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Socioeconomic transition and its influence on body mass index (BMI) pattern in Bangladesh

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Abstract

Rationale, aims, and objectives: Bangladesh is an underdeveloped country that has recently joined the ranks of low-middle-income countries. This study aims to investigate how socioeconomic and developmental factors have influenced women towards a shift in their body mass index (BMI).

Methods: The trend was analysed using data on ever-married women from 6 nationwide surveys covering the years 1996 to 2014, conducted by the Bangladesh Demographic and Health Survey (BDHS). To assess the relationship between the socioeconomic factors and BMI, binary regression models were fitted for 6 surveys and forest plots were applied to display the results.

Results: Factors such as age, education, residence, economic status, and contraceptive use were found to have had an increasing influence on BMI over the years that were being analysed. Age and education for women were potential factors influencing BMI. Growing urbanization and economic inequality were found to have been substantial over time, and marital status and contraceptive use were influential whilst the employment status of women held no consequence.

Conclusions: Rapid urbanization allied with growing wealth inequality and dietary alteration seems to have forced a change in the capacity of women in Bangladesh to control their weight. Additional information is still needed on such factors as the amount of time that women are inactive and sitting down, for example, as well as their daily calorie intake in order to assemble all the pieces for addressing necessary health policy changes in Bangladesh. These factors will also help to indicate a shift of focus from rural malnutrition to urban obesity.

KEYWORDS

BMI, health policy, public health, social trend, trend analysis

1 | INTRODUCTION

Bangladesh has recently been classed as a low-middle-income country after previously being classed as underdeveloped. The change in classification creates the scope for channelling a first world problem into Bangladesh, that is, a problem of its people being overweight and/or obese alongside already existing malnutrition particularly in rural areas. A number of studies have focused on malnutrition in Bangladesh[1-8]; however, assessments of the extent of people who are overweight or obese are still inconclusive. Prevalence of obesity is increasing all around the globe and has consequently become a risk factor for developing many serious illnesses.[9-12] This study considered both underweight and overweight factors based on BMI as an unhealthy factor and assessed its association with various socioeconomic issues. This broad dichotomization was considered due to insufficient nationwide data covering Bangladesh. The clinical association between

BMI and malnutrition was not sufficient to separate malnutrition and obesity based only on BMI, so we settled for a broad binary outcome variable (health and unhealthy).[13-16] This study paves the way for a more focused study, preferably with primary data, that will focus on factors such as age, education, residence, economic status, and contraceptive use that we found to be important in the context of Bangladesh and further scrutinized the trend for problems present in the developed world that are starting to surface in Bangladesh.

The most commonly applied measurement index for health and fitness is the body mass index (BMI). Unfortunately, BMI levels vary over a number of factors: racial groups, ethnicity, geographic location, gender, age, hormone levels, and other socioeconomic influences.[17-19] However, due to the lack of a standard BMI scale for Bangladesh, this study applied the typical BMI scaling for measuring the healthy (18.5-24.9 kg/m^2) and the unhealthy. This study also analysed socioeconomic data to identify trends affecting the BMI of ever-married women covering the years 1996 to 2014. The data were extracted from 6 nationwide surveys conducted by the Bangladesh Demographic and Health Survey (BDHS) and then analysed to determine the trend over these years and thereby helping to narrow the factors that could affect BMI. Rapid urbanization, high wealth inequality, and dietary changes are potential culprits behind the trend. Thus, research in future can focus on specific socioeconomic factors present in Bangladesh that can then help in reassessing existing health policy and determine with more certainty if there are plausible reasons for a shift from rural malnutrition to urban obesity.

An individual's weight and height ratio—BMI (kg/m^2)—are associated with a range of diseases.[20] Previous studies have shown the importance of controlling weight in accordance with individual body measure so as to help in leading a healthy disease-free life. Both low and high BMI give rise to higher risks of developing diseases.[21-23] Creating an individual parameter for proper weight maintenance is inevitably arbitrary; however, BMI is the best available measuring tool.[24] The International Obesity Task Force provided a classification for BMI where healthy weight was considered to be in the range 18.5 to 24.9 (kg/m^2),[25] which is consistent with the decision of a steering committee of the American Institute of Nutrition[26] and an expert committee of the World Health Organization.[27] This paper followed similar guidelines for determining healthy and unhealthy respondents in BDHS data sets. However, the accuracy and interpretations of BMI vary upon several factors like race, geographic locations, gender, ethnicity, and age.[28-30] The focus of the study is not concerned with the diagnostic performance of BMI. Due to the lack of a gold standard BMI range for ever-married women in Bangladesh, the generally accepted range of BMI was applied to segregate the healthy from the unhealthy.

Age and education are important socioeconomic factors for controlling BMI. The average BMI has increased at an alarming rate for all ages but especially for adolescents in the USA and Australia,[31-33] where children and adults are subject to a high BMI (over 30 kg/m^2) and to chronic obesity.[34,35] Another factor closely related to healthy lifestyles is education. The amount of education that individuals experience is associated with better self-reported health for both men and women.[36] Education provides knowledge on side effects, regular medication use, and medication adherence.[37] Furthermore, the education of primary caretakers, usually family members, is also important in helping to lead a healthy lifestyle.[38] The effects of age and education should provide a trend for Bangladesh as they have also had an influence in other countries.

