Secular Trends in Nutritional Status among Bangladeshi Married Women

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ABSTRACT: The change in nutritional status plays an important role in the course of a person's health. The aim of the present study was to study the presence of secular trends in nutritional status of Bangladeshi married women over time. A total of 45,572 Bangladeshi non-pregnant married women were used in this study with an average age 30.11 ± 9.04 years. Analysis of variance and linear regression were used in this study. The mean value of BMI of Bangladeshi non-pregnant married women was 20.65 ± 3.67 kg/m^2. The slope of linear regression showed that the increasing tendency in BMI has occurred over time. A remarkable number of married women (31.4%) were underweight. The decreasing tendency in the number of underweight has been observed, and the opposite direction also observed for the number of obese over time. Underweight can be considered as the major health problems of Bangladeshi married women and requires serious attention.

INTRODUCTION

Nutritional status of a population is generally measured by body mass index. The high prevalence of overweight (25≤BMI<30) and obesity (BMI≥30) of a population has been shown to be a risk factor for hypertension, heart disease, diabetes mellitus, cardiovascular disease, gall bladder disease and various types of cancer. On the other hand, a low BMI (underweight BMI<18.5 kg/m^2) has been associated with a higher risk of hip fracture in women (Gnudi *et al*., 2009; Morin *et al*., 2009). Low birth weight and higher mortality rate has also been associated with a low BMI in pregnant mothers (Hosegood and Campbell, 2003). The prevalence and trends of underweight and overweight over time may provide useful information about changes in the level of public health and reflect the general living environment of a given population. This is particularly important for developing countries where health and medically related reforms are being actively implemented.

Secular trends of increasing body size (BMI) have been observed in many Western countries (Flegal *et al.*,'88; Shah *et al*.,'91; Gullinford *et al*.,'92; Lahti-Koski *et al*., 2001; Lysens and Vansant, 2001; Bielicki *et al.*, 2001; Mascie-Taylor and Goto, 2007; Walls *et al*., 2010). Negative trends in BMI have been reported in a Glasgow alumni cohort (Okasha *et al*., 2003). An increasing tendency towards a negative trend has also been found in Vietnam (Khan *et al*., 2010), China (Chen and Ji, 2009), Kuwait (Al-Isa, 1997) and Japan (Yanai *et al*., '97). An examination of these trends in BMI is of special importance for married women in developing countries. A decreasing tendency in BMI have been observed in female populations using only 2007 BDHS data (Hossain *et al*., 2012) and in university female students (Hossain *et al.*, 2012) in

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Bangladesh. Efforts have been made to improve the general conditions of this population section, and BMI can provide a tool for evaluation of the effectiveness of these measures. Special attention should be paid to married women considering their potential influence on the family and their contribution to the nation's workforce and productivity. To the best of our knowledge, the study of trends in underweight and overweight of Bangladeshi population has been poorly documented.

The purpose of the present study is to test the presence of trends in nutritional status of non-pregnant married Bangladeshi women over time.

MATERIALS AND METHODS

Cross-sectional data were derived from the Bangladesh Demographic and Health Survey (BDHS) 1996-97, 1999-2000, 2004, 2007 and 2011 conducted from November 02, 1996 to March 11, 1997; November 10, 1999 to March 15, 2000; January 01 to May 24, 2004; March 24 to August 11, 2007 and July 08 to December 27, 2011 respectively. These are the national-level surveys with the various districts of Bangladesh represented. The sample population of this study consisted of 45,572 married, currently non-pregnant Bangladeshi women. Ages at the time of measurements ranged from 15 to 49 years, with an average age of 30.11± 9.041 years. The survey collected socio-demographic, health and lifestyle information from each subject. In addition, body height and weight were measured. Body mass index was defined and calculated as the ratio of weight in kilograms to height in metres square. Data from a sample of 59,949 married Bangladeshi women were collected by the 1996-97, 1999-2000, 2004, 2007 and 2011 BDHS. The data set was checked for outliers by the present authors using statistical techniques (Dunn and Clark,'74). Some missing values were also detected, and these cases were excluded. Pregnant women were also excluded in the present study. After removing outliers, cases with incomplete data, and excluding currently pregnant women, the data set was reduced to 45,572 for the analysis in the present study.

