RESEARCH ARTICLE

Interaction between the place of residence and wealth on the risk of overweight and obesity in Bangladeshi women

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Abstract

Background

The prevalence of overweight and obesity in women has increased significantly over the last few decades in Bangladesh, a rapidly urbanising developing country. However, little is known regarding the association between the interaction of the place of residence and household wealth with overweight and obesity, particularly in women from developing countries.

Objective

The objective of this study is to find the association between the interaction of the place of residence and wealth with overweight and obesity among Bangladeshi women.

Methods

This study utilised data from the four Bangladesh Demographic Health Surveys conducted in 2004, 2007, 2011 and 2014 with a total of 54337 women aged 15–49 years. Multivariate logistic regression was used for the analyses.

Results

The prevalence of overweight and obesity among women aged 15–49 years in Bangladesh has considerably increased from 9.96% in 2004 to 24.43% in 2014. The interaction between wealth and place of residence has been found to be associated with obesity. Urban wealthy and richest women were 4.23 (OR: 4.23, 95% CI: 1.25–14.34) and 5.99 (OR: 5.99, 95% CI: 1.91–18.74) times more likely to be obese compared to their rural counterparts in the period

2004. Urban richest were 2.94 times (OR: 2.94, 95% CI: 1.20–7.24) more likely to be obese against their rural counterparts for the survey year 2014.

Conclusions

The place of residence is not associated with obesity, but its interaction with wealth is significant.

Introduction

Overweight and obesity continue to be serious public health concerns [1–3]. Globally, the prevalence of overweight and obesity is increasing rapidly, with about two billion overweight or obese people across the world in 2016. It has been estimated that 39% and 13% of the world's adult population (aged 18 years and above) were overweight and obese in 2016, respectively [4]. Overweight and obesity are considered as a leading risk factor for the global burden of obesity-related morbidity and mortality [5, 6], with an estimated 3.4 million global deaths in 2010 were attributed to overweight or obesity [7, 8]. Although increasing trends in overweight and obesity have been widely recognised in developed countries [9, 10], these are now concerns in many developing countries due to their high incidence rates and increasing mortality rates in the past two decades [1, 2]. Several studies reported that overweight and obesity are strongly linked to non-communicable diseases such as diabetes mellitus, hypertension, cardiovascular disorders, cancers and musculoskeletal disorders [7, 11], which are more common in women than men [12]. For instance, some forms of cancer such as breast cancer, ovarian cancer and uterine cancer, and adverse birth outcomes such as preterm birth, low birth weight and stillbirth have been found to be significantly associated with overweight and obese women [13, 14]. Bangladesh, a low-income and the most densely populated country in the world, has experienced alarming rates of overweight/obesity due to current demographic and nutritional transition, rapid urbanisation, and modifications in dietary and lifestyle patterns [3, 5, 8]. Recent studies have reported that the prevalence of overweight and obesity in Bangladesh has increased from 9% to 39% between 1999 and 2014 [3, 15]. Evidence also suggests that the burden of overweight/obesity is found to be significantly higher among women than men in Bangladesh [10, 12], with negative long term consequences more in women than men [16, 17]. For instance, a study reported that the prevalence of overweight and obesity among urban and rural women in Bangladesh had been increased by 17.5% and 10.4% in the years between 1999 and 2011 [17, 18]. Moreover, another recent study conducted by Kamal et al. [14] in 2015 found that the prevalence of overweight among married women in Bangladesh is 29.2%, which is alarming.

Worldwide, many studies have investigated the correlates of overweight and obesity among children and adults; however, little is known concerning women living in low-income countries [5, 17, 18]. The majority of previous studies conducted in developing countries, including Bangladesh, have focused on the prevalence of overweight and obesity in women, and tested to what extent a single socio-economic, reproductive or lifestyle factor influences women to be overweight or obese [1, 2, 5, 14]. At the same time, only a few studies have examined the effect of an interaction term between two socio-demographic factors on overweight and obesity in women. For example, a study involving multiple middle-income countries tested the obesogenic effect of the co-existence of education and household wealth in women [11]. Further, even though urbanisation and high socio-economic status are critical determinants of

overweight and obesity in adults [7, 18, 19], to the best of our knowledge, none have examined the effect of an interaction term between household wealth and the place of residence (urban/ rural) on overweight and obesity among women in low-income countries like Bangladesh [3, 12, 15]. This lack of examination highlights the importance of investigating the effect of various socio-economic risk factors, including the interaction term between the place of residence and household wealth on overweight and obesity among women in particular [11, 19].

This study investigates whether the interaction between the place of residence and household wealth is associated with overweight and obesity among Bangladeshi women using the nationally-representative sample from the Bangladesh Demographic and Health Survey (BDHS) datasets.

Materials and methods

Data source and sample selection

This study analysed publicly available data from the Demographic and Health Surveys of Bangladesh conducted in 2004, 2007, 2011 and 2014, which are nationally representative household-based cross-sectional surveys of non-institutional Bangladeshi people. These surveys are the source of the significant cradle of data reflecting the status of Bangladeshi women on many demographic and health issues, including obesity, collecting through standard model questionnaires using standardised measurement tools to ensure standardisation and comparability across time and geographic locations. These credential surveys were conducted under the supervision of the Ministry of Health and Family Welfare and the National Institute of Population Research (NIPORT), funded by the United States Agency for International Development.

This study excluded participants below 15 years of age, participants with missing values for measured height and weight, and women who were pregnant at the time of the survey. Observations with missing values for the confounding variables considered in this study were also excluded. After applying the exclusion criteria, the total study population from all the four periods of surveys was 54337 women aged 15–49 years. A two-stage stratified sample was used to select the subjects–at the first stage, enumeration areas were selected with a probability proportional to population size, and in the second stage, a systematic sampling technique was used to select households from the enumeration area to provide statistically reliable estimates of key demographic and health variables for the country. Additionally, sampling weight was applied to ensure the actual representation of the survey results at the national and domain levels. Details of the sampling methods are available from the final report of the surveys [20–23].

Measures

Outcome and exposure variables.   Body Mass Index (BMI) is the primary outcome variable of the study, which is calculated as weight in kilograms divided by height in squared metres. In this analysis, WHO suggested BMI classification for the world population was used for defining overweight (BMI 25.00–29.99 kg/m^2), and Obesity (BMI $\geq$30 kg/m^2). This study merged underweight (BMI<18.5 kg/m^2) and healthy weight (BMI 18.5 to <25 kg/m^2) to form a new category of BMI <25 kg/m^2.

In this study, explanatory variables were selected based on the existing literature on the socio-demographic and behavioural factors associated with obesity [8, 12, 15, 19, 24]. Age, education status or wealth index of the respondents relates to different levels of physiological and social status [12, 15, 17], while watching television indicates the sedentary behaviour of more sitting time [8]. Besides considering the literature, the significance of the chi-square tests between the primarily selected independent variables and the outcome variable (BMI category) from the bivariate analyses of BDHS data were considered to validate the rationale of choosing

these variables. These explanatory variables were: age (15–24, 25–34, 35–49), divisions (Barisal, Chittagong, Dhaka, Khulna, Rajshahi, Sylhet), place of residence (rural or urban), education status (no education, primary, secondary, Higher), marital status (married, widowed, divorced/not living together), parity (0, 1, 2, 3, > = 4), watching television (not at all, less than once a week, at least once a week), wealth index (poorest, poorer, middle, richer, richest), currently working (no, yes) and contraceptive use (not using, hormonal, non-hormonal and traditional methods).

