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Prevalence of overweight and obesity among adolescents in Bangladesh: do eating habits and physical activity have a gender differential effect?

Md. Mostaured Ali Khan[1], Masud Karim[1], Ahmed Zohirul Islam[1], Md. Rafiqul Islam[1*], Hafiz T. A. Khan[2] and Md. Ibrahim Khalilullah[1]

[1]Department of Population Science and Human Resource Development, University of Rajshahi, Rajshahi, Bangladesh and [2]The Graduate School, University of West London, London, UK
*Corresponding author. Email: rafique_pops@yahoo.com

Abstract

The aim of this study was to examine the gender differential effects of eating habits and physical activity on overweight and obesity among school-aged adolescents in Bangladesh. Nationally representative data extracted from the 2014 Global School-based Student Health Survey (GSHS) were utilized. The survey collected information related to physical and mental health from 2989 school-aged adolescents in Bangladesh. An exploratory data analysis and multivariate logistic regression model were employed in this study. Female adolescents were at a lower risk of being overweight or obese (AOR = 0.573) than males, with a prevalence of 7.4% (males: 9.9%). The results showed that high consumption of vegetables (both: AOR = 0.454; males: AOR = 0.504; females: AOR = 0.432), high soft drink consumption (both: AOR = 2.357; males: AOR = 2.929; females: AOR = 1.677), high fast food consumption (both: AOR = 2.777; males: AOR = 6.064; females: AOR = 1.695), sleep disturbance (both: AOR = 0.675; males: AOR = 0.590; females: AOR = 0.555) and regular walking or cycling to school (both: AOR = 0.472; males: AOR = 0.430; females: AOR = 0.557) were vital influencing factors for being overweight or obese among adolescents for both sexes. Sedentary activities during leisure time were also identified as significant predictors of being overweight or obese for males. Regular fruit and vegetable consumption, the avoidance of soft drinks and fast food, an increase in vigorous physical activity, regular attendance at physical education classes and fewer sedentary leisure time activities could all help reduce the risk of being overweight or obese for both sexes.

Introduction

Obese and overweight children and adolescents present one of the biggest challenges to public health in the 21st century and are greatly affecting many low- and middle-income countries (LMICs) (De Onis *et al.*, 2010; Peng *et al.*, 2017). The prevalence of obesity across the world has nearly trebled since 1975 (WHO, 2018). In 2016, over 1.9 billion adults and 340 million adolescents worldwide, including children, were found to be overweight or obese (WHO, 2018). A high risk of obesity has been observed, particularly for Asians and Pacific Islanders (Young *et al.*, 2017), although in South Asian countries malnutrition (stunting, wasting and underweight) among children is a more hazardous situation. Problems with obesity are also a matter of vital concern in many developing countries, including Bangladesh due to its flourishing economy (Shafique *et al.*, 2007). Since the year 2000, the increase in Body Mass Index (BMI) has swiftly accelerated for both sexes, particularly in East and South Asian countries (Collaboration NRF, 2017). Rapid urbanization and industrialization, plus economic development and the

globalization of food production, are some of the important causal factors for this situation emerging in the developing world.

Previous research has identified the many negative aspects of being overweight or obese on the health and growth of children and adolescents, which can extend into adulthood and increase the risk of developing chronic diseases such as cardiovascular disease (Singh *et al.*, 2013), chronic kidney disease (Singh *et al.*, 2013), diabetes, many cancers (Lauby-Secretan *et al.*, 2016) and disabilities (Dereń *et al.*, 2018). Furthermore, being overweight or obese has been shown to be significantly related to mortality (Flegal *et al.*, 2013; Di Angelantonio *et al.*, 2016).