A healthy lifestyle is also enhanced by area of residence, income status, and employment. Fogelholm et al[39] showed that a difference in health was observed between 2 community types, urban and rural, that was explained by educational background, physical activity, and smoking with the urban residents more likely to be obese or overweight.[40] The ability or capacity of individuals to access decent health care and nutrition is also important in maintaining a healthy disease-free life. The wealth gap in the United States has proven to be a strong factor in this, where the poorest Americans experience the greatest disadvantage.[41] However, excess weight is more problematic for rich people in urban areas both in developed and developing nations.[42] Interestingly, obesity also hampers the income of individuals and families by significantly reducing wealth status.[43] A study in Korea that focused on the elderly population in that country found that unemployment was significantly related to obesity prevalence regardless of other socioeconomic factors.[44] This begs the question as to whether these factors are also influencing Bangladesh as it grows economically. Added to this, an increasing number of inhabitants from rural areas are moving to urban areas such as cities. The additional expansion of these urban areas is introducing dietary changes and a reduction in physical work available for residents which is potentially an important determinant in the BMI shift in Bangladesh.[45,46]

For women, marriage has a high association with BMI where married women are found more likely to be overweight than compared to single women.[47-49] However, any assessment on the impact on BMI of a mothers' age at the birth of her first child or number of ever-born children remains a challenge. One of the most researched topics in this area is the effect of contraception on the weight of women and their BMI. Despite some of the results being inconclusive, a relationship was detected with women's weight and a particular contraceptive method.[50-52] Although previous studies concentrated on a specific contraceptive method, it is worthwhile to detect the overall trend of traditional and modern methods of contraception on BMI.

2 | METHODS

Bangladesh Demographic and Health Survey in collaboration with DHS has been conducted in Bangladesh since 1993.[53] Measure DHS+ is a platform where data from developing countries on the demographic and health characteristics of populations are collected and analysed periodically every few years.[54] Two-stage stratified cluster sampling techniques are applied for this survey, and a list of enumeration areas (EAs) from the census is used as the sampling frame.[53] Firstly, 600 EAs (or clusters) are selected using a proportional to size (PPS) sampling method. In the second stage, an equal probability systematic sampling method is applied to draw on an average of 30 households from each cluster. Strong literature exists on each survey conducted by BDHS (from 1993 to 2014), but accumulating all the surveys to try and identify any trends remains a challenge. The data comprised ever-married men aged 15 to 54 and ever-married women between 15 and 49. Only the women's samples

were selected from the data sets with the sample numbers different for each survey. However, models were separately fitted for each survey in order to adjust the dissimilar sample sizes. The respondents with missing information were not included in the study sample. As explained in the Section 1, a broad binary outcome variable was used to assess the BMI pattern. The best possible method for analysing such outcome is the binary regression model. In order to achieve a better fitting binary logistic regression model, available socioeconomic factors were segregated into 3 categories and are displayed in Table 1.

Table 1 displays the covariates used in the models. The scales of each model are defined in the BDHS data sets. However, the authors defined the age categories of the respondents and their partners. Because the respondents were aged between 14 and 49, we dichotomized their age into young (≤25 years) and adult (over 25 years). However, the age of the partners was from 16 to above 80. They were segregated into 3 categories: young (<25 years), adult (≥25 and ≤59), and old (>59 years). We also collapsed the total number of children in the family equal or above 4 as "4+" in the variable "Total children ever born".

The outcome variable is BMI, categorized into 2 scales: healthy (18.5-24.9 kg/m^2) and unhealthy (<18.5 and >24.9 kg/m^2). Bivariate analysis was conducted to provide an overview of the covariates. The significance of their association with the outcome variable (BMI) was determined by *P* values from the chi-squared test (Table 2). Bivariate analysis evaluated the nature of association between the BMI outcome and other covariates of the 6 different surveys. However, bivariate association between 2 variables does not necessarily imply a significant causal relationship. For further understanding of the nature of their relationship and determining the significant effects, binary logistic regression model was fitted for BMI with variables in each category (Table 1) in 3 separate models. All computations were conducted in *R* (version 3.2.3).

3 | RESULTS

3.1 | Bivariate analysis

The outcomes of the bivariate analysis from the 6 surveys are displayed in Tables 2–4. Most of the household characteristics showed significant association (*P* value <0.001) with BMI.

3.2 | Binary regression

To assess the associations between the socioeconomic factors and health status—BMI as well as their level of significance, binary regression models were fitted for all 6 surveys and forest plots were applied to display the results (Figures 1 and 2). Age groups of respondents and their partners in category I showed opposite results. From 1996 to 2016, women's ages indicated high influence over BMI, where the odds showed that the younger generation of women were healthier than the older generation of women. Apart from the 2004 survey, a partners' age did not show similar importance. In the case of levels of education attainment, both respondent's and partner's levels of literacy showed significance.

Women's education levels were significant (*P* value <.05) in 2000, 2011, and 2014, whereas from 2000, all the surveys displayed the importance of a partner's education.

The area of residence of respondents became an important factor in maintaining weight after 2004, demonstrating the segregation between urban and rural areas in recent times. The difference in wealth has been a strong factor in wealth maintenance since 1996, which was gradually followed in every subsequent survey. However, the change in direction of the odds for the highest 2 quantiles are evident. Employment status, just like residence, became a significant phenomenon (*P* value <.05) in later years.