Statistical analysis. Descriptive statistics on sampling characteristics and prevalence of overweight/obesity were computed for all the four survey years. Stata 14 software was used for all the statistical analyses. This study utilised stata survey commands (svy) to take into account the effects of clustering and unequal weights as appropriate when computing frequencies and confidence intervals. Rangpur division was formed in 2010 comprising of several districts of Rajshahi division. Hence, seven divisions were listed in BDHS 2011 and 2014. However, during the analyses, the authors merged this division with Rajshahi division and considered all the sampled observations in six divisions in all the four survey years. In BDHS surveys, the household wealth index was constructed from data on household assets, including ownership of durable goods (such as televisions and bicycles) and dwelling characteristics (such as source of drinking water, sanitation facilities, and construction materials), using principal component analysis [21].

To examine the central hypothesis of whether the place of residence modified the association between wealth and overweight/obesity, interaction terms between the place of residence and wealth index were fitted along with the main effects to measure the interaction effect for overweight and obesity in the logistic regression models for all the survey periods separately. However, during the analyses, the regression models were controlled with the relevant socio-demographic characteristics (educational status, watching television, current working status and use of contraceptive method) and all the results were reported with adjusted risk ratio (ARR) and 95% confidence interval. Before fitting the models, the potential collinearity of the predictor variables and the outcome variable were examined using the variance inflation factors.

As part of sensitivity analysis for the interaction effects of some other variables on overweight and obesity, this study investigated the interaction of both education and television viewing with the wealth index and with the place of residence separately. The analyses found no significant interaction effects on overweight or obesity in any of the surveys of the study sample for these variables. Hence, these interactions were not included in the final models.

Ethical review. The BDHS Data collection procedure was approved by the ICF Institutional Review Board (IRB) along with NIPORT, Mitra and Associates, the International Centre for Diarrhoeal Disease Research, Bangladesh, the Monitoring and Evaluation to Assess and Use the Results of Demographic and Health Surveys (MEASURE DHS) project funded by the United States Agency for International Development (USAID). All the DHS programs maintain strict standards to protect the privacy of respondents and household members, and the participation was voluntary, which was ensured by getting written consent from each participant.

Results

Socio-demographic characteristics and prevalence of obesity

The average age of women in the BDHS surveys across the years (2004, 20007, 2011 and 2014) was between 30.57 to 31.37 years (see Table 1). The cumulative prevalence of overweight and obesity, as shown in Table 1, was around 10% (overweight 7.44%, obese 2.52%) in 2004, while

Table 1. Frequency distribution of BMI and socio-demographic characteristics of women of reproductive age—BDHS 2004, 2007, 2011 and 2014.

Background Characteristics	2004		2007		2011		2014	
	n	%	n	%	n	%	n	%
Body-Mass Index								
Non-Overweight/Obese	9,385	90.04	8,727	87.02	13,387	81.59	12,546	75.57
Overweight	916	7.44	1,160	9.95	2,365	13.17	3,325	19.23
Obese	311	2.52	380	3.03	926	5.24	909	5.20
Age (n, mean)	10,612	30.57	10,267	30.96	16,678	31.23	16,780	31.37
Age Group								
15–24 years	3,340	31.80	3,039	30.30	4,670	28.74	4,476	27.05
25–34 years	3,570	33.73	3,381	33.01	5,738	34.18	6,017	36.40
35–49 years	3,702	34.47	3,847	36.69	6,270	37.08	6,287	36.56
Education Status								
No Education	4,223	42.63	3,380	34.96	4,478	28.47	4,089	25.73
Primary	3,103	29.01	3,051	29.63	4,977	30.00	4,914	29.18
Secondary	2,647	23.41	3,029	29.48	5,858	34.24	6,192	36.69
Higher	639	4.96	807	5.93	1,365	7.29	1,585	8.41
Residence Status								
Rural	6,979	77.40	6,364	77.29	10,821	73.71	10,952	71.56
Urban	3,633	22.60	3,903	22.71	5,857	26.29	5,828	28.44
Wealth by Residence Status								
Rural								
Poorest	1,592	23.32	1441	23.36	2,440	22.81	2,530	23.28
Poorer	1,546	23.00	1505	22.98	2,666	24.44	2,752	24.35
Middle	1,517	21.79	1465	22.44	2,578	23.95	2,626	23.47
Richer	1,510	21.24	1303	21.51	2,083	19.57	1,989	19.11
Richest	814	10.65	650	9.71	1,054	9.23	1,055	9.80
Urban								
Poorest	310	8.60	217	4.99	431	5.25	492	6.57
Poorer	365	9.75	345	7.27	404	5.42	387	5.40
Middle	457	12.51	465	10.29	619	8.99	783	11.36
Richer	604	16.84	768	18.59	1473	24.35	1569	26.35
Richest	1899	52.30	2108	58.86	2930	56.00	2597	50.31
Division								
Barisal	1,059	6.23	1,357	6.25	2,330	11.54	2,405	11.59
Chittagong	1,899	17.66	1,798	18.24	2,682	18.04	2,675	18.35
Dhaka	1,267	6.33	1,344	6.00	1,917	5.63	2,006	6.21
Khulna	1,593	12.25	1,612	12.80	2,525	12.27	2,470	10.46
Rajshahi	2,401	31.24	2,203	31.44	4,771	37.51	4,826	41.47
Sylhet	2,393	26.29	1,953	25.28	2,453	15.01	2,398	11.92
Marital Status								
Married	9,732	91.97	9,419	92.21	15,546	93.32	15,747	94.01
Widowed	494	4.64	466	4.36	644	3.69	623	3.71
Divorced/not living together	386	3.39	382	3.43	488	2.99	410	2.27
Parity								
0	1,035	9.44	955	8.91	1,426	8.67	1,412	8.04
1	2,070	19.02	2,183	21.29	3,627	21.53	3,910	23.33
2	2,570	24.15	2,640	25.72	4,813	28.60	5,020	30.10
3	2,002	19.52	1,958	19.85	3,351	20.28	3,306	20.07

(Continued)

Table 1. (Continued)

Background Characteristics	2004		2007		2011		2014	
	n	%	n	%	n	%	n	%
> = 4	2,935	27.87	2,531	24.24	3,461	20.92	3,132	18.45
Watching Television								
Not at all	4,602	45.45	4,566	46.24	6,355	39.24	6,611	40.19
Less than once a week	947	9.25	648	7.01	1,991	12.28	1,465	8.64
At least once a week	5,063	45.30	5,053	46.75	8,332	48.48	8,704	51.17
Currently Working								
No	8,190	76.82	7,174	67.18	14,386	86.47	11,338	65.89
Yes	2,422	23.18	3,093	32.82	2,292	13.53	5,442	34.11
Contraceptive Use								
Not using	4,498	41.92	4,646	44.28	6,442	38.96	6,313	37.32
Hormonal	3,826	37.04	3,611	36.84	6,660	40.20	6,990	41.91
Non-hormonal	1,134	10.37	1,135	10.63	2,018	11.71	2,137	12.34
Traditional	1,154	10.67	875	8.25	1,558	9.13	1,340	8.44

it rose to 24% in 2014 (overweight 19.23%, obese 5.20%). The trend in the prevalence revealed a two-fold increase of both overweight and obesity in women over the study period, 2004–2014. Over 90% of the sample were married, and around three-quarters were living in rural areas. The distribution of wealth by place of residence remained almost similar over time with a greater concentration of richer and richest women among the residents of urban areas. Under the wealth index, in a rural setting, around 1 in every 4 women was from a very poor household, and 1 in every 10 women was from a very rich household; while in the urban settings, around 1 in every 2 women was from the richest households.