Although there is a growing body of studies that have examined the various risk factors for being overweight or obese, no specific study has focused on the gender differential of obesity as a whole. Some have suggested that the diverse eating habits and physical activities of children have a significant impact on their weight (Virtanen *et al.*, 2015), as do other metabolic and socio-demographic factors (Hossain *et al.*, 2018). These include insufficient physical activity (Li *et al.*, 2017), shortened duration of sleep at night (Brug *et al.*, 2012), physical education (PE) classes in school (Naiman *et al.*, 2015) and the availability of physical activity (PA) facilities (Hood *et al.*, 2014). Eating habits such as the consumption of fast food (Rosenheck, 2008; Davis & Carpenter, 2009), low level of fruit and vegetable intake and high fat and sugar intake (Epstein *et al.*, 2012), food insecurity (Lyons *et al.*, 2008; Robaina & Martin, 2013) and poor diet quality (Robaina & Martin, 2013) have also been found to be important determinants of overweight and obesity in children and adolescents.

In most developing countries, epidemiological studies on school-level risk factors for obesity are still inadequate and any differences in terms of gender are unknown. Males and females display differences in fat stores, anatomical fat distribution and also in high food intake and low physical activity (Reue, 2017). In Bangladesh, gender discrimination exists in all sectors, including health and nutrition (Shafique *et al.*, 2007; Hossain *et al.*, 2018). A number of attempts have been made to uncover the risk factors for being overweight or obese but there has not been any research on the gender differential risk factors among children and adolescents. This study focuses on the determination of the prevalence of overweight and obesity and the gender differential effects of eating habits and physical activity on overweight and obesity in school-aged adolescents in Bangladesh.

Methods

Study design and sampling procedure

The study used data extracted from the Global School-based Student Health Survey (GSHS) 2014, which collected data from school-age adolescents (usually aged 11–17 years) in 43 developing countries, including Bangladesh, and was administered by the World Health Organization (WHO) in collaboration with the Center for Disease Control (CDC). Data were collected using a clustered sampling technique and a standardized scientific sample selection process. Conventional school-based methodology and a combination of core questionnaire modules with expanded questions plus country-specific questionnaires were utilized by the survey. The school response rate was 90–100% with the student response rate ranging between 76 and 96% and the overall response rate being 69–96% for all countries. In Bangladesh, information related to dietary behaviours, hygiene, drug, tobacco and alcohol use, sexual behaviours, mental health, physical activity and so on were collected by the GSHS in 2014 from 2989 adolescents. A full description of the study methods, including the core questionnaire used with items selected from pertinent modules, is available on the WHO websites (WHO, 2017).

Calculation of BMI

The respondent's BMI was calculated as weight (kg)/height(m)^2. As all the respondents were less than 18 years of age, they were classed as being overweight if their calculated BMI exceeded the

Table 1. Description of the explanatory variables

Variable type	Variables	Categories	Measurement	Duration
Food security	How often went hungry	1 = never		In the last 30 days
		2 = rarely		
		3 = most of the time		
Eating habits	Fruit consumption; vegetable consumption; soft drink consumption; fast food consumption	1 = low	Less than once a day	In the last 30 days
		2 = average	1–2 times a day	
		3 = high	More than twice a day	
Mental well-being	Sleep disturbance	1 = never		In the last 30 days
		2 = often		
Physical activity	General physical activity level (PA)	1 = moderate	≤2 days	60 minutes a day in the last 7 days
		2 = vigorous	>2 days	
	Walked or biked to school; attended PE class	1 = never	0 days	In the last 7 days
		2 = occasionally	1–3 days	
		3 = regularly	>3 days	
	Sitting activities (TV watching, playing computer games etc.)	1 = moderate	<5 hours a day	
		2 = high	≥5 hours a day	

standardized value for age and sex at +1SD of Z scores of BMI (equivalent to a BMI of 25 kg/m^2 at 19 years of age). They were classed as being obese if their calculated BMI exceeded the standardized value for age and sex at +2SD of Z scores of BMI (equivalent to BMI 30 kg/m^2 at 19 years of age) on the basis of BMI interpretation provided by the WHO (Onis *et al.*, 2007; WHO, 2015).