Marital status and the number of total children ever born were important covariates influencing BMI score (Figure 2). However, the significant influence (*P* value <.05) of the age of mothers at the birth of their first child was detected in recent times, specifically after the 2007 survey. Only modern contraceptive methods showed a positive impact on control of optimum weight levels, where the reference group was nonusers.

3.3 | Trend analysis

The odds ratios are displayed graphically through forest plots in Figures 1 and 2 to show the change in the effects of socioeconomic factors on BMI over the years. The trends will determine the pathway of the influence of these factors as well as their type of effect (positive or negative). Odds 1 indicates an equilibrium state, which means that there is no impact of that certain socioeconomic factor on BMI—that factor is no longer an important covariate in determining the maintenance of individual weight.

The gradual change in age is apparent in Figure 1A. When compared with adults, young women were found to be more health conscious as the odds of maintaining a healthy BMI gradually declined in the years 2000 to 2014. Young women were less likely to have a higher BMI compared to adult women, indicated by the forest plot. The opposite result was attained from the ages of partners/husbands (Figure 1B). The odds of both young and adult groups increased reaching odds 1, while the reference group of older partners showed that the age of partners had less impact on the BMI of women reaching equilibrium (odds 1) over the years. The education of married

TABLE 1 List of variables in 3 categories

Category I	Category II	Category III
Age	Residence	Marital status
Highest educational level	Wealth index	Total children ever born
Husband/partner's age	Respondent's working status	Age at first birth
Husband/partner's education		Contraceptive method type

TABLE 2 Bivariate analysis of the variables in category I

BMI of Various Years												
	BDHS 1996-1997 (Sample Size = 1867)		BDHS 1999-2000 (Sample Size = 1856)		BDHS 2004 (Sample Size = 10 731)		BDHS 2007 (Sample Size = 10 278)		BDHS 2011 (Sample Size = 16 763)		BDHS 2014 (Sample Size = 16 786)	
Variables	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy
Age												
Adult	486 (47.7%)	533 (52.3%)	654 (54.8%)	540 (45.2%)	4097 (56.3%)	3177 (43.7%)	4071 (56.3%)	3166 (43.7%)	6519 (54.3%)	5493 (45.7%)	6343 (51.5%)	5965 (48.5%)
Young	460 (54.2%)	388 (45.8%)	364 (55%)	298 (45%)	2200 (63.6%)	1257 (36.4%)	1993 (65.5%)	1048 (34.5%)	2956 (62.2%)	1795 (37.8%)	2717 (60.7%)	1761 (39.3%)
P value	.006*		.969		<.001*		<.001*		<.001*		<.001*	
Highest education level												
None	497 (48.6%)	526 (51.4%)	407 (50.1%)	405 (49.9%)	2460 (58%)	1778 (42%)	2005 (59.2%)	1379 (40.8%)	2623 (58.5%)	1863 (41.5%)	2338 (57.2%)	1751 (42.8%)
Primary	295 (54%)	251 (46%)	316 (59.2%)	218 (40.8%)	1912 (60.6%)	1243 (39.4%)	1858 (60.9%)	1194 (39.1%)	2933 (58.5%)	2077 (41.5)	2762 (56.2%)	2156 (43.8%)
Secondary	135 (50.9%)	130 (49.1%)	237 (56.7%)	181 (43.3%)	1609 (59.6%)	1089 (40.4%)	1811 (59.7%)	1221 (40.3%)	3296 (55.8%)	2606 (44.2%)	3271 (52.8%)	2923 (47.2%)
Higher	19 (57.6%)	14 (42.4%)	58 (63%)	34 (37%)	316 (49.4%)	324 (50.6%)	389 (48.2%)	418 (51.8%)	623 (45.6%)	742 (54.4%)	689 (43.5%)	896 (56.5%)
P value	.1803		.0024*		<.001*		<.001*		<.001*		<.001*	
Partner's age												
Old	19 (51.4%)	18 (48.6%)	15 (39.5%)	23 (60.5%)	319 (51%)	307 (49%)	318 (56.5%)	245 (43.5%)	501 (53.7%)	432 (46.3%)	552 (53.1%)	487 (46.9%)
Adult	847 (49.8%)	853 (50.2%)	931 (55.5%)	747 (44.5%)	5157 (59.4%)	3519 (40.6%)	4995 (59.2%)	3445 (40.8%)	7868 (56.8%)	5994 (43.2%)	7482 (53.6%)	6478 (46.4%)
Young	45 (60.8%)	29 (39.2%)	44 (55%)	36 (45%)	356 (65.3%)	189 (34.7%)	292 (68.5%)	134 (31.5%)	509 (61.3%)	322 (38.7%)	471 (62.5%)	283 (37.5%)
P value	.179		.1459		<.001*		<.001*		.0056		<.001*	
Partner's highest education level												
None	414 (48.4%)	441 (51.6%)	371 (49.3%)	381 (50.7%)	2306 (58.9%)	1606 (41.1%)	2065 (60.7%)	1339 (39.3%)	2942 (59.5%)	2005 (40.5%)	2819 (58.5%)	1999 (41.5%)
Primary	262 (52.3%)	239 (47.7%)	288 (61.3%)	182 (38.7%)	1670 (61.8%)	1034 (38.2%)	1618 (61.1%)	1030 (38.9%)	2687 (59.7%)	1814 (40.3%)	2590 (57.1%)	1942 (42.9%)
Secondary	202 (54.3%)	170 (45.7%)	232 (58.7%)	163 (41.3%)	1621 (59.2%)	1118 (40.8%)	1661 (61.5%)	1039 (38.5%)	2706 (56.2%)	2112 (43.8%)	2602 (52.9%)	2317 (47.1%)
Higher	57 (48.3%)	61 (51.7%)	106 (50.7%)	103 (49.3%)	694 (50.8%)	672 (49.2%)	715 (47.3%)	797 (52.7%)	1134 (45.6%)	1355 (54.4%)	1049 (41.7%)	1466 (58.3%)
P value	.4584		<.001*		<.001*		<.001*		<.001*		<.001*	

*Level of significance at 5%.