To find the average trends in height, weight and BMI over time, the sample was subdivided into five groups according to conducted years from 1996-97 to 2011. To examine the interclass variation of height, weight and BMI, a one-way analysis of variance (ANOVA) was utilized. The model corresponding to each variable is:

$$Y_{ij} = \mu + \beta_i + \varepsilon_{ij}, \quad i = 1, 2,..., p, j = 1, 2,..., q.$$

where Y_{ij} is the j th observation (response variable) for the i th measurement year; μ is the general mean effect; $\beta_i = \mu_i - \mu$ the additional effect of i th measurement year; μ_i is the average effect of th measurement year; ε_{ij} is the random error term, which follows normal distribution with mean zero (0) and variance (σ^2), p is the number of years, and q is the number of observations for each year. The ANOVA procedure is primarily concerned with testing the hypothesis $H_0 : \beta_1 = \beta_2 = ... = \beta_p = 0$ or equivalently $\mu_1 = \mu_2 = ... = \mu_p = \mu$ by means of a single F-test. If the hypothesis of equality of year means is rejected, it may be concluded that there are differences among the year means. The standard assumptions of the ANOVA, randomness, normality and homogeneity of cohort variances were checked using the Kolmogorov-Smirnov non-parametric test, a normal probability plot, and the Levene test, respectively. Linear regression analysis was applied to detect the presence of trends in BMI among the birth year cohorts. BMI was subdivided into four classes according to most widely used categories of BMI for adults; underweight (BMI ≤ 18.5 kg/m^2), normal weight (18.5 < BMI <25 kg/m^2), overweight (25 ≤ BMI < 30 kg/m^2) and obese (BMI ≥ 30 kg/m^2) (Hossain *et al.* 2012). Statistical significance was accepted at $p < 0.05$. All statistical analyses were performed using SPSS (verson 17.0).

RESULTS

A total sample of 45,572 married and currently non-pregnant Bangladeshi women were analyzed in this study. The age of subjects varied from 15 to 49 years with mean age 30.11 ± 9.041 years (95% CI: 30.03-30.20).

Secular Trends in Height, Weight and BMI

The average height of the women was 150.60 ± 5.441 cm (95% CI: 150.55-150.65), ranging from 123.40 to 180.00 cm. Their average weight was 46.93 ± 9.236 kg (95% CI: 46.85-47.01), ranging from 24.80 to 99.30 kg. The BMI varied from 12.06 to 45.27 kg/m^2, with a mean of 20.65 ± 3.670 kg/m^2 (95% CI: 20.616-20.684). The mean age, height, weight and

BMI of Bangladeshi married non-pregnant women by measurement year 1996-1997, 1999-2000, 2004, 2007 and 2011 was 25.91, 25.99, 30.64, 31.15 and 31.36 years; 150.14, 150.44, 150.54, 150.51 and 150.87 cm; 42.53, 44.05, 46.15, 47.38 and 49.09 kg; and 18.84, 19.43, 20.32, 20.87 and 21.52 kg/m^2, respectively (Table 1).

First we attempted to look the trends in height, weight and body mass index among the BDHS conducted survey years from 1996-1997 to 2011. Since the data of the current section has subdivided into measurement year, this facilitated a study of possible trends over time. The variation in height, weight and BMI among the measurement years from 1996-1997 to 2011 examined with the ANOVA. Before using ANOVA, it is necessary to ensure that the standard assumptions underlying the ANOVA model is satisfied. Consequently, the data were checked for randomness, normality and homogeneity. The Kolmogorov–Smirnov non-parametric test and the normal probability plot exhibited no serious problems concerning the normality of the data. In addition, the Levene test showed that the data were homogeneous. Thus, the data satisfied the standard assumptions of the ANOVA model. The ANOVA results demonstrated that the variations in height, weight and BMI of Bangladeshi women among the measurement years from 1996-1997 to 2011 were statistically significant ($p<0.001$) (Table 2).