Outcome and explanatory variables

Being overweight or obese was considered as the dependent or outcome variable, dichotomized as Yes = 1 and No = 0. Several explanatory variables related to food insecurity, eating habits, mental well-being and physical activity were treated as risk factors for being overweight and obese, with variables selected in accordance to their importance based on previous research. Information was categorized according to WHO recommendations (WHO, 2012). A complete list of the explanatory variables is given in Table 1.

Statistical analysis

Any associations between the state of being overweight and obese and different explanatory variables were assessed using χ^2 tests (usually set at $p < 0.05$ level of significance). As the outcome variable had two categories, a binary logistic regression model was fitted to measure the impact of

Table 2. Characteristics of the respondents

Characteristic	*n*	Minimum	Maximum	Mean (SD)
Age (years)	2980	11	17	14.2 (±0.98)
Height (m)	2703	1.27	1.9	1.563 (±0.087)
Weight (kg)	2703	28	102	45.88 (±7.868)
BMI	2703	13.05	39.67	18.78 (±2.87)
Male	1192	Percentage overweight or obese: 9.9%		
Female	1788	Percentage overweight or obese: 7.4%		

All percentages are weighted.

selected explanatory variables on the outcome variable. Odds ratios (ORs) were estimated to assess the strength of association between the outcome variable and explanatory variables, and 95% confidence intervals (CIs) were exerted to examine the level of significance. The data were analysed using SPSS for Windows version 23.0 (SPSS Inc., Chicago, IL).

Results

Table 2 presents the characteristics of the study respondents. Their mean age was 14.2 (±0.98) years, mean height 1.563 m (±0.087), mean weight 45.88 kg (±7.868) and mean calculated BMI 18.78 kg/m^2 (±2.87). The prevalence of overweight and obesity was 9.9% for males and 7.4% for females.

Table 3 shows the association between being overweight or obese and selected explanatory variables, assessed by applying a χ^2 test to observe the significance. The frequency of respondents experiencing hunger, their consumption of fruit and vegetables, soft drinks and fast food, sleep disturbance, general level of physical activity (PA) and physical education (PE) class attendance were found to be significantly related to being overweight or obese for adolescents of both sexes. A high consumption of fast food was related to the highest prevalence of overweight and obesity for males (25.3%), while the highest prevalence for females (13.1%) was observed among those who never attended PE classes. Male respondents with high fruit and vegetable consumption displayed a low prevalence of overweight and obesity (2.4% and 5.4% for fruit and vegetables, respectively). Similarly, overweight and obesity rates were only 2.5% and 4.6% for females with high fruit and vegetable consumption. However, 18.7% of males and 12.4% of females who consumed soft drinks at a high frequency were overweight or obese. Only 5.9% of male and 4.9% of female respondents who were vigorously physically active were found to be overweight or obese. The frequency of overweight and obesity was lower among male and female respondents who walked or cycled to school (males: 5.5%; females: 4.8%) or who attended PE classes regularly (males: 8.2%; females: 7.4%). There was a significant positive association among male respondents between a high amount of time sitting or undertaking sedentary activities and overweight and obesity (19.2%).

Effect of eating habits and physical activity on overweight and obesity

Table 4 illustrates the effects of adolescents' eating habits and different physical activities on the prevalence of overweight and obesity. The overall prevalence of overweight or obesity was less for females (AOR = 0.573, CI: 0.403–0.816) than for males. Those with regular feelings of hunger had 2.789 times (AOR = 2.789, CI: 1.733–4.489) greater risk of being overweight or obese compared with those who never felt hungry. A high consumption of fruit (AOR = 0.454, CI: 0.205–0.997) or vegetables (AOR = 0.475, CI: 0.294–0.768) significantly diminished the risk of adolescents being overweight or obese. However, a high consumption of soft drinks

Table 3. Percentage distribution of overweight/obesity among school-aged adolescents in Bangladesh by eating habits and physical activities

