<b>Husband's occupation</b>										
Agriculture	2494(27.0)	4420(29.5)	886(35.5)	1310(29.6)	1452(58.2)	2715(61.4)	142(5.7)	346(7.8)	14(0.6)	49(1.1)
Labor	3765(40.7)	5586(37.3)	1143(30.4)	1342(24.0)	2178(57.8)	3310(59.3)	374(9.9)	799(14.3)	70(1.9)	135(2.4)
Services	555(6.0)	948(6.3)	52(9.4)	88(9.3)	288(51.9)	487(51.4)	174(31.4)	284(30.3)	41(7.4)	89(9.4)
Business	2126(23.0)	3387(22.6)	469(22.1)	575(17.0)	1229(57.8)	1934(57.1)	352(16.6)	692(20.4)	76(3.6)	186(5.5)
Others	2126(23.0)	634(4.2)	85(28.2)	152(24.0)	165(54.8)	352(55.5)	43(14.3)	99(15.6)	8(2.7)	31(4.9)
<b>Husband's education</b>										
Illiterate	3129(33.9)	4598(30.7)	1156(36.9)	1449(31.5)	1788(57.1)	2701(58.7)	165(5.3)	392(8.5)	20(6)	56(1.2)
Primary <sup>1</sup>	2384(25.)	4069(27.2)	791(33.2)	1035(25.4)	1375(57.7)	2483(61.0)	186(7.8)	482(11.8)	32(1.3)	69(1.7)
Secondary <sup>2</sup>	2419(26.2)	4205(28.1)	542(22.4)	802(19.1)	1474(60.9)	2501(59.5)	337(13.9)	724(17.2)	66(2.7)	178(4.2)
Higher	1309(14.2)	2103(14.0)	146(11.2)	181(8.6)	675(51.6)	1113(52.9)	397(30.3)	622(29.6)	91(7.0)	187(8.9)

Note: <sup>1</sup> Primary completed is defined as completing grade 5; <sup>2</sup> Secondary completed is defined as completing grade 10. The numbers within parentheses represent the percentages. NA represents values not available; <sup>a</sup>Widowed, separated or divorced

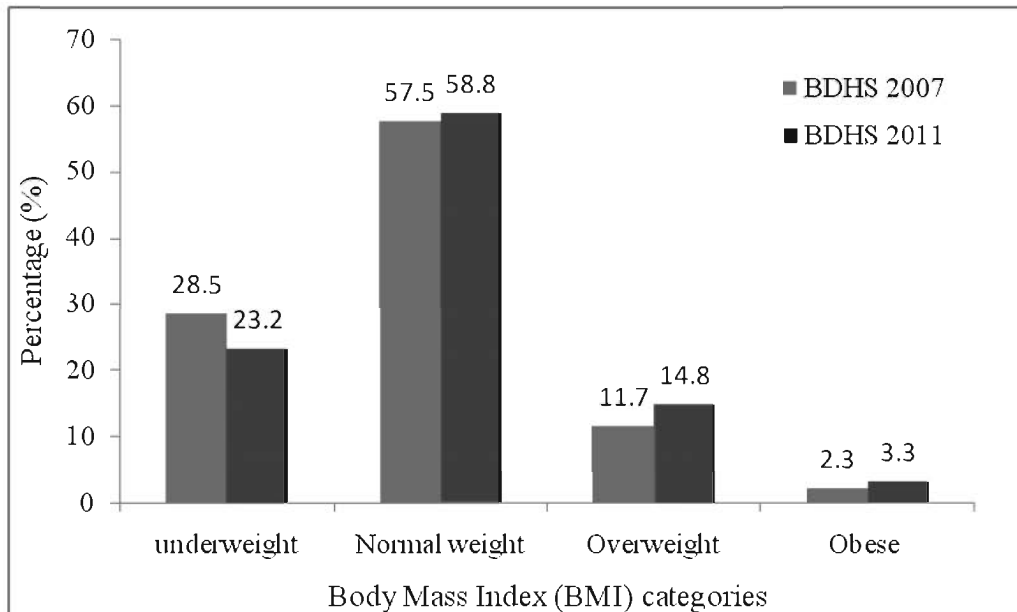


Figure 1. Trend of body mass index by categories over the surveys (BDHS 2007 and BDHS 2011)