TABLE 1

Descriptive statistics of height, weight and BMI of women by measurement years

Variable	Measurement year	N	Mean	SD	SE	95% CI for mean		Mini-mum	Maxi-mum
						Lower	Upper		
Height (cm)	1996-1997	4036	150.14	5.614	0.088	149.96	150.31	123.40	180.00
	1999-2000	4671	150.44	5.420	0.079	150.29	150.60	129.30	178.30
	2004	10483	150.54	5.429	0.053	150.43	150.64	127.50	178.20
	2007	10125	150.51	5.442	0.054	150.40	150.62	126.50	176.40
	2011	16257	150.87	5.398	0.042	150.79	150.96	124.90	179.80
	Total	45572	150.60	5.441	0.026	150.55	150.65	123.40	180.00
Weight (kg)	1996-1997	4036	42.53	6.850	0.108	42.32	42.74	26.10	90.10
	1999-2000	4671	44.05	7.570	0.111	43.84	44.27	27.00	99.20
	2004	10483	46.15	8.821	0.086	45.98	46.32	24.80	99.30
	2007	10125	47.38	9.306	0.093	47.20	47.56	25.40	98.80
	2011	16257	49.09	9.725	0.076	48.94	49.24	26.50	99.00
	Total	45572	46.93	9.236	0.043	46.85	47.01	24.80	99.30
BMI (kg/m^2)	1996-1997	4036	18.84	2.664	0.042	18.76	18.92	12.37	40.32
	1999-2000	4671	19.43	2.937	0.043	19.35	19.51	13.24	42.66
	2004	10483	20.32	3.479	0.034	20.25	20.39	12.06	45.27
	2007	10125	20.87	3.710	0.037	20.80	20.95	12.14	43.74
	2011	16257	21.52	3.879	0.030	21.46	21.58	12.45	43.35
	Total	45572	20.65	3.670	0.017	20.62	20.68	12.06	45.27

TABLE 2

Analysis of variance results for height, weight and BMI of married Bangladeshi women by measurement years from 1996-1997 to 2011

Variable	Source of variation	Sum of squares	df	Mean square	F_{cal}-value	p-value
Height	Between Groups	2311.29	4	577.82	19.55	<0.001
	Within Groups	1346806.58	45567	29.56		
Weight	Between Groups	200777.90	4	50194.47	620.41	<0.001
	Within Groups	3686618.41	45567	80.91		
BMI	Between Groups	34167.11	4	8541.78	671.43	<0.001
	Within Groups	579692.98	45567	12.72		

Fig. 1 displays mean height of Bangladeshi women according to measurement years conducted from 1996-1997 to 2011. The slope (0.154 cm) of linear regression line showed the increasing tendency in height among Bangladeshi married women over time, and R^2-value (0.861) exhibited that linear regression line was the good fitted model to explain the variation of height with changing time (Fig. 1).

The slope (1.644 kg) of linear regression line showed that the increasing tendency in weight of Bangladeshi women among measurement years cohorts from 1996-1997 to 2011. The R^2-value (0.99) of line exhibited that linear model was good fitted to explain the variation of weight among measurement year cohorts (Fig. 2).

Fig. 3 displays the mean value of BMI of Bangladeshi non-pregnant married women according to measurement years conducted from 1996-1997 to 2011. The slope (0.681 kg/m^2) of linear regression line showed that the pattern of increasing tendency in BMI same as height and weight of Bangladeshi women over time, and R^2-value (0.99) of this line was observed that linear model was good fitted to explain the variation of BMI among measurement year cohorts (Fig. 3).