TABLE 3 Bivariate analysis of the variables in category II

BMI of Various Years												
	BDHS 1996-1997 (Sample Size = 1867)		BDHS 1999-2000 (Sample Size = 1856)		BDHS 2004 (Sample Size = 10 731)		BDHS 2007 (Sample Size = 10 278)		BDHS 2011 (Sample Size = 16 763)		BDHS 2014 (Sample Size = 16 786)	
Variables	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy
Residence												
Urban	102 (49.5%)	104 (50.5%)	259 (56.2%)	202 (43.8%)	2010 (54.7%)	1666 (45.3%)	2135 (54.6%)	1775 (45.4%)	2971 (50.6%)	2901 (49.4%)	2697 (46.3%)	3134 (53.7%)
Rural	844 (50.8%)	817 (49.2%)	759 (54.4%)	636 (45.6%)	4287 (60.8%)	2768 (39.2%)	3929 (61.7%)	2439 (38.3%)	6504 (59.7%)	4387 (40.3%)	6363 (58.1%)	4592 (41.9%)
P value	.7813		.5422		<.001*		<.001*		<.001*		<.001*	
Wealth index												
Poorest	153 (39.5%)	234 (60.5%)	224 (48.4%)	239 (51.6%)	1077 (55.8%)	853 (44.2%)	989 (59.7%)	669 (40.3%)	1692	1195 (41.4%)	1822 (60.3%)	1201 (39.7%)
Poorer	204 (49.2%)	211 (50.8%)	174 (50.6%)	170 (49.4%)	1186 (61.4%)	746 (38.6%)	1189 (64.2%)	662 (35.8%)	1969 (63.6%)	1129 (36.4%)	1937 (61.7%)	1203 (38.3%)
Middle	215 (53.6%)	186 (46.4%)	232 (61.1%)	148 (38.9%)	1245 (62.1%)	759 (37.9%)	1246 (64.4%)	688 (35.6%)	2000 (62.1%)	1221 (37.9%)	2005 (58.8%)	1405 (41.2%)
Richer	206 (57.5%)	152 (42.5%)	181 (60.1%)	120 (39.9%)	1325 (62%)	813 (38%)	1281 (61.9%)	790 (38.1%)	2021 (56.6%)	1549 (43.4%)	1901 (53.4%)	1658 (46.6%)
Richest	168 (54.9%)	138 (45.1%)	207 (56.2%)	161 (43.8%)	1464 (53.7%)	1263 (46.3%)	1359 (49.2%)	1405 (50.8%)	1793 (45%)	2194 (55%)	1395 (38.2%)	229 (61.8%)
P value	<.001*		<.001*		<.001*		<.001*		<.001*		<.001*	
Respondent's working status												
Unemployed	644 (51.9%)	598 (48.1%)	828 (54.9%)	679 (45.1%)	4855 (58.5%)	3447 (41.5%)	4140 (57.7%)	3038 (42.3%)	8200 (56.7%)	6267 (43.3%)	5962 (52.6%)	5376 (47.4%)
Employed	302 (48.4%)	322 (51.6%)	190 (54.6%)	158 (45.4%)	1442 (59.4%)	986 (40.6)	1921 (62%)	1175 (38%)	1275 (55.5%)	1021 (44.5%)	3095 (56.9%)	2348 (43.1%)
P value	.222		.5409		.3565		<.001*		.3128		<.001*	

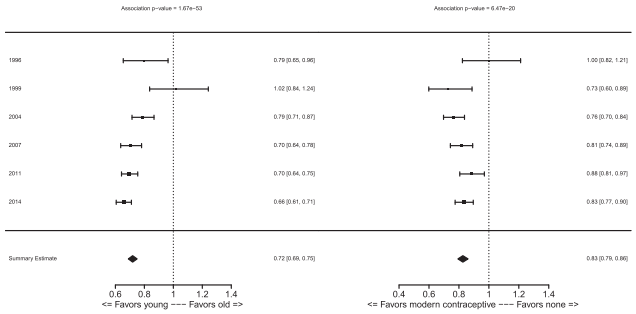
*Level of significance at 5%.