Risk factor	Males			Females		
	No (%)	Yes (%)	χ^2_{cal} (*p*-value)	No (%)	Yes (%)	χ^2_{cal} (*p*-value)
How often went hungry						
Never	333 (93.8%)	22 (6.2%)	15.419 (<0.001)	573 (93.2%)	42 (6.8%)	8.840 (0.012)
Sometimes	507 (92.5%)	41 (7.5%)		728 (94.4%)	43 (5.6%)	
Most of the time	75 (81.5%)	17 (18.5%)		226 (89.0%)	28 (11.0%)	
Fruit consumption						
Low	440 (91.3%)	42 (8.7%)	8.720 (0.013)	754 (93.2%)	55 (6.8%)	11.295 (0.004)
Average	322 (90.2%)	35 (9.8%)		561 (91.1%)	55 (8.9%)	
High	160 (97.6%)	5 (2.4%)		1552 (97.5%)	6 (2.5%)	
Vegetable consumption						
Low	218 (90.1%)	24 (9.9%)	5.656 (0.05)	319 (88.1%)	43 (11.9%)	18.840 (<0.0001)
Average	318 (90.4%)	41 (9.6%)		666 (93.5%)	46 (6.5%)	
High	318 (94.6%)	18 (5.4%)		561 (95.4%)	27 (4.6%)	
Soft drink consumption						
Low	488 (94.6%)	28 (5.4%)	28.429 (<0.0001)	842 (93.0%)	63 (7.0%)	13.590 (0.001)
Average	299 (92.6%)	24 (7.4%)		515 (95.2%)	26 (4.8%)	
High	126 (81.3%)	29 (18.7%)		183 (87.6%)	26 (12.4%)	
Fast food consumption						
Low	533 (94.2%)	33 (5.8%)	42.451 (<0.0001)	1009 (92.7%)	79 (7.3%)	9.912 (0.007)
Average	314 (92.6%)	25 (7.4%)		409 (95.8%)	18 (4.2%)	
High	74 (74.7%)	25 (25.3%)		131 (88.5%)	17 (11.5%)	
Sleep disturbance						
Never	356 (88.6%)	46 (11.4%)	9.502 (0.002)	645 (90.8%)	65 (9.2%)	9.072 (0.003)
Often	577 (94.0%)	37 (6.0%)		917 (94.6%)	52 (5.4%)	
General physical activity level (PA)						
Moderate	281 (87.0%)	42 (13.0%)	14.509 (<0.0001)	567 (90.4%)	60 (9.6%)	13.772 (<0.0001)
Vigorous	635 (94.1%)	40 (5.9%)		959 (95.1%)	49 (4.9%)	
Walked or biked to school						
Never	175 (81.8%)	39 (18.2%)	35.484 (<0.0001)	486 (89.3%)	58 (10.7%)	19.068 (<0.0001)
Occasionally	181 (94.3%)	11 (5.7%)		161 (94.7%)	9 (5.3%)	
Regularly	564 (94.5%)	33 (5.5%)		886 (95.2%)	45 (4.8%)	

Table 3. *Continued*

Risk factor	Males			Females		
	No (%)	Yes (%)	χ^2_{cal} (*p*-value)	No (%)	Yes (%)	χ^2_{cal} (*p*-value)
PE class attendance						
Never	61 (80.3%)	15 (19.7%)	16.001 (<0.0001)	106 (86.9%)	16 (13.1%)	8.673 (0.013)
Occasionally	401 (93.9%)	26 (6.1%)		783 (94.1%)	49 (5.9%)	
Regularly	436 (91.8%)	39 (8.2%)		615 (92.6%)	49 (7.4%)	
Sitting activities						
Moderate	831 (92.4%)	68 (7.6%)	12.567 (<0.0001)	1451 (93.1%)	107 (6.9%)	<0.001 (0.995)
High	63 (80.8%)	15 (19.2%)		68 (93.2%)	5 (6.8%)	

(Header spanning "Overweight or obese" over Males and Females columns)

Significance taken at $p < 0.05$.