PREVALENCE OF MALNUTRITION (UNDERWEIGHT AND OVERWEIGHT)

The prevalence of malnutrition among Bangladeshi married non-pregnant women was 31.4% and 2.1% for underweight and obese, respectively (Table 3). More than half of the participants in the current study were normal in weight (56.1%) and 10.4% was overweight. When we looked for measurement years, the proportion (percentage) of underweight individuals among Bangladeshi non-pregnant married women was 51.1%, 43.2%, 33.2%, 28.6%, 23.5% of measurement years 1996-97, 1999-2000, 2004, 2007 and 2011 respectively. The overweight and obese percentage among the non-

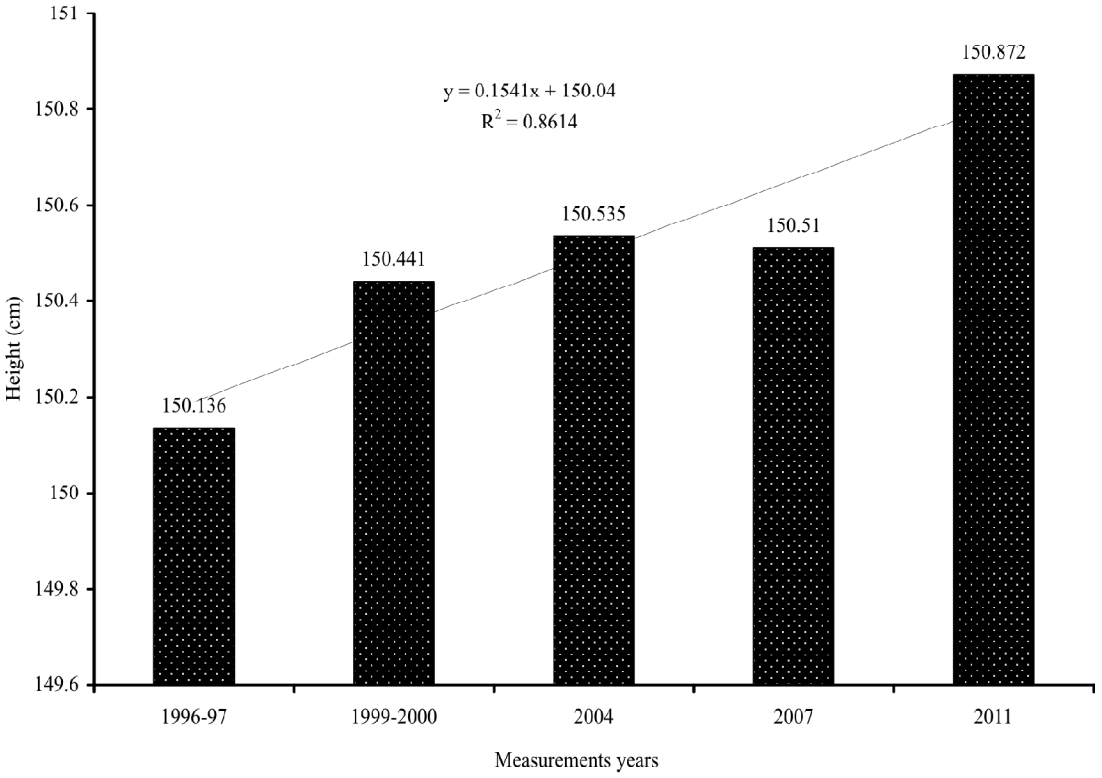

Fig. 1: Trends in height among measurement year cohorts

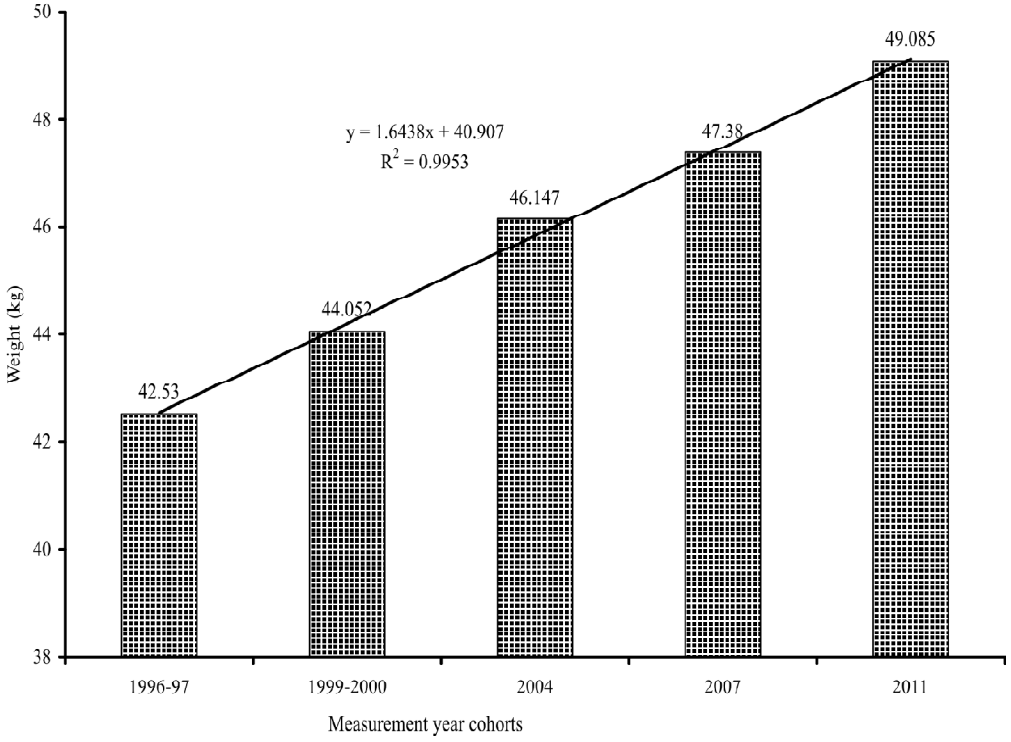

Fig. 2: Trends in weight over time

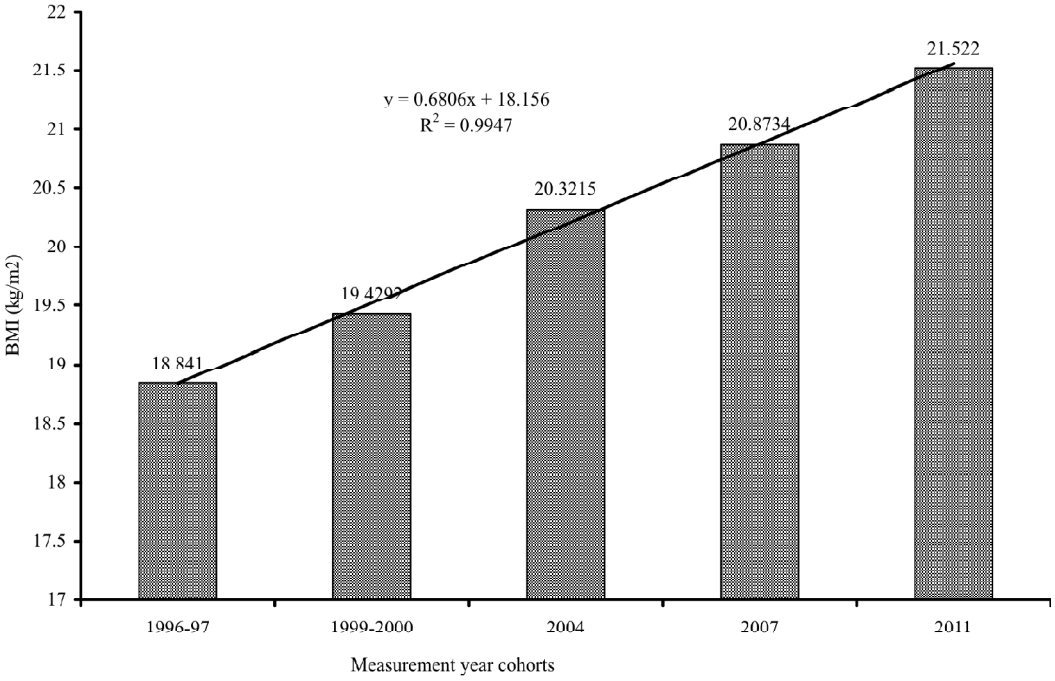

Fig. 3: Trends in BMI over time

pregnant Bangladeshi married women was 2.3%, 4.4%, 8.8%, 11.5% and 14.5%, and 0.5%, 0.8%, 1.7%, 2.3% and 3.1% of measurement years 1996-97, 1999-2000, 2004, 2007 and 2011 respectively (Table 3).

