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

PREVALENCE OF OVERWEIGHT AND OBESITY AMONG ADOLESCENTS IN BANGLADESH: DOES FOOD HABITS AND PHYSICAL ACTIVITIES HAVE GENDER DIFFERENTIAL EFFECT?

Journal:	*Journal of Biosocial Science*
Manuscript ID	JBS-4581.R2
Manuscript Type:	Research Article
Date Submitted by the Author:	29-Jan-2019
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Keywords:	Obesity, Child Health and Nutrition

PREVALENCE OF OVERWEIGHT AND OBESITY AMONG ADOLESCENTS IN BANGLADESH: *DOES FOOD HABITS AND PHYSICAL ACTIVITIES HAVE GENDER DIFFERENTIAL EFFECT?*

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Keywords: Obesity; Adolescent; Food habit; Physical activities; Bangladesh.

Abstract

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

Introduction

Obese and overweight children and adolescents represents one of the biggest challenges to face public health in the 21st century and is 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 was 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) in East and South Asian countries in particular has accelerated swiftly for both sexes (Collaboration, 2017). Rapid urbanization and industrialization, plus economic development and 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 that 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 and obesity are significantly related to mortality (Di Angelantonio *et al*., 2016; Flegal *et al*., 2013).

Although there is a growing body of studies that have examined the various risk factors of being overweight and obese, there is no specific study that is focused on the gender

differential of obesity as a whole. Some studies have mentioned that the diverse food 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 factors include insufficient physical activity (Li *et al*., 2017), shortened duration of sleep at night (Brug *et al*., 2012), physical education (PE) at school (Naiman *et al*., 2015) and physical activity (PA) facilities (Hood *et al*., 2014). Diverse food habits involving the consumption of fast food (Davis & Carpenter, 2009; Rosenheck, 2008), 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), were also found to be important determinants for overweight and obese 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, dissimilation in anatomical fat distribution, and also in high food intake and low physical activity (Reue, 2017) that gives strength to this study. In Bangladesh, gender discrimination exists in all sectors including health and nutrition (Hossain *et al*., 2018; Shafique *et al*., 2007). A number of attempts have been made to uncover the risk factors of 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 prevalence of obesity and on ascertaining the gender differential outcomes of food habits and physical activity on overweight and obese school-aged adolescents in Bangladesh.

Methods

Study design and Sampling procedure

This study has used data extracted from the Global School-based Student Health Survey (GSHS) 2014. The survey collected data from school-age adolescents (usually aged

11-17 years) in 43 developing countries including Bangladesh and was administrated 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 utilized by the survey. The school response rate was 90–100% with the student response rate ranged between 76–96% and the overall response rate at 69–96% for each of the countries. In Bangladesh, information related to dietary behaviors, hygiene, drug, tobacco and alcohol use, sexual behaviors, mental health, physical activity etc. and was collected by GSHS in 2014 from 2989 adolescents. Full clarifications of the study, including the core questionnaire used with items selected from pertinent modules, are available at the websites of CDC and WHO (C. WHO, 2017).

Calculation of BMI

The respondent's BMI was calculated applying the following formula:

$$BMI = \frac{Weight\ (kg)}{Height^2\ (m)}$$

As all the respondents were up to 18 years of age, they were classed as being overweight if their calculated BMI exceeded the standardized value for age and sex at +1SD of Z scores of BMI (equivalent to BMI 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 WHO (Onis *et al*., 2007; WHO, 2015).

95 ***Outcome and Explanatory variables***

96 To achieve the objective of the study, being overweight or obese were considered as
97 dependent or outcome variables. The outcome variable was addressed as follows:

98 $$Y = Overweight\ or\ obese = \begin{cases} 1, \text{ Yes} \\ 0, \text{ No} \end{cases}$$

99 Several explanatory variables related to food insecurity, food habits, depression and physical
100 activities were treated as risk factors for being overweight and obese with variables selected
101 in accordance with their importance based on previous research. The information was
102 categorized according to the recommendation provided by WHO (WHO, 2012). A complete
103 list of explanatory variables is shown in table 1. **(Table 1)**

104 ***Statistical analysis***

105 Any association between the state of being overweight and obese and different
106 explanatory variables were assessed by Chi-square tests (usually, set at $p<0.05$ level of
107 significance). As the outcome variable of this study had two categories, the binary logistic
108 regression model was fitted to measure the impact of selected explanatory variables on the
109 outcome variable. In this study, the odds ratios (ORs) were estimated to assess the strength of
110 association between the outcome variable and the explanatory variables, and 95% confidence
111 intervals (CIs) were exerted to examine the level of significance. The data were analyzed
112 using the computer program SPSS in Windows version 23.0 (SPSS Inc., Chicago, IL).