Tables 2 and 3 show the changes over time in the prevalence of overweight and obesity by socio-demographic characterics in women. The prevalence of both overweight and obesity was significantly greater in all subgroups in the 2014 sample. If we consider the increases of both overweight and obesity, as shown in Fig 1, the larger absolute increases in prevalence over time occurred in those who were in the age group of 25 to 34 and 35 to 49 years, married, having 2/3 children, watching television at least once a week and using non-hormonal contraceptive methods. There was a notable small increase in those who were in the age group of 15 to 24 years, had no children, never watched television and used hormonal contraceptive methods (see Fig 1).

Fig 2 depicts the changes over time in the prevalence of overweight and obesity in each wealth group of urban and rural women over the four survey periods. In both urban and rural households, overweight and obesity prevalence is higher in richest families compared to poorest households, and over time it increases significantly, especially in urban households. Fig 3 shows the increasing overweight and obesity prevalence trends among the women of reproductive age over the years by place of residence and division.

Risk factors of overweight and obesity and interaction results

The adjusted associations between each of the socio-demographic characteristics and overweight or obesity, generated from the multinomial logistic regression models fitted to the overweight and obese category compared with BMI<25, are presented in Table 4. Overall, the risk factors of overweight and obesity differed among the survey years and also among the different sub-groups of socio-demographic characteristics. Increased age, higher education and higher

Table 2. Prevalence of overweight and obesity by household socio-demographic characteristics in women (BDHS: 2004 and 2007).

Background Characteristics	2004			2007		
	BMI <25	Overweight	Obese	BMI <25	Overweight	Obese
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Age Group (years)						
15–24	94.77 (93.94–95.50)	3.63 (3.06–4.31)	1.60 (1.21–2.11)	93.25 (92.22–94.16)	4.77 (4.01–5.67)	1.97 (1.50–2.59)
25–34	89.40 (88.20–90.49)	7.92 (7.06–8.88)	2.68 (2.12–3.38)	84.88 (83.19–86.44)	12.21 (10.92–13.64)	2.9 (2.30–3.66)
35–49	86.31 (84.47–87.95)	10.48 (9.17–11.96)	3.21 (2.57–4.00)	83.78 (82.02–85.41)	12.19 (10.80–13.73)	4.02 (3.43–4.72)
Education Status						
No Education	93.76 (92.89–94.52)	4.28 (3.67–4.98)	1.97 (1.55–2.49)	91.38 (90.24–92.40)	6.06 (5.21–7.03)	2.56 (2.00–3.28)
Primary	91.15 (89.87–92.28)	6.60 (5.64–7.71)	2.25 (1.72–2.94)	89.30 (87.8–90.63)	8.48 (7.25–9.90)	2.22 (1.73–2.84)
Secondary	85.87 (84.16–87.42)	10.91 (9.63–12.33)	3.23 (2.49–4.17)	83.52 (81.61–85.28)	12.67 (11.2–14.29)	3.81 (3.19–4.54)
Higher	71.34 (65.61–76.45)	23.19 (19.25–27.66)	5.47 (3.48–8.52)	67.25 (62.79–71.42)	26.73 (23.37–30.39)	6.01 (4.16–8.61)
Marital Status						
Married	90.02 (89.09–90.88)	7.55 (6.86–8.30)	2.43 (2.06–2.86)	86.92 (85.82–87.95)	10.14 (9.27–11.08)	2.94 (2.55–3.39)
Widowed	90.60 (87.36–93.07)	7.33 (5.28–10.10)	2.07 (1.16–3.66)	87.16 (82.89–90.49)	8.55 (6.07–11.93)	4.29 (2.71–6.71)
Divorced/not living together	89.75 (85.83–92.68)	4.66 (2.93–7.31)	5.59 (3.51–8.81)	89.40 (85.92–92.10)	6.68 (4.3–10.24)	3.93 (2.10–7.21)
Parity						
0	91.41 (88.97–93.34)	6.05 (4.48–8.13)	2.54 (1.69–3.81)	88.93 (86.52–90.95)	6.99 (5.54–8.80)	4.07 (2.86–5.76)
1	91.38 (89.82–92.72)	6.06 (5.01–7.30)	2.56 (1.86–3.52)	88.01 (86.12–89.68)	9.12 (7.73–10.74)	2.86 (2.13–3.84)
2	88.92 (87.33–90.33)	8.47 (7.36–9.72)	2.61 (1.95–3.49)	84.70 (82.97–86.29)	12.40 (11.00–13.93)	2.90 (2.26–3.73)
3	88.69 (86.71–90.41)	8.90 (7.44–10.62)	2.41 (1.75–3.31)	86.52 (84.59–88.24)	10.88 (9.22–12.81)	2.60 (2.00–3.37)
> = 4	90.58 (89.31–91.72)	6.94 (5.99–8.04)	2.47 (1.91–3.19)	88.30 (86.31–90.03)	8.41 (6.99–10.08)	3.29 (2.55–4.24)
Watching Television						
Not at all	94.66 (93.89–95.33)	3.22 (2.66–3.88)	2.12 (1.69–2.68)	92.05 (91.01–92.97)	5.74 (4.98–6.60)	2.21 (1.73–2.83)
Less than once a week	93.41 (91.58–94.87)	5.05 (3.74–6.80)	1.53 (0.90–2.60)	92.19 (89.34–94.32)	7.13 (5.08–9.92)	0.69 (0.27–1.75)
At least once a week	84.72 (83.23–86.10)	12.16 (11.09–13.33)	3.11 (2.54–3.81)	81.27 (79.78–82.67)	14.54 (13.39–15.78)	4.19 (3.57–4.92)
Currently Working						
No	89.40 (88.36–90.35)	7.89 (7.14–8.71)	2.71 (2.30–3.19)	85.46 (84.13–86.69)	11.19 (10.17–12.30)	3.36 (2.87–3.91)
Yes	92.18 (90.94–93.26)	5.94 (4.93–7.15)	1.88 (1.30–2.71)	90.21 (88.81–91.45)	7.42 (6.34–8.67)	2.37 (1.84–3.05)
Contraceptive Use						
Not using	90.68 (89.42–91.80)	6.50 (5.59–7.54)	2.82 (2.32–3.43)	87.71 (86.23–89.05)	8.58 (7.44–9.88)	3.71 (3.10–4.43)
Hormonal	91.67 (90.63–92.60)	6.70 (5.89–7.61)	1.63 (1.21–2.19)	88.79 (87.50–89.97)	9.37 (8.32–10.55)	1.83 (1.41–2.38)
Non-hormonal	84.62 (81.63–87.20)	11.57 (9.46–14.07)	3.82 (2.72–5.33)	80.91 (78.3–83.28)	14.29 (12.27–16.58)	4.79 (3.51–6.51)
Traditional	87.17 (84.89–89.15)	9.70 (8.00–11.73)	3.13 (2.13–4.56)	83.22 (79.9–86.08)	14.28 (11.60–17.46)	2.50 (1.62–3.83)

wealth were associated with higher overweight and obesity risks among the respondents of all four periods.

In 2004, the women in the 35–49 age group were 4.64 times and 3.35 times more likely to be overweight and obese, respectively compared with counterparts aged 15–24 years. In 2014, women of this older age group (35–49) were 2.82 times and 3.71 times more likely to be overweight and obese, respectively, compared to the young age (15–24) women. Thus, there was a consistent trend of women being more likely to be overweight and obese in all the four survey periods over the decades for the age groups of 25–34 years and 35–49 years, with higher odds for the latter age group (see Table 4). Further, the risk of overweight and obesity was increased for women with higher education, ranging from the odds of 1.33–1.98 for secondary education and 1.35–1.79 for higher education compared with no education for all the four survey periods.