TABLE 3

Frequency distribution (percentage) of categories of BMI among non-pregnant Bangladeshi married women (N=45,572) by measurement years

	Measurement years					
BMI category	1996-1997	1999-2000	2004	2007	2011	Total
Underweight (BMI ≤ 18.5 kg/m^2)	2069	2023	3500	2904	3836	14332
N (%)	(51.3)	(43.3)	(33.4)	(28.7)	(23.6)	(31.4)
Normal weight (18.5 < BMI < 25 kg/m^2)	1853	2407	5886	5832	9549	25527
N (%)	(45.9)	(51.5)	(56.1)	(57.6)	(58.7)	(56.0)
Overweight (25 ≤ BMI < 30 kg/m^2)	92	204	918	1161	2365	4740
N (%)	(2.3)	(4.4)	(8.8)	(11.5)	(14.5)	(10.4)
Obese (BMI ≥ 30 kg/m^2)	22	37	179	228	507	973
N (%)	(0.5)	(0.8)	(1.7)	(2.3)	(3.1)	(2.1)

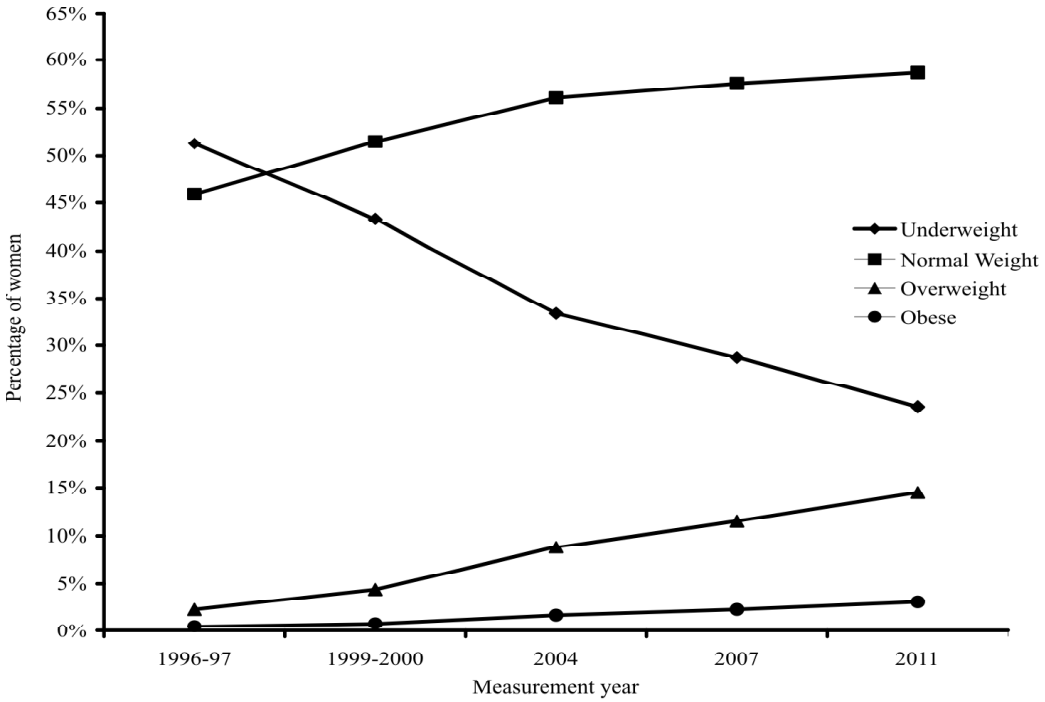

Fig. 4: Trends in various types of body size of Bangladeshi married women over time

Fig. 4 indicates the trend in various types of body size of Bangladeshi women during the measurement years conducted from 1996-1997 to 2011. A decreasing pattern in proportion of underweight women was observed from 1996-1997 to 2011 measurement year. But the proportion of normal weight, overweight and obese individuals showed the increasing pattern over the same periods.