educated; currently working; currently widowed/separated/divorced; having more children; of poor economic status; living in the rural areas; living in Sylhet division; giving birth earlier having husbands whose occupations were in the agricultural or manual labouring sectors; and having illiterate or less educated husbands. For both the survey years, the women with normal weight had the following characteristics: younger (<34 years old); primary or secondary school educated; living with their husbands; having less children; of middle economic status; living in the rural areas; living in Sylhet division; giving births before 22 years; having husbands' whose occupation were in the services or business sectors; and having husbands with primary or secondary school education. For both the survey years, the higher percentages of overweight women were found to be: aged between 30 and 39 years old; more educated; not working; living with their husbands; having less children; having the highest economic status; living in the

urban areas; giving birth after 22 years of age; having husbands whose occupations were in the services sector; and having more educated husbands. For both the survey years, obese women were found to be: between 30 to 39 years old; more educated; not working; having no more than 2 children ever born (CEB); having the highest economic status; living in the urban areas; given birth after 22 years of age; having husbands with occupation in the service sector; and having more educated husbands.

#### Multivariate Analysis

To identify the determinant factors for the prevalence of nourished respondents (BMI  $\geq 18.5\text{kg/m}^2$ ), six binary logistic regression models (Models I-VI) in the following three sets:

$S_1 = \{\text{Model I, Model IV}\}$ ,  $S_2 = \{\text{Model II, Model V}\}$ ,  $S_3 = \{\text{Model III, Model VI}\}$ ,

and were fitted separately for both the survey years for urban areas, rural areas and Bangladesh as a whole, respectively. The results are presented in Tables 2 and 3.

Table 2. Determinants of nourished among ever-married women for the survey year 2007

Factors	Urban (Model I)		Rural (Model II)		Bangladesh (Model III)	
	$\beta$	OR (95% CI)	$\beta$	OR (95% CI)	$\beta$	OR (95% CI)
Age (years)						
15-19 <sup>®</sup>		1.00		1.00		1.00
20-24	0.691 <sup>c</sup>	1.995(1.389-2.866)	0.103	1.108(0.874-1.405)	0.274 <sup>c</sup>	1.315(1.078-1.604)
25-29	1.03 <sup>c</sup>	2.800(1.884-4.162)	0.452 <sup>c</sup>	1.572(1.215-2.034)	0.627 <sup>c</sup>	1.871(1.508-2.323)
30-34	1.227 <sup>c</sup>	3.409(2.222-5.232)	0.756 <sup>c</sup>	2.129(1.605-2.825)	0.909 <sup>c</sup>	2.481(1.960-3.142)
35-39	1.651 <sup>c</sup>	5.210(3.311-8.200)	0.496 <sup>c</sup>	1.642(1.224-2.203)	0.850 <sup>c</sup>	2.341(1.831-2.992)
40-44	1.378 <sup>c</sup>	3.968(2.467-6.382)	0.518 <sup>c</sup>	1.679(1.231-2.288)	0.780 <sup>c</sup>	2.182(1.685-2.826)
45-49	1.216	3.373(2.067-5.504)	0.375 <sup>c</sup>	1.454(1.053-2.009)	0.645 <sup>c</sup>	1.906(1.457-2.493)
Education						
Illiterate <sup>®</sup>		1.00		1.00		1.00
Primary <sup>1</sup>	0.169	1.185(0.942-1.490)	0.212 <sup>c</sup>	1.237(1.071-1.427)	0.200 <sup>c</sup>	1.221(1.082-1.379)
Secondary <sup>2</sup>	0.329 <sup>c</sup>	1.390(1.035-1.866)	0.363 <sup>c</sup>	1.437(1.187-1.740)	0.356 <sup>c</sup>	1.427(1.217-1.674)
Higher	0.926 <sup>c</sup>	2.525(1.403-4.545)	0.638 <sup>c</sup>	1.893(1.147-3.124)	0.888 <sup>c</sup>	2.431(1.674-3.530)
Working status						
No <sup>®</sup>		1.00		1.00		1.00
Yes	-0.025	0.975(0.799-1.190)	-0.028	0.972(0.854-1.107)	-0.022	0.978(0.878-1.089)
Marital status						
Married <sup>®</sup>		1.00		1.00		1.00
Others <sup>a</sup>	-0.240	0.787(0.573-1.080)	-0.388 <sup>c</sup>	0.678(0.546-0.842)	-0.351 <sup>c</sup>	0.704(0.590-0.840)
Children ever born						
$\leq 2$ <sup>®</sup>		1.00		1.00		1.00
3-4	-0.282 <sup>c</sup>	0.754(0.589-0.966)	-0.089	0.915(0.777-1.077)	-0.153 <sup>c</sup>	0.858(0.749-0.983)
>4	-0.491 <sup>c</sup>	0.612(0.440-0.852)	-0.294 <sup>c</sup>	0.745(0.608-0.914)	-0.377 <sup>c</sup>	0.686(0.577-0.815)
Wealth index						
Poorest	-0.942 <sup>c</sup>	0.390(0.272-0.558)	-1.353 <sup>c</sup>	0.258(0.193-0.346)	-1.255 <sup>c</sup>	0.285(0.237-0.344)
Poorer	-0.688 <sup>c</sup>	0.503(0.367-0.689)	-1.060 <sup>c</sup>	0.347(0.261-0.461)	-0.977 <sup>c</sup>	0.376(0.315-0.450)
Middle	-0.613 <sup>c</sup>	0.542(0.406-0.723)	-0.994 <sup>c</sup>	0.370(0.279-0.490)	-0.901 <sup>c</sup>	0.406(0.341-0.484)
Richer	-0.523 <sup>c</sup>	0.593(0.463-0.759)	-0.760 <sup>c</sup>	0.468(0.353-0.619)	-0.703 <sup>c</sup>	0.495(0.418-0.587)
Richest <sup>®</sup>		1.00		1.00		1.00