(AOR = 2.357, CI: 1.544–3.597) and fast food (AOR = 2.777, CI: 1.755–4.392) significantly increased the risk. Adolescents with frequent sleep disturbances (AOR = 0.675, CI: 0.481–0.947) were found to be less likely to be overweight or obese. This was also the case for adolescents who walked or cycled to school (AOR = 0.472, CI: 0.327–0.682) or who attended regular PE classes (AOR = 0.592, CI: 0.327–0.682) compared with those who never walked or cycled or attended PE classes.

In the fitted model the Cox and Snell R^2 and Nagelkerke R^2 were 61.0% and 81.3%, respectively; these were estimated from the linear relationship between the independent variables. The overall model was significant when all independent variables were controlled for age.

Gender differential effect of eating habits on overweight and obesity

Table 5 shows the results of the logistic regression model of the gender differential influence of food patterns on overweight and obesity among the adolescents. The likelihood of either of these states was less for males who sometimes went hungry (AOR = 1.399, CI: 1.036–1.891) or who went hungry most of the time (AOR = 2.759, CI: 1.846–4.125) than it was for respondents who never went hungry. The risk of being overweight or obese was also less for males who ate a lot of fruit (AOR = 0.372, CI: 0.203–0.683). The prevalence of overweight and obesity was less for males with a high frequency of vegetable intake (AOR = 0.504, CI: 0.333–0.764), and also for females with an average (AOR = 0.582, CI: 0.372–0.910) or high vegetable diet (AOR = 0.432, CI: 0.248–0.753) compared with males and females with a low vegetable diet. However, males with average soft drink consumption were at a higher risk of being overweight or obese (AOR = 2.583, CI: 1.855–3.597), as were adolescents with high soft drink consumption (males: AOR = 2.929, CI: 2.086–4.112; females: AOR = 1.677, CI: 1.022–2.753) compared with adolescents whose weekly consumption of soft drinks was lower. High consumption of fast food significantly increased the chances of ending up overweight or obese for both sexes (males: AOR = 6.064, CI: 4.327–8.499; females: AOR = 1.695, CI: 1.011–3.174), as it was for males with average fast food consumption (AOR = 1.503, CI: 1.084–2.083).

In the fitted model the Cox and Snell R^2 and Nagelkerke R^2 were 56.1% and 74.7% respectively of the variance for males, and 58.9% and 78.6% respectively of the variance for females, and was estimated from the linear relationship between the independent variables. The overall model was significant when all independent variables were controlled for age.

Table 4. Logistic regression analysis of the effect of adolescents' eating habits and physical activity on overweight/obesity, Bangladesh, 2014

Risk factor	Overweight or obese	
	AOR	95% CI
Sex		
Male (Ref.)	1.00	
Female	0.573**	(0.403–0.816)
How often went hungry		
Never (Ref.)	1.00	
Sometimes	1.475*	(1.001–2.175)
Most of the time	2.789**	(1.733–4.489)
Fruit consumption		
Low (Ref.)	1.00	
Average	1.070	(0.749–1.530)
High	0.454*	(0.205–0.997)
Vegetable consumption		
Low (Ref.)	1.00	
Average	0.625*	(0.420–0.930)
High	0.475**	(0.294–0.768)
Soft drink consumption		
Low (Ref.)	1.00	
Average	1.244	(0.814–1.900)
High	2.357**	(1.544–3.597)
Fast food consumption		
Low (Ref.)	1.00	
Average	1.244	(0.804–1.923)
High	2.777**	(1.755–4.392)
Sleep disturbance		
Never (Ref.)	1.00	
Often	0.675*	(0.481–0.947)
General physical activity level (PA)		
Moderate (Ref.)	1.00	
Vigorous	0.850	(0.597–1.209)
Walked or biked to school:		
Never (Ref.)	1.00	

Table 4. *Continued*

Risk factor	Overweight or obese	
	AOR	95% CI
Occasionally	0.334**	(0.185–0.601)
Regularly	0.472**	(0.327–0.682)
PE class attendance		
Never (Ref.)	1.00	
Occasionally	0.483**	(0.284–0.822)
Regularly	0.592*	(0.327–0.682)
Sitting activities		
Moderate (Ref.)	1.00	
High	1.551	(0.860–2.797)
Model summary		
Model χ^2 (*p*-value)	2220.687 (*p* < 0.001)	
−2 log likelihood	1048.196	
Cox and Snell R^2	0.610	
Nagelkerke R^2	0.813	

Sample are weighted and controlled by age.
Ref.: reference category; AOR: adjusted odds ratio.
**$p < 0.01$; *$p < 0.05$.