Table 3. Prevalence of overweight and obesity by household socio-demographic characteristics in women (BDHS: 2011 and 2014).

Background Characteristics	2011			2014		
	BMI <25	Overweight	Obese	BMI <25	Overweight	Obese
Age Group (years)						
15–24	89.80 (88.73–90.77)	6.65 (5.89–7.51)	3.55 (2.98–4.22)	86.18 (84.68–87.55)	11.13 (9.92–12.47)	2.69 (2.17–3.33)
25–34	78.93 (77.37–80.41)	15.70 (14.38–17.12)	5.37 (4.66–6.18)	72.41 (70.35–74.37)	22.39 (20.76–24.11)	5.20 (4.49–6.03)
35–49	77.68 (76.11–79.17)	15.88 (14.74–17.09)	6.44 (5.69–7.27)	70.88 (68.81–72.87)	22.08 (20.54–23.70)	7.04 (6.11–8.10)
Education Status						
No Education	87.16 (85.90–88.32)	9.07 (8.11–10.13)	3.78 (3.16–4.51)	83.37 (81–85.49)	13.05 (11.24–15.10)	3.58 (2.92–4.40)
Primary	84.49 (83.08–85.79)	11.17 (10.04–12.42)	4.34 (3.73–5.05)	78.69 (77.11–80.18)	17.00 (15.74–18.33)	4.32 (3.66–5.09)
Secondary	78.41 (76.85–79.90)	15.59 (14.45–16.81)	5.99 (5.24–6.85)	71.40 (69.48–73.24)	22.55 (21.11–24.06)	6.05 (5.13–7.14)
Higher	62.82 (59.21–66.30)	26.01 (23.52–28.68)	11.16 (8.65–14.28)	59.16 (55.71–62.53)	31.42 (28.40–34.60)	9.42 (7.96–11.11)
Marital Status						
Married	81.54 (80.48–82.56)	13.26 (12.44–14.12)	5.20 (4.72–5.74)	75.21 (73.64–76.73)	19.60 (18.45–20.80)	5.19 (4.61–5.84)
Widowed	81.68 (77.66–85.12)	12.50 (9.70–15.96)	5.82 (3.98–8.42)	79.52 (74.82–83.54)	15.23 (12.00–19.14)	5.24 (3.43–7.95)
Divorced/not living together	82.95 (77.89–87.04)	11.29 (8.20–15.35)	5.76 (3.61–9.06)	83.96 (79.45–87.64)	10.61 (7.52–14.78)	5.43 (3.31–8.77)
Parity						
0	84.14 (81.73–86.28)	10.13 (8.49–12.05)	5.73 (4.45–7.36)	81.37 (78.73–83.75)	13.34 (11.32–15.65)	5.29 (3.92–7.11)
1	83.63 (81.99–85.14)	11.48 (10.28–12.81)	4.89 (4.01–5.94)	79.32 (77.04–81.43)	16.59 (14.79–18.56)	4.09 (3.43–4.86)
2	78.37 (76.84–79.82)	15.98 (14.66–17.38)	5.66 (4.87–6.56)	70.91 (68.82–72.91)	22.98 (21.37–24.67)	6.11 (5.22–7.15)
3	79.92 (78.18–81.54)	14.73 (13.28–16.31)	5.35 (4.57–6.26)	73.69 (70.79–76.39)	20.59 (18.39–22.98)	5.72 (4.74–6.88)
> = 4	84.46 (82.8–85.98)	10.81 (9.58–12.18)	4.74 (4.02–5.57)	77.97 (76.00–79.83)	17.54 (15.93–19.28)	4.49 (3.67–5.47)
Watching Television						
Not at all	89.96 (88.94–90.89)	7.09 (6.32–7.95)	2.95 (2.48–3.50)	85.72 (84.24–87.08)	11.72 (10.54–13.00)	2.56 (2.05–3.20)
Less than once a week	85.76 (83.86–87.46)	10.09 (8.67–11.71)	4.15 (3.28–5.24)	80.54 (78.18–82.70)	16.01 (13.96–18.29)	3.45 (2.54–4.67)
At least once a week	73.76 (72.18–75.27)	18.87 (17.70–20.10)	7.38 (6.53–8.32)	66.77 (64.94–68.54)	25.68 (24.33–27.07)	7.56 (6.71–8.50)
Currently Working						
No	81.88 (80.74–82.95)	13.01 (12.16–13.90)	5.12 (4.60–5.69)	73.58 (71.77–75.31)	20.33 (19.07–21.65)	6.09 (5.35–6.94)
Yes	79.75 (77.64–81.72)	14.20 (12.57–16.00)	6.05 (4.92–7.41)	79.43 (77.64–81.11)	17.11 (15.62–18.71)	3.46 (2.86–4.18)
Contraceptive Use						
Not using	81.35 (79.87–82.75)	12.86 (11.77–14.04)	5.79 (5.08–6.58)	75.62 (73.62–77.52)	18.54 (16.99–20.20)	5.83 (5.11–6.65)
Hormonal	84.01 (82.77–85.17)	12.13 (11.10–13.25)	3.86 (3.36–4.42)	78.98 (77.54–80.35)	17.47 (16.33–18.68)	3.55 (2.97–4.25)
Non-hormonal	75.20 (72.60–77.63)	17.52 (15.68–19.54)	7.27 (5.97–8.84)	68.11 (64.82–71.23)	24.72 (22.18–27.44)	7.17 (5.82–8.80)
Traditional	80.15 (77.43–82.62)	13.44 (11.43–15.75)	6.4 (5.09–8.03)	69.36 (64.45–73.87)	22.99 (19.56–26.81)	7.65 (5.83–9.98)

In terms of wealth index, the richest women had 4.11 and 4.13 higher odds of being overweight compared with women in the poorest wealth index group in 2004 and 2014 respectively. Though there were fluctuations in the magnitude of odds of being obese for both richer and richest women, there were consistent trends in the odds of being overweight for the women of these wealth groups in all four time periods. The poorer women were not significantly associated with the risk of being overweight or obese.