Factors	Urban (Model I)		Rural (Model II)		Bangladesh (Model III)	
	$\beta$	OR (95% CI)	$\beta$	OR (95% CI)	$\beta$	OR (95% CI)
<b>Residence region</b>						
Barisal <sup>®</sup>	0.278 <sup>c</sup>	1.320(0.949-1.837)	0.071	1.074(0.872-1.323)	0.132	1.142(0.958-1.360)
Chittagong	-0.005	0.995(0.724-1.368)	0.153	1.166(0.952-1.428)	0.082	1.085(0.916-1.286)
Dhaka	0.127	1.135(0.807-1.597)	0.308 <sup>c</sup>	1.360(1.093-1.693)	0.248 <sup>c</sup>	1.282(1.067-1.539)
Khulna	-0.051	0.951(0.682-1.325)	0.097	1.102(0.901-1.349)	0.052 <sup>c</sup>	1.054(0.888-1.250)
Rajshahi	-0.180 <sup>b</sup>	0.835(0.587-1.188)	-0.335 <sup>c</sup>	0.715(0.575-0.889)	-0.288 <sup>c</sup>	0.750(0.625-0.901)
Sylhet						
<b>Age at first birth (years)</b>						
<18		1.00		1.00		1.00
18-22	-0.175 <sup>c</sup>	0.840(0.678-1.041)	-0.120	0.887(769-1.022)	-0.141	0.869(0.772-0.977)
>22	-0.105	0.901(0.605-1.341)	-0.121 <sup>c</sup>	0.886(0.684-1.149)	-0.123 <sup>b</sup>	0.885(0.713-1.097)
<b>Husband's occupation</b>						
Agriculture <sup>®</sup>		1.00		1.00		1.00
Labour	0.102	1.107(0.844-1.453)	-0.014	0.987(0.864-1.126)	0.011	1.011(0.901-1.134)
Service men	0.398 <sup>b</sup>	1.488(0.789-2.806)	0.220	1.246(0.799-1.945)	0.275	1.317(0.922-1.882)
Businessmen	0.311 <sup>c</sup>	1.364(1.005-1.851)	0.129	1.138(0.962-1.347)	0.197 <sup>c</sup>	1.217(1.055-1.404)
Others	0.107	1.113(0.653-1.896)	-0.045	0.956(0.683-1.338)	-0.017	0.983(0.744-1.300)
<b>Husband's education</b>						
Illiterate <sup>®</sup>		1.00		1.00		1.00
Primary <sup>1</sup>	0.077	1.080(0.858-1.359)	-0.062 <sup>b</sup>	0.940(0.814-1.085)	-0.032	0.968(0.857-1.094)
Secondary <sup>2</sup>	0.488 <sup>c</sup>	1.629(1.246-2.129)	0.096 <sup>b</sup>	1.101(0.931-1.302)	0.193 <sup>c</sup>	1.213(1.053-1.397)
Higher	0.727 <sup>c</sup>	2.070(1.318-3.251)	0.082 <sup>c</sup>	1.085(0.792-1.488)	0.304 <sup>c</sup>	1.356(1.049-1.752)

Note: <sup>1</sup> Primary completed is defined as completing grade 5; <sup>2</sup> Secondary completed is defined as completing grade 10.