Gender differential effect of physical activity on overweight or obesity

The results of the logistic regression model shown in Table 6 illustrate the effect of physical activity on being overweight or obesity among the school-aged adolescents. It was observed that sleep disturbance significantly decreased the chance of obesity (males: AOR = 0.590, CI: 0.455–0.766; females: AOR = 0.555, CI: 0.369–0.837). As expected, the rate of overweight and obesity was lower among vigorously physically active males (AOR = 0.751, CI: 0.592–0.991) compared with those who only took part in moderate physical activity. The risk of being overweight or obese was less for both males and females who occasionally walked or cycled to school (males: AOR = 0.265, CI: 0.171–0.410; females: AOR = 0.453, CI: 0.205–0.924) or who regularly walked or cycled to school (males: AOR = 0.430, CI: 0.322–0.576; females: AOR = 0.557, CI: 0.359–0.866) compared with respondents that never walked or cycled to school. The likelihood of being overweight or obese decreased among males and females who occasionally attended PE classes (males: AOR = 0.420, CI: 0.281–0.627; females: AOR = 0.445, CI: 0.266–0.745) or for males who regularly attended such classes (male: AOR = 0.488, CI: 0.330–0.722) compared with males and females who never attended PE classes. The risk of being overweight or obese was increased by 3.404 times (AOR = 3.404, CI: 2.343–4.945) for males with high levels of sitting or sedentary activity compared with males with moderate sitting.

In the fitted model the Cox and Snell R^2 and Nagelkerke R^2 were 54.1% and 77.2% respectively. The variances for males and females were 60.0% and 80.0% respectively, estimated from the linear relationship between the independent variables. The overall model was significant when all explanatory variables were included.

Table 5. Logistic regression analysis of the gender differential effect of eating habits on adolescent overweight/obesity in Bangladesh, 2014

Risk factor	Males		Females	
	AOR	95% CI	AOR	95% CI
How often went hungry				
Never (Ref.)	1.00		1.00	
Sometimes	1.399*	(1.036–1.891)	1.235	(0.791–1.928)
Most of the time	2.759**	(1.846–4.125)	1.540	(0.904–2.623)
Fruit consumption				
Low (Ref.)	1.00		1.00	
Average	1.201	(0.901–1.601)	1.163	(0.763–1.773)
High	0.372**	(0.203–0.683)	0.645	(0.258–1.613)
Vegetable consumption				
Low (Ref.)	1.00		1.00	
Average	1.043	(0.753–1.446)	0.582*	(0.372–0.910)
High	0.504**	(0.333–0.764)	0.432**	(0.248–0.753)
Soft drink consumption				
Low (Ref.)	1.00		1.00	
Average	2.583**	(1.855–3.597)	0.785	(0.470–1.312)
High	2.929**	(2.086–4.112)	1.677*	(1.022–2.753)
Fast food consumption				
Low (Ref.)	1.00		1.00	
Average	1.503*	(1.084–2.083)	0.737	(0.411–1.321)
High	6.064**	(4.327–8.499)	1.695*	(1.011–3.174)
Model summary				
Model χ^2 (*p*-value)	2327.11 (<0.001)		1401.33 (<0.001)	
−2 log likelihood	1596.663		781.801	
Cox and Snell R^2	0.561		0.589	
Nagelkerke R^2	0.747		0.786	

Sample are weighted and controlled by age.
Ref.: reference category; AOR: adjusted odds ratio.
**$p < 0.01$; *$p < 0.05$.