DISCUSSIONS

The data used in this study gathered by the Bangladesh Demographic and Health Surveys (BDHS) conducted in 1996-1997, 1999-2000, 2004,

2007 and 2011. The samples were nationally representative, covering both urban and rural areas of Bangladesh. Previous studies in Bangladesh have examined the relationship between BMI and age, mortality, level of education, wealth index and other social variables (Shafique *et al*., 2007; Khan and Kraemer, 2009), but they used much smaller data sets that were not representative of the nation. Recently, Hossain *et al*. (2012) investigated the trend in BMI of Bangladeshi women but they used only BDHS 2007 data.

The result in this study demonstrated that the mean BMI of married Bangladeshi women between the ages of 15 and 49 years was 20.65 ± 3.67 kg/m^2 for whole sample. When observed the individual measurement period of BDHS, the mean BMI in surveys conducted years 1996-1997, 1999-2000, 2004, 2007 and 2011 was 18.84, 19.43, 20.32, 20.87 and 21.52 kg/m^2, respectively. More than half of the women (56.1%) were of normal weight. Underweight women constituted 31.4% of the study population, while overweight women constituted 10.4%. Only 2.1% were considered obese. This information is consistent with other studies on Bangladeshi women. A study on Bangladeshi women reported that 57.73% were normal weight, 28.66% were underweight, 11.45% were overweight and 2.16% were obese (Hossain *et al*., 2012). Other study on Bangladeshi women living in an urban area reported that 15.7% were overweight and 3.9% were obese (Khan and Kraemer, 2009), while another study on women living in the slum area of Dhaka reported that 54% of women were underweight (Pryer *et al*., 2003). A relatively similar pattern was also observed in a large population study in neighbouring India, where 56.9% of married women were reported to be of normal weight, 31.2% were underweight, 9.4% were overweight and 2.6% were obese (Bharati *et al*., 2007).

The BMI of married Bangladeshi women varied over the birth year cohorts from measurement years 1996-97 to 2011 (Fig. 3). The increasing trend in BMI of Bangladeshi non-pregnant married women was observed during the measurement years from 1999-97 to 2011. The change of BMI over time for other populations have been occurred, a slight decrease in mean BMI was reported in female students attending Glasgow University in the United Kingdom between 1948 and 1964, although the value increased in male students over the same period (Okasha *et al*., 2003). On the other hand, a study on the secular trend of various anthropometric measurements conducted for two generations of 38- and 50- year-old Swedish women was not able to detect a significant change in BMI over the years (Lissner *et al*., 2008). A similar finding was noted in another study conducted in Finland from 1972 to 1997 (Lahti-Koski *et al*., 2001).

In the present study also demonstrated that there was a decreasing trend the number (proportion) of underweight women during the measurement years from 1996-97 to 2011. This study also showed the increasing tendency of the number of overweight and obese women over time. In most other parts of the world, a decrease in the percentage of underweight women and an increase in the percentage of overweight and obese women have been reported over the last 50 years. The most obvious changes have been observed in North American (Freedman *et al*., 2002; Torrance *et al*., 2002) and European countries (Gullinford *et al*., 1992; Bendixen *et al*., 2004; Berg *et al*., 2005), and a similar pattern has also been reported for Australia (Dal Grande *et al*., 2005) and parts of Asia (Aekplakorn and Mo-Suwan, 2009). However, the percentage of normal weight of Bangladeshi women has shown an increasing tendency over the last four decades.

It is important to determine the risk factors which are related to BMI of Bangladeshi married women. BDHS used multistage stratified cluster sampling for selecting household from different enumeration areas. Since the data collected by BDHS from multistage clustered samples and the dependence among observations came from several levels of the hierarchy. There is a cluster effect of the data set. The single level statistical model is not appropriate for analyzing such kind of data set. Further studies should be needed to analyze the BDHS data.

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