<sup>a</sup>Widowed, separated or divorced, bp<0.05, cp<0.01; OR, Odd Ratio; <sup>®</sup>, reference category; <sup>c</sup>CI, confidence interval

Table 3. Determinants of nourished among ever-married women in the survey year 2011

Factors	Urban (Model IV)		Rural (Model V)		Bangladesh (Model VI)	
	$\beta$	OR (95% CI)	$\beta$	OR (95% CI)	$\beta$	OR (95% CI)
Age (years)						
15-19 <sup>®</sup>		1.00		1.00		1.00
20-24	0.391 <sup>c</sup>	1.478(1.073-2.036)	0.513 <sup>c</sup>	1.670(1.375-2.029)	0.474 <sup>c</sup>	1.606(1.361-1.896)
25-29	1.048 <sup>c</sup>	2.853(2.017-4.035)	0.850 <sup>c</sup>	2.340(1.905-2.874)	0.898 <sup>c</sup>	2.454(2.057-2.927)
30-34	1.358 <sup>c</sup>	3.890(2.631-5.750)	1.009 <sup>c</sup>	2.742(2.185-3.440)	1.104 <sup>c</sup>	3.017(2.481-3.669)
35-39	1.668 <sup>c</sup>	5.301(3.487-8.059)	1.068 <sup>c</sup>	2.910(2.288-3.700)	1.221 <sup>c</sup>	3.390(2.755-4.172)
40-44	1.751 <sup>c</sup>	5.758(3.692-8.979)	1.037 <sup>c</sup>	2.822(2.199-3.621)	1.218 <sup>c</sup>	3.381(2.724-4.196)
45-49	1.696 <sup>c</sup>	5.454(3.446-8.633)	0.847 <sup>c</sup>	2.332(1.791-3.036)	1.069 <sup>c</sup>	2.912(2.320-3.656)
Education						
Illiterate <sup>®</sup>		1.00		1.00		1.00
Primary <sup>1</sup>	0.216 <sup>b</sup>	1.241(0.994-1.548)	-0.197	0.821(0.555-1.214)	0.057	1.059(0.952-1.771)
Secondary <sup>2</sup>	0.510 <sup>c</sup>	1.666(1.278-2.171)	-0.193	0.824(0.564-1.206)	0.174 <sup>c</sup>	1.191(1.042-1.361)
Higher	0.858 <sup>c</sup>	2.358(1.428-3.894)	-0.145	0.865(0.600-1.247)	0.441 <sup>c</sup>	1.554(1.148-2.104)
Working status						
No <sup>®</sup>		1.00		1.00		1.00
Yes	-0.154	0.857(0.695-1.058)	0.022	1.023(0.877-1.193)	-0.023	0.978(0.865-1.104)
Marital status						
Married <sup>®</sup>		1.00		1.00		1.00
Others <sup>a</sup>	-0.377 <sup>b</sup>	0.686(0.504-0.933)	-0.387 <sup>c</sup>	0.679(0.561-.823)	-0.394 <sup>c</sup>	0.675(0.574-0.793)
Children ever born						
$\leq 2$ <sup>®</sup>		1.00		1.00		1.00
3-4	-0.249 <sup>c</sup>	0.780(0.618-0.985)	-0.122	0.885(0.779-1.007)	-0.152 <sup>b</sup>	0.859(0.768-0.960)
>4	-0.817 <sup>c</sup>	0.422(0.322-0.606)	-0.317 <sup>c</sup>	0.728(0.613-0.864)	-0.445 <sup>c</sup>	0.641(0.551-0.744)
Wealth index						
Poorest	-1.286 <sup>c</sup>	0.276(0.203-0.376)	-1.566 <sup>c</sup>	0.209(0.161-0.271)	-1.604 <sup>c</sup>	0.201(0.169-0.239)
Poorer	-0.847 <sup>c</sup>	0.429(0.312-0.588)	-1.212 <sup>c</sup>	0.298(0.231-0.383)	-1.250 <sup>c</sup>	0.287(0.243-0.339)
Middle	-0.545 <sup>c</sup>	0.580(0.436-0.772)	-1.046 <sup>c</sup>	0.351(0.274-0.450)	-1.064 <sup>c</sup>	0.345(0.293-0.406)
Richer	-0.554 <sup>c</sup>	0.575(0.458-0.772)	-0.760 <sup>c</sup>	0.468(0.363-0.602)	-0.806 <sup>c</sup>	0.447(0.381-0.524)
Richest <sup>®</sup>		1.00		1.00		1.00