Marital status was not significantly associated with overweight or obesity for the years 2004, 2007 and 2011. In 2014, widowed or divorced women were considerably less likely to be overweight or obese compared with married women. Further, residence status was not significantly associated with overweight or obesity across all survey years. Watching television at least once a week was a risk factor in selected BDHS surveys for overweight (with the odds of 2.01,1.43, and 1.32 for 2004, 2011 and 2014 respectively) and obesity (with the odds of 1.46 and 1.43 for 2011 and 20014 respectively), compared with the women who did not watch television at all.
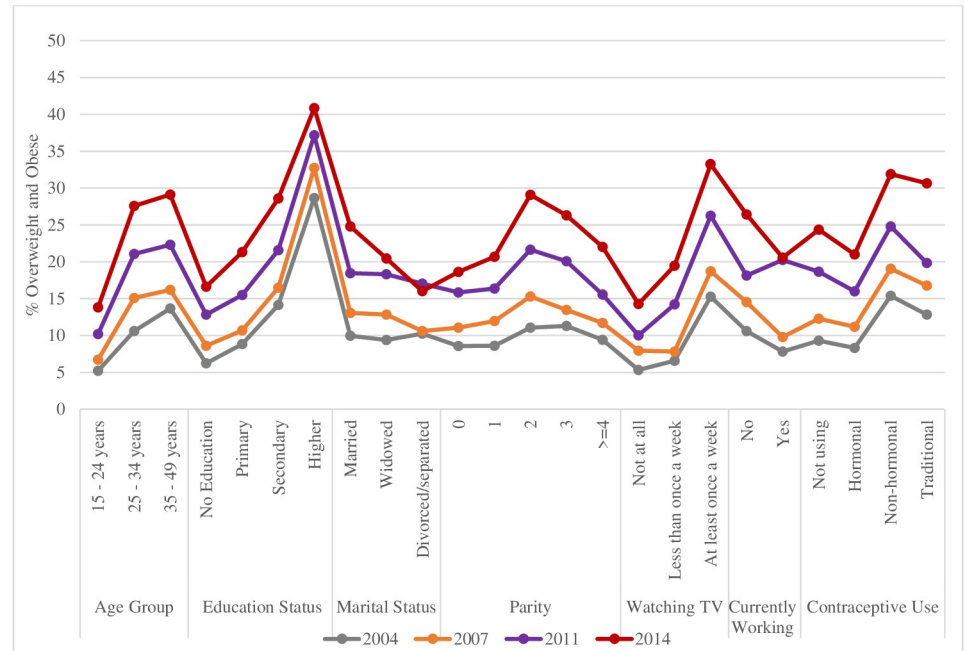
Fig 1. Prevalence of sum of overweight and obese women aged 15–49 years over the survey periods by socio-demographic characteristics–BDHS 2004, 2007, 2011, 2014.

https://doi.org/10.1371/journal.pone.0243349.g001

Working women were less likely to be overweight and obese in all three survey time points, except for the 2011 survey year which did not show any association in this regard.

The interaction between the place of residence and wealth index showed that the place of residence modified the association between wealth and obesity significantly, but not
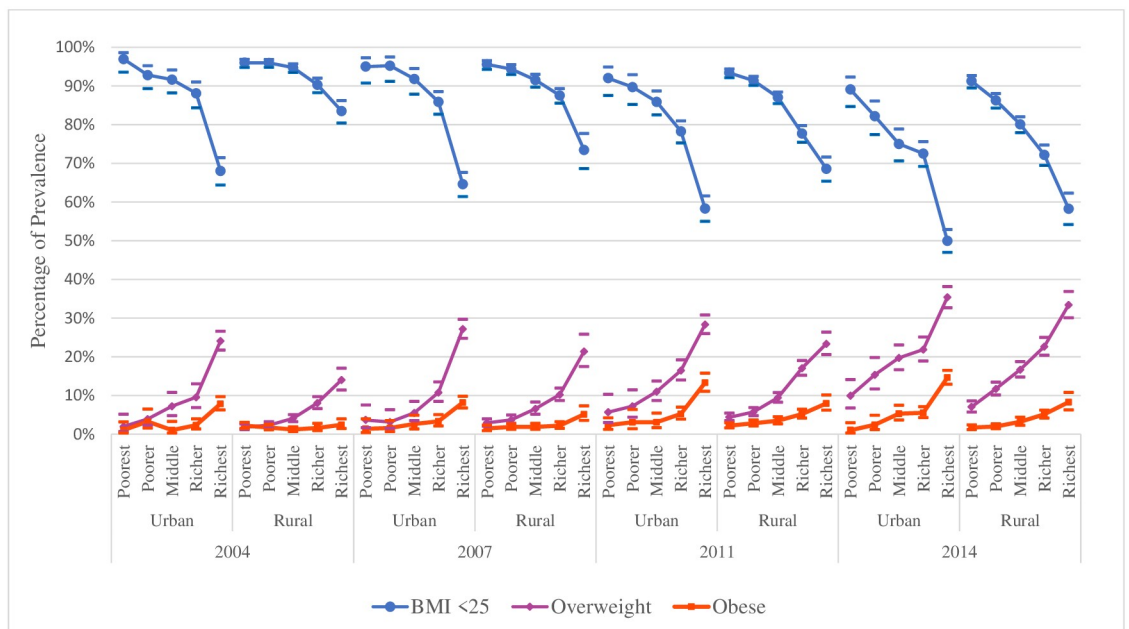
Fig 2. BMI status of women aged 15–49 years over the survey periods by type of residence and wealth index—BDHS 2004, 2007, 2011 and 2014.

https://doi.org/10.1371/journal.pone.0243349.g002
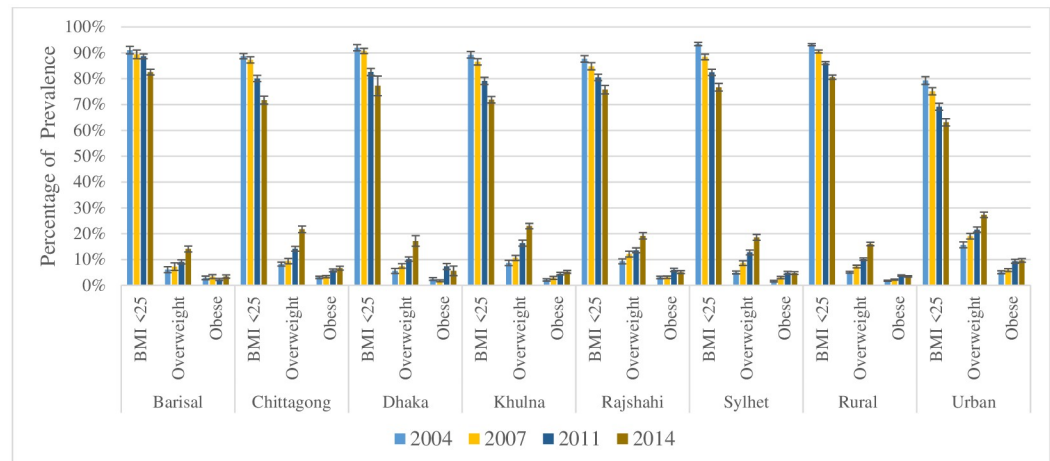
Fig 3. BMI status of women aged 15–49 years over the survey periods by division or place of residence—BDHS 2004, 2007, 2011, 2014.

https://doi.org/10.1371/journal.pone.0243349.g003

overweight. The study result revealed that the urban richer and richest women were respectively 4.23 and 5.99 times more likely to be obese in 2004. In comparison, the study observed a reduced magnitude of odds ratio in 2014 where urban middle income and richest women were respectively 3.00 times and 2.94 times more likely to be obese, compared to their counterparts in rural areas.

Discussion

The present study articulates that the prevalence of overweight and obesity among women aged 15–49 years has considerably increased from 9.96% in 2004 to 24.43% in 2014. Using multinomial logistic regression, this study found a significant multiplicative interaction between wealth and place of residence with an increased risk of obesity in 2004 and 2014 BDHS surveys. Moreover, the present study found that higher wealth, higher education, older age and increased television viewing were positively associated and the working status of women was negatively associated with overweight and obesity in women in all survey periods.

This study further revealed that the place of residence appeared to be a risk factor of obesity among women belonging to the richest wealth quantile. Women living in urban settings, moving up to the richest wealth quantile were associated with higher odds of being obese in the 2004 and 2014 BDHS survey periods. However, the place of residence alone was not associated with the increased risk of overweight or obesity among women.