113 **Results**

114 Table 2 represents the characteristics of the respondents. The mean age was 14.2 (±0.98)
115 years, mean height was 1.563 meters (±0.087), mean weight was 45.88 kilograms (±7.868)
116 and mean calculated BMI was 18.78 kg/m^2 (±2.87). The prevalence of being overweight and
117 obese was 9.9% for males and 7.4% for females. **(Table 2)**

Table 3 illustrates the association between being overweight and obesity and selected explanatory variables were pursued by applying a Chi-square test to observe the significance. In this study, the frequency of respondents to experience hunger, fruit and vegetable eating, consumption of soft drinks, fast food eating, sleep disturbance, physical activity (PA), physical education (PE) attendance were significantly related to being overweight or obesity for adolescents of both sexes. A high consumption of fast food had the highest prevalence of being overweight and obesity for males (25.3%), while the highest prevalence observed for females (13.1%) was among those that never attended PE classes. Male respondents with higher fruit (2.4%) and vegetable (5.4%) eating habits displayed a lower prevalence of being overweight or obese. Similarly, there were only 2.5% and 4.6% of females with high fruit and vegetable eating habits that were either overweight or obese. Alternatively, 18.7% of males and 12.4% of females who consumed soft drinks at a high frequency were overweight and 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 being overweight and obese was lower among male and female respondents who walked or cycled to school (male: 5.5% and female: 4.8%) and attended PE classes regularly (male: 8.2% and female: 7.4%). There was a significant association among male respondents between a high amount of sitting or sedentary activities leading to a high prevalence of being overweight and obesity (19.2%). **(Table 3)**

Effect of food habits and physical activities on being overweight and obesity

Table 4 illustrates the effects of adolescent food habits and physical activities for being overweight and obese in Bangladesh. The occurrence of either state was decreased for female adolescents (AOR = 0.573, CI: 0.403-0.816) compared to male adolescents. Regular feelings of hunger at 2.789 (AOR = 2.789, CI: 1.733-4.489) times, highly accelerates the risk of being overweight and obese than among those that never feel hunger. A high consumption

of fruit (AOR = 0.454, CI: 0.205-0.997) and 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 (AOR = 2.357, CI: 1.544-3.597) and fast food (AOR = 2.777, CI: 1.755-4.392) significantly increased the risks. Adolescents with frequent sleep disturbances (AOR = 0.675, CI: 0.481-0.947) were found less likely to be overweight or obese. This was also the case for those adolescents that walked or cycled to school (AOR = 0.472, CI: 0.327-0.682) and attended regular PE classes (AOR = 0.592, CI: 0.327-0.682) when compared to those that never walked or cycled or attended PE.

The fitted model of Cox and Snell R^2, and Nagelkerke R^2 was shown to be 61.0% and 81.3%, respectively 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)**

Gender differential effect of food habits on being overweight and obesity

Table 5 shows the results of the logistic regression model of the gender differential influence of food patterns on being overweight and obesity among school-aged adolescents in Bangladesh. The likelihood of either of these states was decreased for males who sometimes went hungry (AOR = 1.399, CI: 1.036-1.891) or went hungry most of the time (AOR = 2.759, CI: 1.846-4.125) than it was for respondents that never went hungry. The risk of being overweight or obese was also decreased for males that ate a lot of fruit (AOR = 0.372, CI: 0.203-0.683). The occurrence was decreased for males with a high frequency of vegetable (AOR = 0.504, CI: 0.333-0.764) eating and reduced for females with an average (AOR = 0.582, CI: 0.372-0.910) or high vegetable eating habit (AOR = 0.432, CI: 0.248-0.753) compared to males and females with a low vegetable eating habit. However, males with an average soft drink consumption habit were at a higher risk of being overweight or obese (AOR = 2.583, CI: 1.855-3.597) as were adolescents with a high soft drinks' consumption

habit (male: AOR = 2.929, CI: 2.086-4.112; female: AOR = 1.677, CI: 1.022-2.753) compared to 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 (male: AOR = 6.064, CI: 4.327-8.499; and female: AOR = 1.695, CI: 1.011-3.174) as it was for males with an average fast food eating habit (AOR = 1.503, CI: 1.084-2.083).