Factors	Urban (Model IV)		Rural (Model V)		Bangladesh (Model VI)	
	$\beta$	OR (95% CI)	$\beta$	OR (95% CI)	$\beta$	OR (95% CI)
<b>Residence region</b>						
Barisal <sup>®</sup>		1.00		1.00		1.00
Chittagong	0.094	1.028(0.759-1.393)	0.172	1.187(0.990-1.424)	0.135	1.145(0.979-1.338)
Dhaka	0.403	1.383(0.997-1.918)	-0.114	0.892(0.748-1.065)	-0.005	0.995(0.853-1.162)
Khulna	0.067	1.024(0.748-1.402)	0.397 <sup>c</sup>	1.487(1.231-1.796)	0.301 <sup>c</sup>	1.351(1.149-1.589)
Rajshahi	0.131	1.090(0.792-1.501)	0.104	1.110(0.925-1.332)	0.114	1.120(0.956-1.313)
Rangpur	0.111	1.049(0.759-1.449)	0.133	1.142(0.955-1.365)	0.130	1.138(0.974-1.331)
Sylhet	-0.253	0.769(0.549-1.079)	-0.426 <sup>c</sup>	0.653(0.541-0.788)	-0.398 <sup>c</sup>	0.671(0.570-0.791)
<b>Age at first birth (years)</b>						
<18		1.00		1.00		1.00
18-22	-0.201 <sup>b</sup>	0.818(0.681-0.981)	-0.133	0.876(0.790-0.970)	-0.154 <sup>c</sup>	0.857(0.784-0.937)
>22	-0.457 <sup>b</sup>	0.633(0.444-0.903)	-0.234	0.792(0.642-0.977)	-0.280 <sup>c</sup>	0.756(0.632-0.905)
<b>Husband's occupation</b>						
Agriculture <sup>®</sup>		1.00		1.00		1.00
Labour	0.186	1.204(0.946-1.532)	0.159	1.172(0.923-1.448)	0.086	1.090(0.988-1.202)
Service men	0.425	1.529(0.918-2.548)	0.220	1.247(0.979-1.587)	0.099	1.104(0.837-1.455)
Businessmen	0.485 <sup>c</sup>	1.624(1.231-2.143)	0.112	1.119(0.757-1.652)	0.197 <sup>c</sup>	1.217(1.079-1.374)
Others	0.125	1.133(0.730-1.759)	0.238	1.269(0.985-1.634)	-0.098	0.907(0.737-1.115)
<b>Husband's education</b>						
Illiterate <sup>®</sup>		1.00		1.00		1.00
Primary <sup>1</sup>	0.139	1.149(0.923-1.432)	0.137	1.147(1.019-1.291)	0.130 <sup>b</sup>	1.138(1.026-1.263)
Secondary <sup>2</sup>	0.174	1.190(0.933-1.518)	0.180	1.197(1.040-1.378)	0.159 <sup>b</sup>	1.172(1.039-1.323)
Higher	0.511 <sup>b</sup>	1.667(1.116-2.490)	0.522 <sup>c</sup>	1.686(1.279-2.224)	0.517 <sup>c</sup>	1.667(1.338-2.101)

Note: <sup>1</sup>Primary completed is defined as completing grade 5; <sup>2</sup>Secondary completed is defined as completing grade 10

<sup>a</sup>Widowed, separated or divorced; bp<0.05, cp<0.01; OR, Odd Ratio; <sup>®</sup>, reference category; <sup>c</sup>CI, confidence interval