Previous studies separately identified wealth and place of living as risk factors of obesity among women. There is limited literature to compare the interaction results as no study investigated the association between wealth and place of living with the risk of obesity. However, prior studies on Bangladeshi women confirmed that the odds of being obese are higher among women from the richest households living in urban settings (3, 6). One possible explanation might be that wealthier people in urban settings lead a sedentary lifestyle, do less physical activities, and engage in less labour-intensive occupations along with the consumption of energy-dense foods (18), compared with their rural counterparts. Another possible explanation is that wealth gives more access to food and escape from physical labour (17), and rapid urbanisation contributes to overweight and obesity by providing more access to technologies that require less energy, together with the availability of high-calorie foods, and limited space for physical activities.

Table 4. Multinomial logistic regression models for the association of overweight and obesity with socio-demographic characteristics and the interaction of the place of residence and wealth of women at four-time points (BDHS Surveys: 2004, 2007, 2011 and 2014).

Sociodemographic factors	2004		2007		2011		2014	
	Overweight	Obese	Overweight	Obese	Overweight	Obese	Overweight	Obese
	RRR (95% CI), *p*-value	RRR (95% CI), *p*-value	RRR (95% CI), *p-value*	RRR (95% CI), *p*-value	RRR (95% CI), *p*-value	RRR (95% CI), *p*-value	RRR (95% CI), *p*-value	RRR (95% CI), *p*-value
Age group								
15–24 (Ref.)								
25–34	**2.83 (2.22–3.60), <0.001**	**2.24 (1.55–3.25), <0.001**	**3.44 (2.76–4.30), <0.001**	**2.55 (1.80–3.62), <0.001**	**2.59 (2.22–3.02), <0.001**	**1.87 (1.50–2.34), <0.001**	**2.39 (2.09–2.72), <0.001**	**2.57 (2.02–3.27), <0.001**
35–49	**4.64 (3.55–6.06), <0.001**	**3.35 (2.23–5.02), <0.001**	**4.42 (3.45–5.65), <0.001**	**3.53 (2.41–5.17), <0.001**	**3.29 (2.77–3.91), <0.001**	**2.63 (2.06–3.37), <0.001**	**2.82 (2.42–3.27), <0.001**	**3.71 (2.85–4.84), <0.001**
Education Level								
No education (Ref.)								
Primary	**1.36 (1.10–1.68), 0.005**	**1.54 (1.11–2.15), 0.011**	**1.40 (1.14–1.71), 0.001**	1.10 (0.80–1.53), 0.549	1.14 (0.99–1.32), 0.065	1.13 (0.91–1.40), 0.262	**1.25 (1.10–1.41), <0.001**	1.21 (0.97–1.51), 0.092
Secondary	**1.98 (1.59–2.46), <0.001**	**2.41 (1.68–3.45), <0.001**	**1.89 (1.53–2.32), <0.001**	**1.87 (1.35–2.59), <0.001**	**1.36 (1.17–1.57), <0.001**	**1.41 (1.13–1.76), 0.003**	**1.50 (1.32–1.71), <0.001**	**1.33 (1.06–1.67), 0.014**
Higher	**2.71 (2.03–3.61), <0.001**	**2.79 (1.73–4.52), <0.001**	**2.50 (1.93–3.25), <0.001**	**1.74 (1.14–2.65), 0.010**	**1.52 (1.25–1.85), <0.001**	**1.78 (1.35–2.36), <0.001**	**1.63 (1.37–1.94), <0.001**	**1.35 (1.01–1.80), 0.042**
Residence								
Rural (Ref.)								
urban	0.99 (0.40–2.42), 0.979	0.56 (0.20–1.60), 0.281	1.35 (0.62–2.94), 0.448	0.92 (0.27–3.12), 0.897	0.90 (0.55–1.49), 0.696	1.16 (0.61–2.19), 0.651	**1.39 (1.00–1.91), 0.047**	0.70 (0.30–1.66), 0.417
Wealth Index								
Poorest (Ref.)								
poorer	0.97 (0.57–1.64), 0.911	0.68 (0.41–1.13), 0.133	1.29 (0.85–1.95), 0.227	1.15 (0.66–2.02), 0.621	1.18 (0.92–1.53), 0.193	1.28 (0.90–1.80), 0.165	**1.33 (1.10–1.61), 0.004**	1.21 (0.81–1.79), 0.356
middle	**1.67 (1.04–2.67), 0.032**	**0.41 (0.23–0.73), 0.003**	**2.00 (1.36–2.94), <0.001**	0.94 (0.53–1.68), 0.836	**1.82 (1.43–2.31), <0.001**	1.25 (0.88–1.77), 0.214	**1.72 (1.42–2.08), <0.001**	1.38 (0.93–2.06), 0.109
richer	**2.61 (1.68–4.06), <0.001**	**0.45 (0.26–0.79), 0.005**	**2.70 (1.84–3.96), <0.001**	1.12 (0.63–1.99), 0.708	**3.02 (2.37–3.84), <0.001**	**1.87 (1.31–2.67), 0.001**	**2.64 (2.16–3.23), <0.001**	**2.72 (1.83–4.03), <0.001**
richest	**4.11 (2.59–6.52), <0.001**	0.83 (0.46–1.48), 0.523	**5.60 (3.75–8.36), <0.001**	**2.29 (1.27–4.15), 0.006**	**4.29 (3.28–5.60), <0.001**	**2.93 (1.99–4.32), <0.001**	**4.13 (3.30–5.18), <0.001**	**4.44 (2.90–6.80), <0.001**
Division								
Dhaka (Ref.)								
Chittagong	1.25 (0.94–1.66), 0.131	1.07 (0.70–1.63), 0.770	1.06 (0.82–1.37), 0.661	1.37 (0.89–2.11), 0.150	1.05 (0.87–1.26), 0.635	**0.70 (0.55–0.90), 0.005**	1.15 (0.98–1.35), 0.084	1.24 (0.94–1.64), 0.131
Rajshahi	1.32 (1.01–1.74), 0.046	1.06 (0.70–1.59), 0.790	1.10 (0.86–1.41), 0.432	1.06 (0.69–1.62), 0.805	0.83 (0.70–0.99), 0.036	**0.58 (0.46–0.72), <0.001**	0.88 (0.76–1.02), 0.095	0.87 (0.67–1.13), 0.302
Khulna	1.23 (0.92–1.65), 0.159	0.92 (0.59–1.45), 0.722	1.14 (0.88–1.47), 0.324	1.24 (0.79–1.94), 0.351	1.23 (1.02–1.48), 0.026	**0.59 (0.46–0.76), <0.001**	1.27 (1.08–1.49), 0.004	1.25 (0.94–1.66), 0.132
Sylhet	1.02 (0.76–1.36), 0.919	0.65 (0.41–1.03), 0.069	1.15 (0.89–1.48), 0.290	1.51 (0.99–2.31), 0.056	1.07 (0.89–1.30), 0.466	**0.64 (0.49–0.82), 0.001**	1.13 (0.96–1.33), 0.154	1.23 (0.92–1.64), 0.163
Barisal	1.09 (0.78–1.54), 0.617	1.16 (0.72–1.88), 0.537	0.79 (0.59–1.06), 0.118	1.28 (0.81–2.02), 0.284	0.90 (0.74–1.10), 0.310	**0.38 (0.28–0.52), <0.001**	0.94 (0.79–1.12), 0.495	0.99 (0.73–1.35), 0.949
Marital Status								
Married (Ref.)								
Widowed	1.01 (0.70–1.46), 0.945	0.85 (0.48–1.50), 0.580	0.88 (0.62–1.26), 0.491	1.42 (0.92–2.19), 0.115	0.91 (0.71–1.17), 0.447	1.00 (0.70–1.42), 0.998	**0.72 (0.57–0.91), 0.006**	0.78 (0.54–1.12), 0.181
Divorced/not living together	0.78 (0.48–1.29), 0.339	1.66 (0.95–2.88), 0.074	0.73 (0.47–1.12), 0.153	0.94 (0.53–1.65), 0.822	0.73 (0.52–1.01), 0.058	1.05 (0.69–1.59), 0.820	**0.51 (0.36–0.72), <0.001**	0.96 (0.61–1.52), 0.869
Parity								
0 (Ref.)								