TABLE 4 Bivariate analysis of the variables in category III

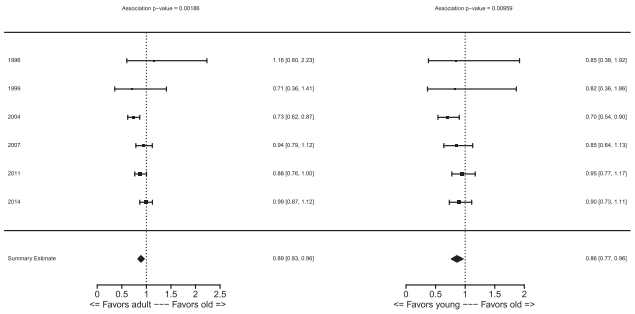
BMI of Various Years												
	BDHS 1996-1997 (Sample Size = 1867)		BDHS 1999-2000 (Sample Size = 1856)		BDHS 2007 (Sample Size = 10 278)		BDHS 2011 (Sample Size = 16 763)		BDHS 2014 (Sample Size = 16 786)		BDHS 2011 (Sample Size = 16 763)	
Variables	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy
Marital status												
Married	911 (50.3%)	900 (49.7%)	990 (55.1%)	806 (44.9%)	5832 (59.2%)	4015 (40.8%)	5605 (59.4%)	3824 (40.6%)	8878 (56.8%)	6748 (43.2%)	8505 (54%)	7248 (46%)
Widowed	12 (52.2%)	11 (47.8%)	11 (57.9%)	8 (42.1%)	248 (50.2%)	246 (49.8%)	236 (50.6%)	230 (49.4%)	323 (50.2%)	321 (49.8%)	314 (50.4%)	309 (49.6%)
Divorced	23 (69.7%)	10 (30.3%)	3 (42.9%)	4 (57.1%)	85 (54.8%)	70 (45.2%)	84 (60.4%)	55 (39.6%)	115 (53.5%)	100 (46.5%)	104 (61.2%)	66 (38.8%)
Not living together	NA	NA	14 (41.2%)	20 (58.8%)	132 (56.2%)	103 (43.8%)	139 (57%)	105 (43%)	159 (57.2%)	119 (42.8%)	137 (57.1%)	103 (42.9%)
P value	.3767		.3767		.0006*		.0020*		.0072*		.0529	
Total children ever born												
None	NA	NA	NA	NA	688 (66%)	355 (34%)	521 (60.1%)	346 (39.9%)	523 (58.4%)	373 (41.6%)	783 (59.1%)	541 (40.9%)
1	239 (51.8%)	222 (48.2%)	279 (55.2%)	226 (44.8%)	1131 (60.5%)	737 (39.5%)	1199 (60.6%)	779 (39.4%)	1261 (58.7%)	889 (41.3%)	2008 (54.9%)	1651 (45.1%)
2-3	403 (55.9%)	318 (44.1%)	452 (57.1%)	339 (42.9%)	2425 (59.6%)	1644 (40.4%)	2461 (59.5%)	1673 (40.5%)	2547 (54.7%)	2109 (45.3%)	4083 (52.4%)	3714 (47.6%)
4+	304 (44.4%)	381 (55.6%)	287 (51.3%)	273 (48.7%)	2053 (54.7%)	1698 (45.3%)	1883 (57.1%)	1416 (42.9%)	1491 (56.1%)	1165 (43.9%)	2186 (54.6%)	1820 (45.4%)
P value	<.001*		.098		<.001*		.0442		.0107*		<.001*	
Age at first birth												
<20 years	826 (50.3%)	815 (49.7%)	853 (55.1%)	694 (44.9%)	4885 (58.5%)	3472 (41.5%)	4649 (59.7%)	3135 (40.3%)	7302 (57.6%)	5366 (42.4%)	6995 (54.6%)	5813 (45.4%)
20-30 years	119 (53.1%)	105 (46.9%)	162 (53.3%)	142 (46.7%)	703 (54.6%)	585 (45.4%)	877 (55.6%)	699 (44.4%)	1315 (50.5%)	1287 (49.5%)	1238 (48.2%)	1328 (51.8%)
30-40 years	1 (50%)	1 (50%)	3 (60%)	2 (40%)	21 (50%)	21 (50%)	17 (34%)	33 (66%)	44 (47.3%)	49 (52.7%)	43 (50%)	43 (50%)
Over 40	NA	NA	NA	NA	0 (0%)	1 (100%)	0 (0%)	1 (100%)	NA	NA	1 (50%)	1 (50%)
P value	.7356 [α]		.8168 [α]		.0253[α]		<.001* [α]		<.001*		<.001* [α]	
Contraceptive method type												
None used	523 (51.1%)	501 (84.9%)	438 (51%)	420 (49%)	2570 (56.2%)	2004 (43.8%)	2639 (56.8%)	2011 (43.2%)	3525 (54.4%)	2959 (45.6%)	3285 (52%)	3029 (48%)
Folkloric	6 (35.3%)	11 (64.7%)	4 (36.4%)	7 (63.6%)	37 (56.1%)	29 (43.9%)	27 (54%)	23 (46%)	39 (60.9%)	25 (39.1%)	13 (46.4%)	15 (53.6%)
Traditional	57 (47.9%)	62 (52.1%)	85 (53.1%)	75 (46.9%)	575 (52.4%)	522 (47.6%)	451 (54.5%)	376 (45.5%)	801 (53.4%)	698 (46.6%)	638 (48.7%)	672 (51.3%)
Modern	360 (50.9%)	347 (49.1%)	491 (59.4%)	336 (40.6%)	3115 (62.4%)	1879 (37.6%)	2947 (62%)	1804 (38%)	5110 (58.6%)	3606 (41.4%)	5124 (56.1%)	4010 (43.9%)
P value	.5605		.0036*		<.001*		<.001*		<.001*		<.001*	

[α]Expected cell count is below 5, which compromised the *P* value in the particular scale.