### Determinant factors to be nourished among women

Model I and Model IV in  $S_1$  were fitted for the urban respondents of the survey years 2007 and 2011 respectively. Both the models identified that the respondents' age, education, CEB, wealth index, age at first birth, husband's occupation, and husband's education were the significant determinants. Moreover, marital status was identified as the significant determinant in Model IV. Similarly, Model II and Model V of the set  $S_2$  were fitted for the rural respondents of the survey years 2007 and 2011, respectively. Both the models identified that the respondent's age, education, marital status, CEB, and wealth index were the significant determinants. Moreover, husbands' occupation was identified as the significant determinant in Model II. Again, Model III and Model VI in  $S_3$  were fitted for Bangladesh as a whole for the respondents of the survey years 2007 and 2011 respectively. Both the models identified that the respondent's age, education, marital status, CEB, wealth index, area of residence, age at first birth, and husband's education were the significant determinants. As the results of the models explained in  $S_1$ ,  $S_2$ , and  $S_3$  were found to be almost similar, only the results of the models in  $S_1$  are explained in the following section.

For both the surveys, the women in urban areas, those in the 20 to 49 years old age group were found to be more likely to be nourished when compared to the women in the 15 to 19 years group. For example, in Model I, women in the 30 to 34 years group were 3.41 times (OR, 3.21; 95% CI: 2.22-5.23), and the women in the 35 to 39 years group were 5.21 times (OR, 5.21; 95% CI: 3.31-8.20) more likely to be nourished when compared to the women in the 15 to 19 years group. Similarly, in Model IV, the women in the 30-34 years group were 3.89 times (OR, 3.89; 95% CI: 2.63-5.75) while those in the 35-39 years group were 5.30 times (OR, 5.30; 95% CI: 3.49-8.06)

more like to be nourished compared to the women in the 15-19 years group. In Model I, it is found that secondary and higher level educated women were 1.39 times (OR, 1.39; 95% CI: 1.04-1.87) and 2.53 times (OR, 2.53; 95% CI: 1.40-4.55) more likely to be nourished compared to illiterate women, respectively. Similarly, in Model IV, it was found that primary, secondary and higher level educated women were 1.24 times (OR, 1.24; 95% CI: 0.99-1.55), 1.67 times (OR, 1.67; 95% CI: 1.28-2.17) and 2.36 times (OR, 2.36; 95% CI: 1.43-3.89) more likely to be nourished compared to illiterate women, respectively. In the case of CEB for the survey year 2007, the women with 3 to 4 children, and more than 4, were 25% (OR, 0.75; 95% CI: 0.59-0.97) and 39% (OR, 0.61; 95% CI: 0.44-0.85) less likely to be nourished compared to the women with 2 children or less. When the economic status (wealth index) was considered, for both the survey years, it was found that the respondents in the lower economic groups were less likely to be nourished. For the case of age at first birth, it was seen that the respondents who have given birth at 18 years of age and above were less likely to be nourished. The results revealed that women whose husbands were in comparatively better occupations and were more highly educated were more likely to be nourished.

### DISCUSSION

The results of this study demonstrate a clear distribution of changes in nutritional status by socio-demographic factors over the surveys (BDHS 2007 and BDHS 2011) among non-pregnant ever-married women 15 to 49 years old in Bangladesh. In health science, BMI is considered as a marker of nutritional status and a low BMI increases women's susceptibility to a wide range of diseases and may have adverse long term health consequences with likely effects on their children. Moreover, it may have adverse social and educational outcomes

which lead to malnutrition in adulthood and diseases, disability and mortality. This study identified that the prevalence of women being underweight decreased over the survey years, but alarmingly affected a quarter of the sample. Furthermore, there was an increasing trend in the prevalence of overweight and obesity among women over the survey years. The results of this study were found to be consistent with the study conducted in Bangladesh (Corsi *et al.*, 2011). Similar patterns were also reported in India (Subramanian *et al.*, 2009) and Indonesia (Winkvist *et al.*, 2000). Though the prevalence of women being underweight to overweight or obese shows a slow increase in recent years, it is still not acknowledged as a serious public health issue in Bangladesh. This study also demonstrated a clear difference in the prevalence of malnourished (underweight) and nourished women between urban areas and rural areas of Bangladesh. Whilst observing from different socio-demographic perspectives, this study identified that the prevalence of underweight was consistently higher amongst rural women than urban women. Women in the rural areas were more likely to be underweight. The results revealed a slight decrease in the percentage of underweight women, a pattern consistent with the results of a similar study (Subramanian & Smith, 2006). The percentage of nourished respondents for both the surveys was found to be higher in the urban areas and showed an increasing trend. In this regard, rising urbanisation and continued economic development are offered as possible reasons (Mendez, Monteiro & Popkin, 2005). Moreover, urban characteristics may have all contributed to the rising trend of women being overweight or obese in the urban areas. These are excessive use of cars and other fuel-based vehicles; limited space for walking and physical activity; the availability, preference and consumption