(Continued)

Table 4. (Continued)

Sociodemographic factors	2004		2007		2011		2014	
	Overweight	Obese	Overweight	Obese	Overweight	Obese	Overweight	Obese
	RRR (95% CI), *p*-value	RRR (95% CI), *p*-value	RRR (95% CI), *p-value*	RRR (95% CI), *p*-value	RRR (95% CI), *p*-value	RRR (95% CI), *p*-value	RRR (95% CI), *p*-value	RRR (95% CI), *p*-value
1	1.04 (0.75–1.43), 0.831	1.33 (0.82–2.17), 0.246	0.92 (0.69–1.23), 0.583	0.68 (0.45–1.01), 0.055	1.03 (0.83–1.27), 0.798	0.89 (0.67–1.18), 0.413	**1.23 (1.02–1.48), 0.030**	1.00 (0.74–1.36), 0.996
2	1.07 (0.77–1.48), 0.677	1.24 (0.75–2.04), 0.400	0.99 (0.74–1.33), 0.947	**0.64 (0.42–0.97), 0.037**	1.11 (0.89–1.37), 0.357	0.91 (0.68–1.22), 0.528	**1.43 (1.17–1.73), <0.001**	1.11 (0.81–1.53), 0.507
3	1.07 (0.76–1.53), 0.692	1.18 (0.68–2.03), 0.557	0.85 (0.62–1.17), 0.320	**0.54 (0.34–0.85), 0.008**	1.01 (0.80–1.27), 0.963	0.83 (0.60–1.15), 0.258	**1.32 (1.07–1.63), 0.010**	1.08 (0.76–1.52), 0.673
> = 4	0.93 (0.65–1.33), 0.689	1.10 (0.64–1.91), 0.726	0.75 (0.54–1.04), 0.082	**0.60 (0.38–0.95), 0.031**	0.89 (0.70–1.14), 0.353	0.85 (0.61–1.19), 0.343	**1.21 (0.97–1.51), 0.095**	0.88 (0.61–1.27), 0.493
Watching Television								
Not at all (Ref.)								
Less than once a week	**1.42 (1.02–1.97), 0.040**	0.70 (0.41–1.20), 0.194	0.85 (0.60–1.20), 0.356	**0.47 (0.23–0.98), 0.044**	**1.20 (1.00–1.43), 0.050**	1.25 (0.95–1.63), 0.108	1.13 (0.96–1.34), 0.132	1.05 (0.76–1.45), 0.760
At least once a week	**2.01 (1.62–2.49), <0.001**	0.90 (0.66–1.24), 0.528	1.15 (0.96–1.37), 0.130	1.30 (0.97–1.74), 0.080	**1.43 (1.25–1.64), <0.001**	**1.46 (1.18–1.80), <0.001**	**1.32 (1.18–1.48), <0.001**	**1.43 (1.15–1.78), 0.001**
Currently Working								
No (Ref.)								
Yes	**0.80 (0.66–0.97), 0.023**	**0.64 (0.46–0.88), 0.006**	**0.67 (0.57–0.79), <0.001**	**0.67 (0.51–0.87), 0.003**	0.99 (0.86–1.14), 0.909	0.99 (0.81–1.21), 0.937	**0.89 (0.82–0.98), 0.013**	**0.63 (0.53–0.74), <0.001**
Contraceptive use								
Not using (Ref.)								
Hormonal	0.92 (0.76–1.11), 0.377	**0.53 (0.39–0.73), <0.001**	1.00 (0.85–1.19), 0.984	**0.59 (0.44–0.79), <0.001**	0.93 (0.83–1.05), 0.243	**0.76 (0.63–0.90), 0.002**	0.91 (0.82–1.01), 0.068	**0.64 (0.53–0.77), <0.001**
Non-hormonal	0.94 (0.74–1.19), 0.588	0.97 (0.68–1.37), 0.853	1.06 (0.86–1.31), 0.596	1.14 (0.83–1.55), 0.421	1.15 (1.00–1.34), 0.057	1.12 (0.91–1.39), 0.294	1.01 (0.89–1.15), 0.872	0.93 (0.75–1.15), 0.499
Traditional	1.21 (0.96–1.54), 0.109	0.88 (0.60–1.29), 0.523	1.12 (0.88–1.41), 0.359	0.76 (0.50–1.14), 0.179	0.88 (0.74–1.05), 0.156	1.02 (0.80–1.29), 0.874	1.12 (0.96–1.31), 0.139	1.17 (0.92–1.49), 0.199
Interaction of Place of Residence and Wealth Index								
urban#poorer	2.06 (0.69–6.12), 0.194	3.15 (0.88–11.33), 0.078	0.71 (0.26–1.94), 0.503	1.01 (0.22–4.58), 0.989	1.40 (0.73–2.66), 0.310	0.57 (0.22–1.47), 0.246	1.02 (0.66–1.59), 0.921	2.02 (0.69–5.88), 0.199
urban#middle	1.58 (0.58–4.33), 0.371	1.55 (0.34–7.04), 0.567	0.71 (0.29–1.73), 0.448	1.70 (0.42–6.92), 0.460	1.42 (0.80–2.51), 0.234	0.88 (0.39–1.96), 0.753	1.08 (0.73–1.58), 0.709	**3.00 (1.16–7.74), 0.023**
urban#richer	1.07 (0.41–2.81), 0.883	**4.23 (1.25–14.34), 0.021**	0.88 (0.38–2.03), 0.774	1.64 (0.43–6.22), 0.465	1.22 (0.71–2.07), 0.471	0.89 (0.44–1.79), 0.735	0.77 (0.54–1.11), 0.157	1.65 (0.66–4.09), 0.283
urban#richest	1.82 (0.72–4.60), 0.206	**5.99 (1.91–18.74), 0.002**	1.09 (0.48–2.44), 0.841	2.27 (0.63–8.15), 0.209	1.69 (1.00–2.88), 0.052	1.44 (0.73–2.87), 0.293	0.97 (0.68–1.39), 0.866	**2.94 (1.20–7.24), 0.019**

This study revealed that the obesity level increased in women who were in the richest quantile compared with women from the poorest wealth quantile in all the survey periods. The findings of the study concerning the wealth-obesity relationship are consistent with prior studies (6, 12). One possible explanation for the richest women having higher rates of obesity than the poorest women is changing in dietary behaviour with the changes in income. There is evidence that consumption of higher energy and fat, and processed food increases with higher income (17).

An earlier study showed that a higher level of education is a protective factor of obesity among women (16). The association between wealth and obesity is not inevitable and can be changed through investment in education (16). Taking it into consideration, this study suggests that initiatives should be undertaken to develop socio-culturally appropriate

guidelines to maintain a healthy weight and implement interventions for those who are already obese.