The fitted model of Cox and Snell R^2, and Nagelkerke R^2 was shown to be 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 5)**

Gender differential effect of physical activities on being overweight and obesity

The results of the logistic regression model shown in Table 6 illustrate the effect of PA on being overweight and obesity among school-aged adolescents. Sleep disturbance was found to have a significantly decreased association with obesity (male: AOR = 0.590, CI: 0.455-0.766; and female: AOR = 0.555, CI: 0.369-0.837). As would be expected, being overweight or obese decreased among vigorously physically active males (AOR = 0.751, CI: 0.592-0.991) as it was for respondents who took part in moderate PA. The risk of being overweight or obese was reduced for both males and females who occasionally walked or cycled to school (male: AOR = 0.265, CI: 0.171-0.410; and female: AOR = 0.453, CI: 0.205-0.924) or who regularly walked or cycled to school (male: AOR = 0.430, CI: 0.322-0.576; and female: AOR = 0.557, CI: 0.359-0.866) compared to respondents that never walked or cycled to school. The likelihood of being overweight or obese decreased among males and females that occasionally attended PE classes (male: AOR = 0.420, CI: 0.281-0.627; and female: AOR = 0.445, CI: 0.266-0.745) or for males that regularly attended such classes

(male: AOR = 0.488, CI: 0.330-0.722) compared to males and females that never attended PE. The risk of being overweight or obese was increased by 3.404 (AOR = 3.404, CI: 2.343-4.945) times higher for males with high sitting or sedentary activities compared to males with moderate sitting activities.

In the fitted model, the Cox and Snell R^2, and Nagelkerke R^2 was 54.1% and 77.2% respectively. The variances of males and for females was 60.0% and 80.0% respectively, that can be estimated from the linear relationship between the independent variables. The overall model was significant when all explanatory variables were included. **(Table 6)**

Discussion

The prevalence of being overweight and obesity is showing an increasing trend 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. This study findings also show that male adolescents with high food insecurity are at an increased risk of being overweight or obese that is consistent with earlier studies (Robaina & Martin, 2013; Sanjeevi *et al*., 2018). As well as Sanjeevi *et al*. (2018) showing a uniformity with the results of our study, these authors concluded that food insecurity is associated with a less conducive multidimensional home environmental subscale score and poor diet quality that, in turn, is 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 behavior and different food patterns have a diverse impact on being overweight or obesity (Rautiainen *et al*., 2015; Virtanen *et al*., 2015). This study has identified a significantly lower risk of both these states in adolescents with a high fruit and vegetable eating habit. A gender differential effect was seen again when such eating habits

significantly decreased the risk for male adolescents, but in the case of females, no significant effect due to fruit-eating was found but a highly significant effect was identified with average to higher vegetable consumption. Previous research supports this hypothesis by identifying that there is a significant positive impact of regular fruit and vegetable intake among children and adolescents (Epstein *et al*., 2012; Field *et al*., 2003). 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 fiber, are low in calories and rich in minerals and vitamins that help to keep a person healthy and energized.

This study shows that a high consumption of soft drinks and fast food increases the risk for both male and female adolescents of becoming overweight or obese. As a consequence, adolescents are at a high risk of experiencing problems with their weight regardless of their intake of junk food. A number of previous studies have shown that high consumption of soft drinks and fast food has a highly negative effect on obesity in adolescents and young children (Davis & Carpenter, 2009; Moore *et al*., 2009; Rosenheck, 2008). 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 further to a risk of obesity (Lucan & DiNicolantonio, 2015). In recent experiments, researchers have shown that reducing soft drink and fast food consumption in adolescents has been successful in lessening the prevalence of obesity (Cantoral *et al*., 2016; Hu, 2013; Laxy *et al*., 2015). 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 that is perhaps a similar situation in other developing countries.