of fast and fatty foods and less preference for vegetables; improved technologies that require less energy; and sedentary and changing lifestyles. More instances of lower BMIs were observed amongst illiterate and less educated groups of women when compared with women with higher levels of education, whereas there was an increasing prevalence of overweight amongst the more highly educated women. The findings of this study are similar to other studies conducted in Bangladesh (Corsi *et al.*, 2011; Khan & Kramer, 2009), Ethiopia (Teller & Yimar, 2000), India (Bose *et al.*, 2009; Subramanian, Kawachi & Smith, 2007; Subramanian & Smith, 2006), and China (Razak *et al.*, 2005). Very often, illiterate women were not aware of the importance of diets, food habits, personal hygiene, and were not careful about their nutritional status. The education level of their husband was found to be significantly associated with women's nutritional status. The results of this study showed a higher prevalence of underweight amongst women with illiterate husbands. Currently, working women were found to be more likely to be underweight than non-working women. The results revealed that, widowed, divorced and separated women were less likely to be nourished than married women. This study also identified contrasting statistically significant associations between number of CEB and pattern of BMI and found a comparatively lower prevalence of being underweight amongst women who have had no more than two children. A similar relationship was found between nourished women and age at first birth. In reality, the women who gave birth at an early age were not physically and mentally prepared to give birth, resulting in a higher percentage of underweight women. More women living in Sylhet division were identified as underweight in both survey years. Obviously, it is important to ascertain the factors causing women in this region to

be malnourished. Positive and statistically significant effects were observed between economic status (measured by wealth index) and nutritional status. The respondents in the higher economic status groups were identified as significantly more likely to be nourished, as in the case of previous studies (Corsi *et al.*, 2011; Subramanian, Kawachi & Smith, 2007).

## CONCLUSIONS

This study identified a decrease in underweight women whilst those who were of normal weight, overweight, and obese increased over the survey years. Underweight was more prevalent amongst women with the following characteristics: in the younger age groups; illiterate or less educated; currently working; currently widowed/separated/divorced; having more children; of poor economic status; living in the rural areas; living in Sylhet division; giving birth earlier; with husbands employed in the agricultural or manual laboring sectors; and having illiterate or less educated husbands. Further systematic and frequent monitoring and surveillance of the social trajectory of nutritional status in Bangladesh is necessary to develop appropriate policy responses that address the persistent and chronic problem of underweight women as well as the emerging problem of overweight women.

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## Conflict of interest

The authors declare that they have no competing interest.

## REFERENCES

- Bose K, Bisai S, Sadhukhan S, Mukhopadhyay A & Bhadra M (2009). Under nutrition among adult Bengalees of Dearah, Hooghly District, West Bengal, India: relationship with educational status and food habit. *Anthropo Anz* 67(2): 121-128.
- Chan YH (2004). Biostatistics 202: logistic regression analysis. *Singapore Med J* 45(4): 149-153.
- Corsi DJ, Kyu HH & Subramanain SV (2011). Socioeconomic and geographic patterning of under- and over-nutrition among women in Bangladesh. *J Nutr* 141(4): 631-638.
- Ehrenberg HM, Dierker L, Milluzzi C & Mercer BM (2003). Low maternal weight, failure to thrive in pregnancy, and adverse pregnancy outcomes. *Am J Obstet Gynecol* 189(6): 1726-1730.
- Gnudi S, Sitta E & Lisi L (2009). Relationship of body mass index with main limb fragility fractures in post-menopausal women. *J Bone Miner Metab* 27(4): 479-484.
- Haque MM, Bhuiyan MR, Naser MA, Arafat Y, Roy SK & Khan MZH (2014). Nutritional status of women dwelling in urban slum area. *J Nutr Health Food Eng* 1(3): 00014.
- Hossain MG, Bharati P, Saw A, Lestrel P, Almasri A & Kamarul T (2012). Body mass index of married Bangladeshi women: trends and association with sociodemographic factors. *J Biosoc Sci* 44(4): 385-399.
- Hossain MG, Khatun MS, Islam MR, Mondal MNI, Bharati P & Pal M (2014). Factors associated with age at menarche of secondary school girls in Rajshahi City, Bangladesh. *Adv Life Sci* 4(2): 88-93.
- Kamal SMM & Islam MA (2010). Socio-economic correlates of malnutrition among married women in Bangladesh. *Mal J Nutr* 16(3): 349-359.
- Khan MMH & Kramer A (2009). Factors associated with being underweight, overweight and obese among ever-married