The present study has several notable strengths that should be mentioned. The main strength of the present study is the large sample size and its representativeness of the general population. This study utilised four large and nationally representative surveys that extensively cover both rural and urban settings in Bangladesh. One strength of the present study is that unlike previous studies in Bangladesh, this is the first study that has attempted to identify the association between wealth, place of living and their interaction with obesity. Another strength of this study is that BMI is the focus of the present study, and data on BMI were collected by trained interviewers following the internationally recommended standard protocols. The use of trained interviewers helps to capture the BMI of the study participants accurately, and thus this study has avoided self-reported bias.

Conclusion

Overweight and obesity among women at reproductive age is a growing public health concern in Bangladesh. This study offered insights that urban wealthier women of reproductive age are more prone to be obese. However, the underlying reasons for the greater risk of urban wealthier women to be obese require further investigation. The present study has some limitations: first, the present study is unable to draw directional causal inferences as it is based on a cross-sectional design. Additionally, this study cannot incorporate some critical risk factors of obesity, such as respondents' dietary habits, physical activity, sedentary behaviour, and comorbid conditions, due to their unavailability in BDHS data sets. Future studies may recheck the association following prospective longitudinal research design where individuals will have been tracked and thus can capture the within-person change in BMI. Finally, we suggest that policymakers should undertake intervention programs targeting urban wealthier women who are more prone to be obese.

Acknowledgments

Author Contributions

Conceptualization: Kabir Ahmad.

Data curation: Kabir Ahmad.

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References

1. Masood M, Reidpath DD. Effect of national wealth on BMI: an analysis of 206,266 individuals in 70 low-, middle-and high-income countries. PloS one. 2017; 12(6). https://doi.org/10.1371/journal.pone.0178928 PMID: 28662041

2. Conklin A, Ponce NA, Frank J, Nandi A, Heymann J. Minimum wage and overweight and obesity in adult women: a multilevel analysis of low and middle income countries. PloS one. 2016; 11(3). https://doi.org/10.1371/journal.pone.0150736 PMID: 26963247

3. Chowdhury MAB, Adnan MM, Hassan MZ. Trends, prevalence and risk factors of overweight and obesity among women of reproductive age in Bangladesh: a pooled analysis of five national cross-sectional surveys. BMJ open. 2018; 8(7):e018468. https://doi.org/10.1136/bmjopen-2017-018468 PMID: 30030307

4. World Health Organization. Obesity and overweight 2020 [cited 2020 24 February]. https://www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight.

5. Biswas T, Garnett SP, Pervin S, Rawal LB. The prevalence of underweight, overweight and obesity in Bangladeshi adults: Data from a national survey. PloS one. 2017; 12(5). https://doi.org/10.1371/journal.pone.0177395 PMID: 28510585

6. Swinburn BA, Sacks G, Hall KD, McPherson K, Finegood DT, Moodie ML, et al. The global obesity pandemic: shaped by global drivers and local environments. The Lancet. 2011; 378(9793):804–14. https://doi.org/10.1016/S0140-6736(11)60813-1 PMID: 21872749

7. Madise NJ, Letamo G. Complex association between rural/urban residence, household wealth and women's overweight: evidence from 30 cross-sectional national household surveys in Africa. BMC obesity. 2017; 4(1):5. https://doi.org/10.1186/s40608-016-0141-1 PMID: 28127440

8. Ghose B. Frequency of TV viewing and prevalence of overweight and obesity among adult women in Bangladesh: a cross-sectional study. BMJ Open. 2017; 7(1):e014399. https://doi.org/10.1136/bmjopen-2016-014399 PMID: 28143839

9. Dinsa GD, Goryakin Y, Fumagalli E, Suhrcke M. Obesity and socio-economic status in developing countries: a systematic review. Obesity reviews. 2012; 13(11):1067–79. https://doi.org/10.1111/j.1467-789X.2012.01017.x PMID: 22764734

10. Sarma H, Saquib N, Hasan MM, Saquib J, Rahman AS, Khan JR, et al. Determinants of overweight or obesity among ever-married adult women in Bangladesh. BMC obesity. 2016; 3(1):13. https://doi.org/10.1186/s40608-016-0093-5 PMID: 26962459

11. Aitsi-Selmi A, Bell R, Shipley MJ, Marmot MG. Education modifies the association of wealth with obesity in women in middle-income but not low-income countries: an interaction study using seven national datasets, 2005–2010. PloS one. 2014; 9(3).

12. Tanwi TS, Chakrabarty S, Hasanuzzaman S, Saltmarsh S, Winn S. Socioeconomic correlates of overweight and obesity among ever-married urban women in Bangladesh. BMC public health. 2019; 19(1):842. https://doi.org/10.1186/s12889-019-7221-3 PMID: 31253123

13. Hu FB. Overweight and obesity in women: health risks and consequences. Journal of women's health. 2003 Feb 1; 12(2):163–72. https://doi.org/10.1089/154099903321576565 PMID: 12737715

14. Kamal SM, Hassan CH, Alam GM. Dual burden of underweight and overweight among women in Bangladesh: patterns, prevalence, and socio-demographic correlates. Journal of health, population, and nutrition. 2015; 33(1):92. PMID: 25995726

15. Al Kibria G, Swasey K, Hasan MZ, Sharmeen A, Day B. Prevalence and factors associated with underweight, overweight and obesity among women of reproductive age in India. Global health research and policy. 2019; 4(1):24. https://doi.org/10.1186/s41256-019-0117-z PMID: 31517064

16. Ridker PM. The pathogenesis of atherosclerosis and acute thrombosis: relevance to strategies of cardiovascular disease prevention. Prevention of Myocardial Infarction. Manson JE, Ridker PM, Gaziano JM, Hennekens CH, Eds. New York, Oxford University Press. 1996:32–54.

17. Tanwi TS, Chakrabarty S, Hasanuzzaman S. Double burden of malnutrition among ever-married women in Bangladesh: a pooled analysis. BMC women's health. 2019; 19(1):24. https://doi.org/10.1186/s12905-019-0725-2 PMID: 30704454

18. Hoque ME, Long KZ, Niessen LW, Mamun AA. Rapid shift toward overweight from double burden of underweight and overweight among Bangladeshi women: a systematic review and pooled analysis. Nutrition reviews. 2015 Jul 1; 73(7):438–47. https://doi.org/10.1093/nutrit/nuv003 PMID: 26081454

19. Aitsi-Selmi A, Chandola T, Friel S, Nouraei R, Shipley MJ, Marmot MG. Interaction between education and household wealth on the risk of obesity in women in Egypt. PloS one. 2012; 7(6). https://doi.org/10.1371/journal.pone.0039507 PMID: 22761807

20. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ORC Macro. Bangladesh Demographic and Health Survey 2004. Dhaka, Bangladesh and Calverton, Maryland,

USA: National Institute of Population Research and Training, Mitra and Associates, and ORC Macro, 2005.

21. National Institute of Population Research and Training (NIPORT), Mitra and Associates, Macro International. Bangladesh Demographic and Health Survey 2007. Dhaka, Bangladesh and Calverton, Maryland, USA: National Institute of Population Research and Training, Mitra and Associates, and Macro International, 2009.

22. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International. Bangladesh Demographic and Health Survey 2011. Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates, and ICF International., 2013.

23. National Institute of Population Research and Training (NIPORT) MaA, ICF International,. Bangladesh Demographic and Health Survey 2014. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT, Mitra and Associates, and ICF International., 2016.

24. Biswas RK, Rahman N, Khanam R, Baqui AH, Ahmed S. Double burden of underweight and overweight among women of reproductive age in Bangladesh. Public health nutrition. 2019; 22(17):3163–74. https://doi.org/10.1017/S1368980019002611 PMID: 31544733