The study results show there is a lower risk of obesity among adolescents of both sexes who often face sleep problems due to depression, that is inconsistent with findings from

several previous studies (Brug *et al*., 2012; Mannan *et al*., 2016; Nielsen *et al*., 2011). 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 (PA) is an emerging determinant of weight for both children and adults. The study found there was a much lower risk of male adolescents being overweight or obese if they were vigorously active compared to those who were moderately active. This hypothesis is supported by a few earlier studies such as Ogden *et al.* (2016). Also showing a consistency with the study findings, Chaput *et al.* (2018) noticed there was a lower risk of obesity by level of sedentary behavior in children who were vigorously physically active but found no significant effect of PA in case of overweight or obese males or females. Males and females that regularly walked or cycled to school were at a very low risk of being overweight or obese. Walking and cycling carry twofold advantages: 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 has also been identified as a feasible predictor of being overweight and obesity in Bangladesh. The respondents of both sexes that regularly attended PE had a very low risk of developing weight problems compared to those that never attended PE (Naiman *et al*., 2015). Spending time at PE can help reduce the gap between actual and recommended physical activity for children and adolescents (Fernandes & Sturm, 2010) and also help increase the number of days per week spent in vigorous PA (Jinsook, 2012). So, it can be seen that PE indirectly affects excessive weight gain among adolescents and children. Unfortunately, however, 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.

Sedentary activities of adolescents show a negative impact on being overweight or obesity for male adolescents but show no significant effects on female adolescents. Those male adolescents with high levels of sitting activity per day are almost at three times higher risk of becoming overweight or obese. This finding is supported by previous research related to adults (Chau *et al*., 2012; Ng *et al*., 2017). In Australia, the risk of being overweight or obese increases significantly among workers with mostly sitting jobs than workers with mostly standing jobs (Chau *et al*., 2012). However, there are no studies that describe the effect of sitting behaviors as a cause of weight problems or obesity among children and adolescents. Adolescent leisure time activities per day such as watching TV, gossiping, playing computer games etc. increase their risk of becoming overweight or obese especially for male adolescents.

This study had several limitations. For example, a secondary source of data was used for analysis and thus some important variables are missing in relation to being overweight and obesity. Nevertheless, an attempt has been made to depict a compact demonstration of the effect of adolescent eating behaviors and PA on being overweight and obese. Future studies could be undertaken to collect data covering variables involved in differences between rural-urban areas.

In conclusion, findings from the study suggest that the levels of being overweight or obesity among school-aged adolescents in Bangladesh have yet to be improved. This research discovered gender differences in food practice and physical activity among adolescents that affect their overweight or obesity levels and therefore indicates improvements are needed in their behavior around eating and physical activity. A regular consumption of healthy food, particularly a diet rich in fruit and vegetables and avoidance of soft drinks and fast food especially for males, are necessary components for helping 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, be helpful for prolonging their good health.

Abbreviations

GSHS, Global School-based Student Health Survey; BMI, Body Mass Index; SD, Standard Deviation; PE, Physical Education; PA, Physical Activity; WHO, World Health Organization; CDC, Center for Disease Control; CI, Confidence Interval; OR, Odds Ratio.

Acknowledgments

The authors are thankful to the Office of the Global School-based Student Health Survey (GSHS), Department of Chronic Diseases and Health Promotion, World Health Organization, jointly worked with Center for Disease Control (CDC), for permitting us to use the datasets for this analysis.

Ethical Approval

The study was ethically approved and the statement was obtained from the Ministry of Health and Family Welfare, Dhaka, Bangladesh. The World Health Organization (WHO) financially and technically supports this survey with the collaboration of the Center for Disease Control (CDC). Further, written permission was obtained from each participating school and from all classroom teachers.

Conflicts of interest

The authors have no competing interests to declare.

Funding

The authors received no funding grant from any funding agency, commercial entity or not-for-profit organization for this study.

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457 **Table 1.** The complete list of explanatory variables.