- non-pregnant urban women in Bangladesh. *Singapore Med J* 50(8): 804-813.
- Mahajan SD, Singh S, Shah P, Gupta N & Kochupillai N (2004). Effect of maternal malnutrition and anemia on the endocrine regulation of fetal growth. *Endocr Res* 30(2): 189-203.
- Mendez MA, Monteiro CA & Popkin BM (2005). Overweight exceeds underweight among women in most developing countries. *Am J Clin Nutr* 81(3): 714-721.
- Mondal MNI, Hoque N, Chowdhury MRK & Hossain MS (2015). Factors associated with misconceptions about HIV transmission among ever-married women in Bangladesh. *Jpn J Infect Dis* 68(1): 13-19.
- Mondal MNI, Hossain MK & Ali MK (2009). Factors influencing infant and child mortality: a case study of Rajshahi District, Bangladesh. *J Hum Ecol* 26(1): 31-39.
- Mondal MNI, Rahman MM, Rahman OR & Akther MN (2012). Level of awareness about HIV/AIDS among ever married women in Bangladesh. *Food Public Hlth* 2(3): 73-78.
- NIPORT (2009). Bangladesh Demographic and Health Survey 2007. National Institute of Population Research and Training (NIPORT), Mitra and Associates & Macro International; Dhaka, Bangladesh and Calverton, Maryland, USA.
- NIPORT (2013). Bangladesh Demographic and Health Survey 2011. National Institute of Population Research and Training (NIPORT), Mitra and Associates & Macro International; Dhaka, Bangladesh and Calverton, Maryland, USA.
- Norshafawati AA, Rosta J & Norhaizan ME (2014). Body mass index as the predictor of high sensitivity C-reactive protein: a risk of marker of cardiovascular diseases. *Mal J Nutr* 20(3): 291-301.
- Pryer JA & Rogers S (2006). Epidemiology of undernutrition in adults in Dhaka slum households, Bangladesh. *Eur J Clin Nutr* 60(7): 815-822.
- Rahman MS, Mondal MNI, Islam MR, Ahmed KM, Karim MR & Alam MS (2015). Under weightiness among ever-married non-pregnant women in Bangladesh: a population based study. *Univ J Food Nutr Sci* 3(2): 29-36.
- Rampal L, Saeedi P, Aminizadeh BS, Salmia MS & Norlijah (2012). Obesity and associated health related factors among university staff in Serdang, Malaysia. *MJMHS* 8(2): 23-32.
- Rayhan MI & Khan MSH (2006). Factors causing malnutrition among under five children in Bangladesh. *Pak J Nutr* 5(6): 558-562.
- Razak F, Anand S, Vuksan V, Davis B, Jacobs R, Teo KK & Yusuf S (2005). Ethnic differences in the relationships between obesity and glucose-metabolic abnormalities: a cross-sectional population-based study. *Int J Obes (Lond)* 29(6): 656-667.
- Subramanian SV & Smith GD (2006). Patterns, distribution, and determinants of under- and over-nutrition: a population-based study of women in India. *Am J Clin Nutr* 84(3): 633-640.
- Subramanian SV, Kawachi I & Smith GD (2007). Income inequality and the double burden of under- and over-nutrition in India. *J Epidemiol Comm Hlth* 61: 802-809.
- Subramanian SV, Perkins JM & Khan KT (2009). Do burdens of underweight and overweight coexist among lower socioeconomic groups in India? *Am J Clin Nutr* 90(2): 369-376.
- Teller CH & Yimar G (2000). Levels and determinants of malnutrition in adolescent and adult women in Southern Ethiopia. *Ethiopian J Hlth Development* 14(1): 57-66.
- WHO Expert Consultation (2004). Appropriate body mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 363(9403): 157-1563.
- Winkvist A, Nurdianti DS, Stenlund H & Hakimi M (2000). Predicting under- and over-nutrition among women of reproductive age: a population-based study in central Java, Indonesia. *Pub Hlth Nutr* 3(20): 193-200.