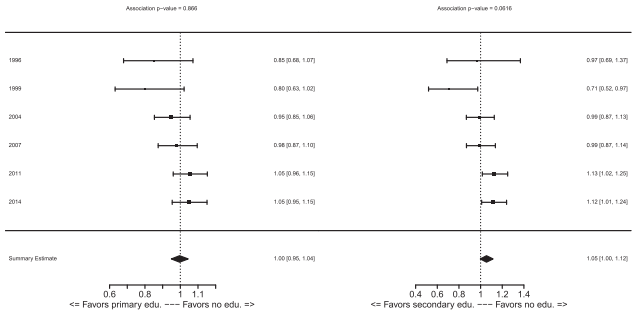
*Level of significance at 5%.



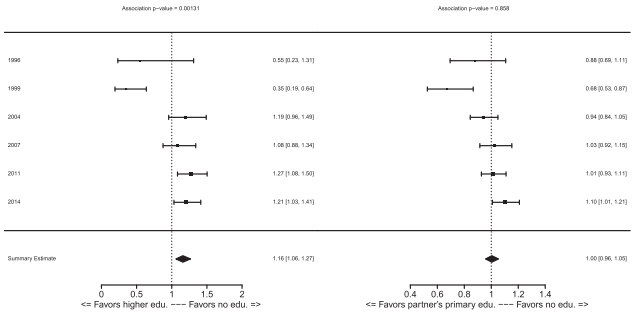
(A) Age of respondents and modern contraceptive use



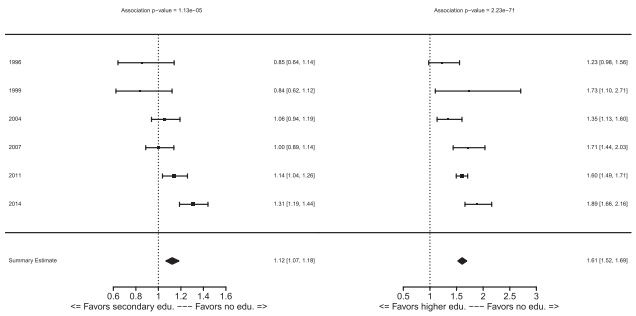
(B) Partner's age



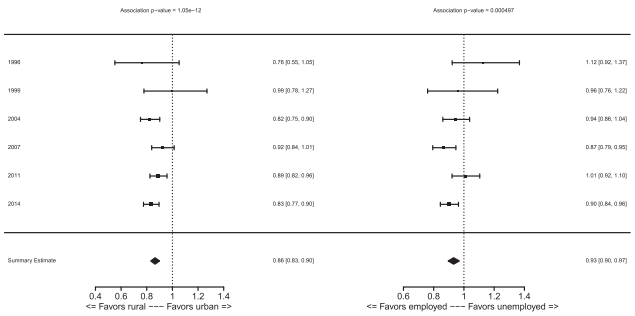
(C) Primary and secondary education of respondents



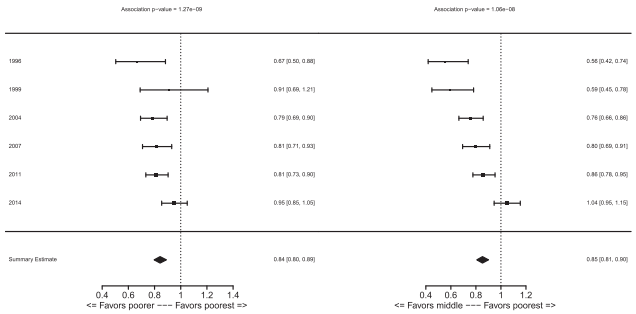
(D) Higher education of respondent and partner's primary education



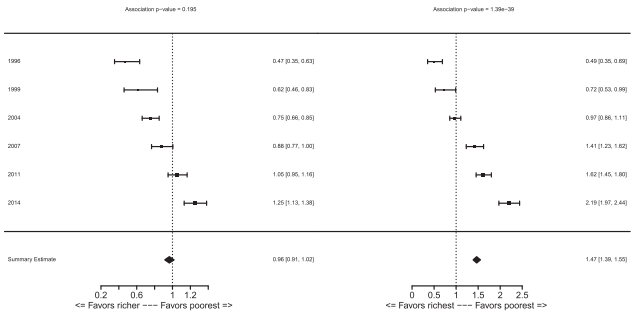
(E) Partner's secondary and higher education



(F) Residence and working status



(G) Poorer and middle in wealth index



(H) Richer and richest in wealth index

FIGURE 1 The odds and CI from binary regression fitted for BMI with the covariates, captioned in each figure. A, Age of respondents and modern contraceptive use. B, Partner's age. C, Primary and secondary education of respondents. D, Higher education of respondent and partner's primary education. E, Partner's secondary and higher education. F, Residence and working status. G, Poorer and middle in wealth index. H, Richer and richest in wealth index

women over 20 years has changed to positive odds ratios from negative ones. Educated women were more likely to be maintaining their weight levels before 2007 but then shifted in the opposite direction in later years (Figure 1C). This shift was more evident in higher educated women compared to the uneducated, displayed in Figure 1D. However, such a magnitude of change was not apparent in education