Variables	Category	Measurements	Duration	Variable Type
How often went hungry	1 = Never		During the past 30 days	Food insecurity
	2 = Rarely			
	3 = Most of the time			
Fruit eating Vegetable eating Soft drinks Fast food eating	1 = Low	less than one time per day	During the past 30 days	Food habits
	2 = Average	1-2 times per day		
	3 = High	More than 2 times per day		
Sleep disturbance	1 = Never		During the past 30 days	Depression
	2 = Often			
Physical activity	1 = Moderate	≤2 days	60 Minutes per day During the past 7 days	Physical activity
	2 = Vigorous	> 2 days		
Walk or bike to school Physical education attendance	1 = Never	0 days	During the past 7 days	
	2 = occasionally	1-3 days		
	3 = Regularly	> 3 days		
Sitting activities (includes TV watching, playing computer games etc.)	1 = Moderate	< 5 hours per day		
	2 = High	≥ 5 hours per day		

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459

460 **Table 2.** The characteristics of study population.

Characteristics	n	Minimum	Maximum	Mean (SD)
Age (in 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)
Gender	**n**	**Overweight and obese (%)**		
Male	1192	9.9%		
Female	1788	7.4%		

461 **Note**: All percentages are weighted.

462

463 **Table 3.** Percentage distribution of overweight/obesity among school-aged adolescents in Bangladesh according
464 to their food habits and physical activities.

Risk Factors	Overweight or obese					
	Male		χ^2_{cal}	Female		χ^2_{cal}
	No (%)	Yes (%)	*(p-value)*	No (%)	Yes (%)	*(p-value)*
How often went hungry:						
Never	333(93.8%)	22(6.2%)	15.419	573(93.2%)	42(6.8%)	8.840
Sometimes	507(92.5%)	41(7.5%)	(0.000)	728(94.4%)	43(5.6%)	(0.012)
Most of the time	75(81.5%)	17(18.5%)		226(89.0%)	28(11.0%)	
Fruit eating:						
Low	440(91.3%)	42(8.7%)	8.720	754(93.2%)	55(6.8%)	11.295
Average	322(90.2%)	35(9.8%)	(0.013)	561(91.1%)	55(8.9%)	(0.004)
High	160(97.6%)	5(2.4%)		1552(97.5%)	6(2.5%)	
Vegetable eating:						
Low	218(90.1%)	24(9.9%)	5.656	319(88.1%)	43(11.9%)	18.840
Average	318(90.4%)	41(9.6%)	(0.05)	666(93.5%)	46(6.5%)	(<0.0001)
High	318(94.6%)	18(5.4%)		561(95.4%)	27(4.6%)	

Soft drinks:						
Low	488(94.6%)	28(5.4%)	28.429	842(93.0%)	63(7.0%)	13.590
Average	299(92.6%)	24(7.4%)	(<0.0001)	515(95.2%)	26(4.8%)	(0.001)
High	126(81.3%)	29(18.7%)		183(87.6%)	26(12.4%)	
Fast food eating:						
Low	533(94.2%)	33(5.8%)	42.451	1009(92.7%)	79(7.3%)	9.912
Average	314(92.6%)	25(7.4%)	(<0.0001)	409(95.8%)	18(4.2%)	(0.007)
High	74(74.7%)	25(25.3%)		131(88.5%)	17(11.5%)	
Sleep disturbance:						
Never	356(88.6%)	46(11.4%)	9.502	645(90.8%)	65(9.2%)	9.072
Often	577(94.0%)	37(6.0%)	(0.002)	917(94.6%)	52(5.4%)	(0.003)
Physical activity:						
Moderate	281(87.0%)	42(13.0%)	14.509	567(90.4%)	60(9.6%)	13.772
Vigorous	635(94.1%)	40(5.9%)	(<0.0001)	959(95.1%)	49(4.9%)	(<0.0001)
Walk or bike to school:						
Never	175(81.8%)	39(18.2%)	35.484	486(89.3%)	58(10.7%)	19.068
Occasionally	181(94.3%)	11(5.7%)	(<0.0001)	161(94.7%)	9(5.3%)	(<0.0001)
Regularly	564(94.5%)	33(5.5%)		886(95.2%)	45(4.8%)	
PE attendance:						
Never	61(80.3%)	15(19.7%)	16.001	106(86.9%)	16(13.1%)	8.673
Occasionally	401(93.9%)	26(6.1%)	(<0.0001)	783(94.1%)	49(5.9%)	(0.013)
Regularly	436(91.8%)	39(8.2%)		615(92.6%)	49(7.4%)	
Sitting activities:						
Moderate	831(92.4%)	68(7.6%)	12.567	1451(93.1%)	107(6.9%)	0.000
High	63(80.8%)	15(19.2%)	(<0.0001)	68(93.2%)	5(6.8%)	(0.995)

Note: Significant at $\rho<0.05$ level; PE, Physical Education

Table 4. Logistic regression analysis to estimate the effect of adolescents' food habits and physical activities on the state of overweight/obesity in Bangladesh, 2014.