Discussion

The prevalence of overweight and obesity is increasing in Bangladesh (Biswas *et al.*, 2017). It has not yet become an alarming situation for adolescents but it is increasing day-by-day. The findings of this study indicate that the risk of males being overweight or obese is notably higher than it is for females. They also show that male adolescents with high food insecurity are at an increased risk of being overweight or obese, which is consistent with the findings of earlier studies (Robaina

Table 6. Logistic regression analysis of the gender differential effect of physical activity on adolescents' overweight/obesity in Bangladesh, 2014

Risk factor	Males		Females	
	AOR	95% CI	AOR	95% CI
Sleep disturbance				
Never (Ref.)	1.00		1.00	
Often	0.590**	(0.455–0.766)	0.555**	(0.369–0.837)
General physical activity level (PA)				
Moderate (Ref.)	1.00		1.00	
Vigorous	0.751*	(0.562–0.991)	0.809	(0.532–1.229)
Walked or biked to school				
Never (Ref.)	1.00		1.00	
Occasionally	0.265**	(0.171–0.410)	0.453*	(0.205–0.924)
Regularly	0.430**	(0.322–0.576)	0.557**	(0.359–0.866)
PE class attendance				
Never (Ref.)	1.00		1.00	
Occasionally	0.420**	(0.281–0.627)	0.445**	(0.266–0.745)
Regularly	0.488**	(0.330–0.722)	0.754	(0.461–1.234)
Sitting activities				
Moderate (Ref.)	1.00		1.00	
High	3.404**	(2.343–4.945)	0.469	(0.154–1.427)
Model summary				
Model χ^2 (*p*-value)	2102.016 (<0.001)		1403.618 (<0.001)	
−2 log likelihood	1638.223		718.459	
Cox and Snell R^2	0.541		0.600	
Nagelkerke R^2	0.772		0.800	

Sample are weighted and controlled by age.
Ref.: reference category; AOR: adjusted odds ratio.
**$p < 0.01$; *$p < 0.05$.

& Martin, 2013; Sanjeevi *et al.*, 2018). Sanjeevi *et al.* (2018) concluded that food insecurity was associated with a 'less conducive multidimensional home environmental subscale score' and poor diet quality which, in turn, was related to greater BMI. Lohman *et al.* (2016) also identified a gender differential outcome of household food insecurity for being overweight or obese. In Bangladesh, less importance is generally given to female children than to males in all sectors.

Dietary behaviour and different food patterns have diverse impacts on being overweight or obese (Rautiainen *et al.*, 2015; Virtanen *et al.*, 2015). The present study identified a significantly lower risk of both overweight and obesity in adolescents with a high fruit and vegetable diet, but there was a gender differential effect. Although both high fruit and high vegetable diets significantly decreased the risk of overweight and obesity in males, in females no significant effect was found for fruit-eating, but a highly significant effect was identified for average to higher

vegetable consumption. Previous research by Epstein *et al.* (2012) and Field *et al.* (2003) showed that regular fruit and vegetable intake among children and adolescents reduced their risk of overweight and obesity. According to Rohde *et al.* (2017), 'responsible' intake of macronutrients, energy, fruit and vegetables can help restrain excessive weight gain among children. More precisely, fruit and vegetables provide fibre and are low in calories and rich in minerals and vitamins, which helps to keep a person healthy and correctly energized.

This study shows that a high consumption of soft drinks and fast food increases the risk of becoming overweight or obese among male and female adolescents. As a consequence, adolescents are at a high risk of experiencing problems with their weight regardless of their intake of junk food. Previous studies have shown that a high consumption of soft drinks and fast food greatly increases the risk of obesity in adolescents and young children (Rosenheck, 2008; Davis & Carpenter, 2009; Moore *et al.*, 2009). These types of food and drink contain more fat and sugar, and fewer vitamins and minerals than healthier alternatives and therefore can lead to poor weight management and body metabolism leading to a higher risk of obesity (Lucan & DiNicolantonio, 2015). In recent experiments, researchers have shown that reducing soft drink and fast food consumption in adolescents successfully lessens the prevalence of obesity (Hu, 2013; Laxy *et al.*, 2015; Cantoral *et al.*, 2016). In addition, a high intake of artificially sweetened soft beverages enhances the risk of obesity-related cancers (Hodge *et al.*, 2018). In Bangladesh, the quality of soft drinks and fast food is much poorer than in developed countries, and is perhaps the case in other developing countries.