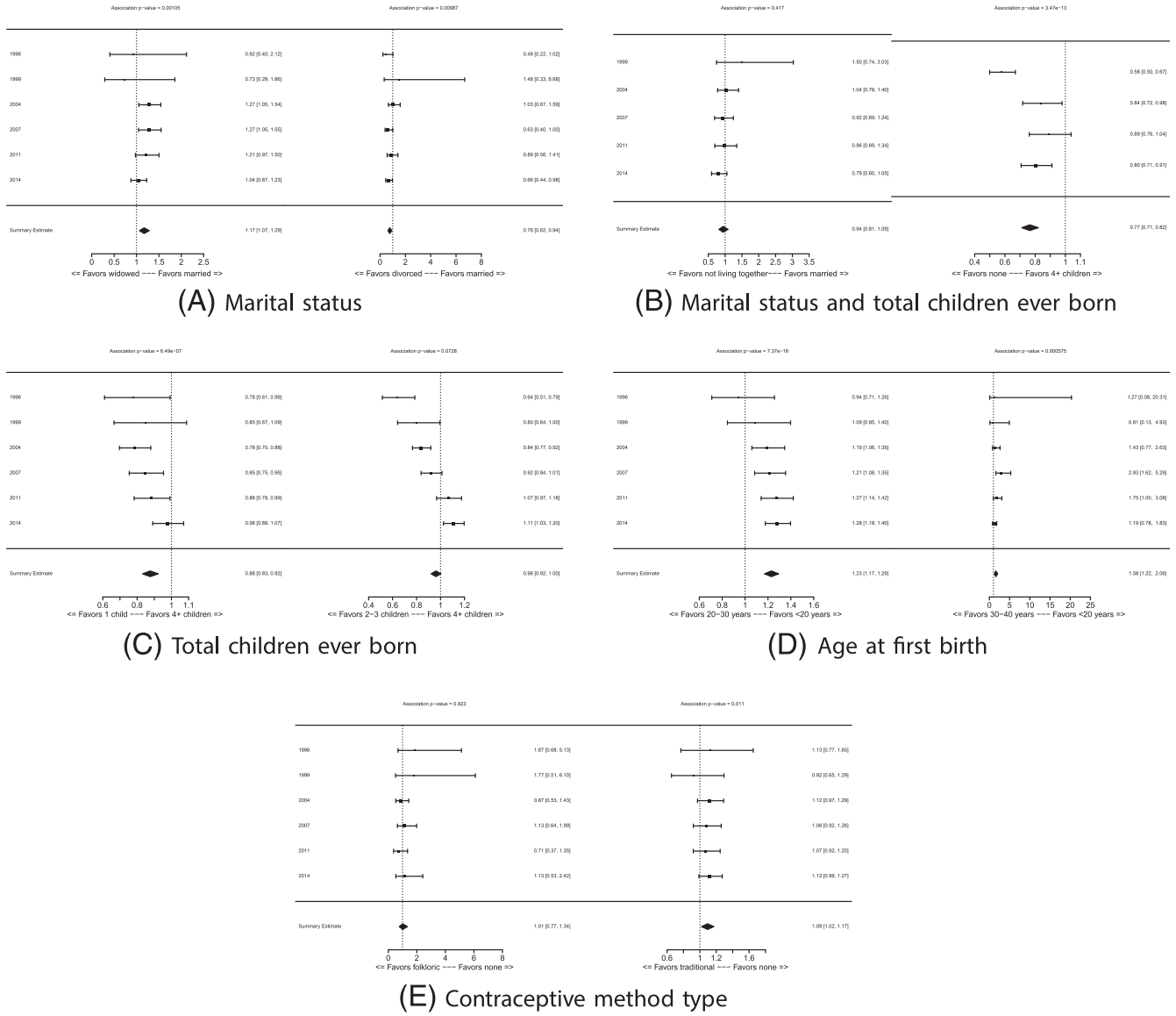


FIGURE 2 The odds and CI from binary regression fitted for BMI with the covariates, captioned in each figure. A, Marital status. B, Marital status and total children ever born. C, Total children ever born. D, Age at first birth. E, Contraceptive method type

of their partners (Figure 1D, E). Interestingly, the highest educated married woman has never been able to maintain a healthy BMI in Bangladesh. The conclusion therefore is that a woman's age and education is currently more important than that of their partner/husband in Bangladesh.

Odds of the residences of respondents showed consistency over the years. The forest plot never favoured urban residents (Figure 1F) meaning that a healthy BMI was more controlled in rural areas compared to urban areas in Bangladesh. Employment status, whether employed or not, showed inconsistent results with the odds ratios, moving around the equilibrium line indicating that work status did not have much effect in terms of maintaining a healthy BMI. However, the economic variation within society showed a clear trend for controlling weight (Figure 1G, H). The lower and middle wealth quantile remained under the odds 1 line over the years showing no change in the last 20 years; the richer quantiles, especially the richest section, displayed tremendous changes as wealthy respondents failed to maintain a healthy weight in current times as compared to a few years ago. The tendency for wealthy urban residents to become overweight and obese is running concurrently with economic growth in Bangladesh.