Risk Factors	Overweight or obese	
	AOR	95% CI
Gender		
Male(RC)	1.00	…….
Female	0.573**	(0.403-0.816)
How often went hungry:		
Never(RC)	1.00	……
Sometimes	1.475*	(1.001-2.175)
Most of the time	2.789**	(1.733-4.489)
Fruit eating:		
Low(RC)	1.00	…..
Average	1.070	(0.749-1.530)
High	0.454*	(0.205-0.997)
Vegetable eating:		
Low(RC)	1.00	…….
Average	0.625*	(0.420-0.930)
High	0.475**	(0.294-0.768)
Soft drinks:		
Low(RC)	1.00	…….
Average	1.244	(0.814-1.900)
High	2.357**	(1.544-3.597)
Fast food eating:		
Low(RC)	1.00	…….
Average	1.244	(0.804-1.923)
High	2.777**	(1.755-4.392)

Sleep disturbance:		
Never(RC)	1.00	…….
Often	0.675*	(0.481-0.947)
Physical activity:		
Moderate(RC)	1.00	…….
Vigorous	0.850	(0.597-1.209)
Walk or bike to school:		
Never(RC)	1.00	…….
Occasionally	0.334**	(0.185-0.601)
Regularly	0.472**	(0.327-0.682)
PE attendance:		
Never(RC)	1.00	…….
Occasionally	0.483**	(0.284-0.822)
Regularly	0.592*	(0.327-0.682)
Sitting activities:		
Moderate(RC)	1.00	…….
High	1.551	(0.860-2.797)
Model summary:		
Model Chi-Square (p-value)	2220.687 (<0.001)	
-2Log Likelihood	1048.196	
Cox and Snell R-square	0.610	
Nagelkerke R-square	0.813	

Note: Sample are weighted and controlled by age. "(RC)" denotes reference category; AOR, adjusted odds ratio; Significant at **p<0.01, and *p<0.05 level.

Table 5. Logistic regression analysis to estimate the gender differential effect of food habits on adolescents' overweight/obesity in Bangladesh, 2014.

Risk Factors	Male		Female	
	AOR	95% CI	AOR	95% CI
How often went hungry:				
Never(RC)	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 eating:				
Low(RC)	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 eating:				
Low(RC)	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 drinks:				
Low(RC)	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 eating:				
Low(RC)	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 Chi-Square (p-value)	2327.11 (<0.001)		1401.33 (<0.001)	
-2Log Likelihood	1596.663		781.801	
Cox and Snell R-square	0.561		0.589	
Nagelkerke R-square	0.747		0.786	

474 **Table 6.** Logistic regression analysis to estimate the gender differential effect of physical activities on
475 adolescents' overweight/obesity in Bangladesh, 2014.

Risk Factors	Male		Female	
	AOR	95% CI	AOR	95% CI
Sleep disturbance:				
Never(RC)	1.00	…….	1.00	…….
Often	0.590**	(0.455-0.766)	0.555**	(0.369-0.837)
Physical activity:				
Moderate(RC)	1.00	…….	1.00	……..
Vigorous	0.751*	(0.562-0.991)	0.809	(0.532-1.229)
Walk or bike to school:				
Never(RC)	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 attendance:				
Never(RC)	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(RC)	1.00	…….	1.00	…….
High	3.404**	(2.343-4.945)	0.469	(0.154-1.427)
Model summary:				
Model Chi-Square (p-value)	2102.016 (<0.001)		1403.618 (<0.001)	
-2Log Likelihood	1638.223		718.459	
Cox and Snell R-square	0.541		0.600	
Nagelkerke R-square	0.772		0.800	

476 **Note:** Sample are weighted and controlled by age. "(RC)" denotes reference category; AOR, adjusted odds ratio;
477 Significant at **p<0.01, and *p<0.05 level.