The study results show there is a lower risk of obesity among adolescents of both sexes who often experience sleep problems, which is inconsistent with the findings of several previous studies (Nielsen *et al.*, 2011; Brug *et al.*, 2012; Mannan *et al.*, 2016). In addition, Neilsen *et al.* (2011) observed a significant link between short duration of sleep and being overweight or obesity among young adults, including children. A meta-analysis and systematic review of longitudinal studies conducted by Mannan *et al.* (2016) revealed a 70% greater risk of depressed male and female adolescents being overweight or obese.

Physical activity is an emerging determinant of weight for both children and adults. The present study found that there was a much lower risk of male adolescents being overweight or obese if they were vigorously active compared with if they were only moderately active. This has also been shown by a few earlier studies such as Ogden *et al.* (2016). Chaput *et al.* (2018) noticed there was a lower risk of obesity in children who were vigorously physically active, but found no significant effect of physical activity in the case of overweight or obese males or females. Males and females who regularly walked or cycled to school were at a very low risk of being overweight or obese. Walking and cycling have a two-fold advantage: they help protect the environment and prevent excessive weight gain by increasing body metabolism. Responsible parents should therefore encourage their children to regularly walk or cycle to school.

The attendance of adolescents at PE classes has also been identified as a feasible predictor of being overweight and obesity in Bangladesh. The respondents of both sexes who regularly attended PE classes had a very low risk of developing weight problems compared with those who never attended PE classes (Naiman *et al.*, 2015). Physical education classes can help reduce the gap between actual and recommended physical activity for children and adolescents (Fernandes & Sturm, 2010) and help increase the number of days per week spent in vigorous exercise (Jinsook, 2012). Unfortunately, PE facilities in Bangladesh are very poor and there is poor awareness of the benefits of PE among parents, plus a lack of strict regulations. This study found that sedentary activities increased the chance of overweight and obesity in male adolescents, but showed no significant effects among female adolescents. Those male adolescents with high levels of sitting activity per day were almost at three times higher risk of becoming overweight or obese. This finding is supported by previous research with adults (Chau *et al.*, 2012; Ng *et al.*, 2017). In Australia, the risk of being overweight or obese has been found to be significantly higher among workers with mostly sitting jobs compared with workers with mostly standing jobs (Chau *et al.*,

2012). However, there are no studies that describe the effect of sitting behaviours as a cause of weight problems or obesity among children and adolescents. Adolescent leisure time activities such as watching TV, gossiping and playing computer games increase the risk of becoming overweight or obese, especially for male adolescents.

This study has several limitations. For example, a secondary source of data was used for analysis and thus some important variables in relation to being overweight and obesity were missing. Nevertheless, an attempt has been made to provide a compact description of the effect of adolescent eating behaviours and physical activity on being overweight and obesity. Future studies could be undertaken to collect data covering variables involved in differences between rural and urban areas.

In conclusion, the study findings suggest that the levels of overweight and obesity among school-aged adolescents in Bangladesh need to be decreased. Gender differences in food practice and physical activity among adolescents which affect their overweight and obesity levels have been demonstrated. The regular consumption of healthy food, particularly a diet rich in fruit and vegetables, and the avoidance of soft drinks and fast food, especially for males, are necessary to lessen the risk of adolescents in Bangladesh being overweight or obese. Increasing levels of physical activity, cutting back on high levels of leisure time sitting activities, especially among males, and encouraging adolescents of both sexes to regularly walk or cycle to school, can all help to cut the risk of developing weight problems. Policy in this area should focus on the need for regular attendance at PE classes to help improve the health of school-age adolescents. The implementation of such policies would help decrease the risk of adolescent obesity in Bangladesh and, in turn, help promote their good health.

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