The survey only targeted ever-married women and so single respondents were not included. The odds ratios of those widowed, divorced, and living separately were compared in reference to married women (Figure 2A, B). After 2004, all the groups showed a decline in odds towards a healthy BMI. Women who were not living with their partners and were divorced were maintaining their weight more so than married women, whereas widows did not maintain a healthy weight. Unlike marital status, all the scales of total children ever born showed consistency and reached equilibrium (odds 1) from 1996 to 2014 (Figure 2B, C). Similar consistency was observed in the respondents' age at first birth. The group aged 20 to 30 years had near constant odds over the years compared to the group of mothers under the age of 20, showing that a healthy BMI was favouring women who gave birth under the age of 20. However, the group that became mothers at age 30 to 40 years showed equilibrium since 2004 (Figure 2D). The effects of modern, traditional, and folkloric

contraceptive methods on BMI were compared in reference to nonusers. The results showed 2 distinctive patterns: The respondents using modern methods had stronger control over their BMI and maintained their weight (Figure 1A), whereas the odds of traditional users remained slightly above the equilibrium (odds 1) line so favouring the nonusers (Figure 2E). The sample size of the folkloric method users was too small to be conclusive.

4 | DISCUSSION

The public health situation in Bangladesh has improved dramatically in recent years.[55-57] However, that success features more prominently in the areas of sanitation and nutrition. This paper engages with the problems that Bangladesh will soon face as its economic growth continues specifically with overweight citizens and obesity.[58-60] With the gradual urbanization and fast food availability in Bangladesh increasing, weight control needs to receive more of a focus.[61,62] We approached this problem by analysing trends in socioeconomic factors in 3 categories that affect BMI, using data from 6 nationwide surveys conducted over the last 20 years. The results are displayed in Figures 1 and 2.

Older people in Bangladesh are failing to control their weight with the odds ratios showing that younger people are better at maintaining their weight levels. A weight increase alongside age is a common phenomenon even for the most active individuals, but physical exercise is not very popular in Bangladesh, especially as part of a fitness regime which means that adults are getting caught in the trap of uncontrolled BMI.[63] Additionally, the effect of stress in BMI is stronger for women and is higher for older individuals compared to the young and younger adults.[64-66] Occupational sitting time is high for educated individuals who prefer desk jobs that in turn increase the risk of being overweight or obese.[67,68] These characteristics are considered to be problems in developed countries, and are emerging as trends in Bangladesh as well.[69,70] A woman in Bangladesh with a highly educated husband/partner did not maintain a healthy BMI. This could be an indication for the lack of a necessity to work and earn of women in rich families as well as the availability of domestic help, which release such women from manual labour also leading to weight gain.[71,72]

The gradual effect of place of residence and wealth index over BMI can be explained by a change in dietary habits. With greater economic capacity and urbanization, a change in food habits is observed, particularly overconsumption of junk food that is more accessible to wealthier members of the population residing in metropolitan areas.[73] Wealthy individuals have higher sitting times due to their occupations and the availability of such jobs in urban areas, making wealthy urban women fall victim to an unhealthy BMI.[74]

From the results, divorced or separated women looked to maintain better weight levels than married women. Lee et al[75] showed that divorced women are more physically active, and Schoenborn[76] also claimed that married adults have a higher prevalence of being overweight or obese. The odds ratio of the widowed compared to the married woman moved towards odds 1 in the latest survey. This suggests that married women are less concerned about their body weight compared to other marital influences. However, no change was found in the overall trend of the odds in the number of total children or a mother's age at childbirth. Contraceptive use showed an expected result where those using modern methods showed greater control of their BMI than traditional contraceptive users where the nonusers were the reference category. Current literature accentuates these points.[77] So young separated mothers and modern contraceptive users in Bangladesh tended to be fitter than their counterparts among ever-married women.

5 | CONCLUSIONS

In search of trends for socioeconomic factors influencing BMI in Bangladesh, this paper applied the BDHS from 1996 to 2014 and analysed the odds ratios of the available socioeconomic factors in order to aid understanding of their long-term relationship. The factors were categorized into 3 groups and were fitted with a binary regression model with BMI that was scaled into the healthy and the unhealthy. The big question to emerge from the findings in this study is, with the rate of its current economic growth, will Bangladesh have to start dealing with health problems more usually associated with the first world and is it ready to face such challenges?

Over the years, the age and education of women in Bangladesh have become potential factors that influence BMI, whereas their partner's/husband's characteristics showed that there was less of an impact. Growing urbanization and economic inequality are becoming more noteworthy as time progresses, and yet, the employment status of women did not show any effect on BMI. Marital status and contraceptive use showed an expected consequence on BMI. All the socioeconomic factors indicated that rapid urbanization coupled with wealth inequality and dietary changes is disrupting the weight control capacities of Bangladeshi women. A detailed data set of sitting time and specific calorie intake is required to assemble the rest of the pieces for addressing health policy changes in Bangladesh. Such data should then further indicate the shift of focus from malnutrition in rural areas to obesity in urban areas.

ETHICAL APPROVAL

This article does not contain any studies with human participants performed by any of the authors. The Bangladesh Demographic and Health Surveys were approved by ICF Macro Institutional Review Board and the National Research Ethics Committee of the Bangladesh Medical Research Council. A written consent about the survey was given by participants before interview. All identifications of the respondents were disidentified before publishing data. The secondary data sets analysed during the current study are freely available upon request from the DHS website at http://dhsprogram.com/data/available-datasets.com.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORS' CONTRIBUTIONS

RK Biswas conceptualized the study, compiled the data, synthesized the analysis plan, interpreted the outcomes, and drafted the manuscript. E Kabir aided the statistical analysis and helped to draft the manuscript. The manuscript was critically reviewed and edited by HTA Khan. All authors helped to write the manuscript and finalized the current version.

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