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

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

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## 1 **Abstract**

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

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## Introduction

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

39           Previous research has identified the many negative aspects of being overweight or  
40 obese on the health and growth of children and adolescents that can extend into adulthood  
41 and increase the risk of developing chronic diseases such as cardiovascular disease (Singh *et al.*  
42 *al.*, 2013), chronic kidney disease (Singh *et al.*, 2013), diabetes, many cancers (Lauby-  
43 Secretan *et al.*, 2016), and disabilities (Dereń *et al.*, 2018). Furthermore, being overweight  
44 and obesity are significantly related to mortality (Di Angelantonio *et al.*, 2016; Flegal *et al.*,  
45 2013).

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

48 differential of obesity as a whole. Some studies have mentioned that the diverse food habits  
49 and physical activities of children have a significant impact on their weight (Virtanen *et al.*,  
50 2015), as do other metabolic and socio-demographic factors (Hossain *et al.*, 2018). These  
51 factors include insufficient physical activity (Li *et al.*, 2017), shortened duration of sleep at  
52 night (Brug *et al.*, 2012), physical education (PE) at school (Naiman *et al.*, 2015) and  
53 physical activity (PA) facilities (Hood *et al.*, 2014). Diverse food habits involving the  
54 consumption of fast food (Davis & Carpenter, 2009; Rosenheck, 2008), low level of fruit and  
55 vegetable intake and high fat and sugar intake (Epstein *et al.*, 2012), food insecurity (Lyons *et*  
56 *al.*, 2008; Robaina & Martin, 2013) and poor diet quality (Robaina & Martin, 2013), were  
57 also found to be important determinants for overweight and obese children and adolescents.

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

## 68 **Methods**

### 69 ***Study design and Sampling procedure***

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

72 11-17 years) in 43 developing countries including Bangladesh and was administrated by the  
73 World Health Organization (WHO) in collaboration with the Center for Disease Control  
74 (CDC). Data were collected using a clustered sampling technique and a standardized  
75 scientific sample selection process, conventional school-based methodology, and a  
76 combination of core questionnaire modules with expanded questions plus country-specific  
77 questionnaires utilized by the survey. The school response rate was 90–100% with the student  
78 response rate ranged between 76–96% and the overall response rate at 69–96% for each of  
79 the countries. In Bangladesh, information related to dietary behaviors, hygiene, drug, tobacco  
80 and alcohol use, sexual behaviors, mental health, physical activity etc. and was collected by  
81 GSHS in 2014 from 2989 adolescents. Full clarifications of the study, including the core  
82 questionnaire used with items selected from pertinent modules, are available at the websites  
83 of CDC and WHO (C. WHO, 2017).

#### 84 ***Calculation of BMI***

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

$$86 \quad BMI = \frac{Weight (kg)}{Height^2 (m)}$$

87 As all the respondents were up to 18 years of age, they were classed as being overweight if  
88 their calculated BMI exceeded the standardized value for age and sex at +1SD of Z scores of  
89 BMI (equivalent to BMI 25 kg/m<sup>2</sup> at 19 years of age). They were classed as being obese if  
90 their calculated BMI exceeded the standardized value for age and sex at +2SD of Z scores of  
91 BMI (equivalent to BMI 30 kg/m<sup>2</sup> at 19 years of age) on the basis of BMI interpretation  
92 provided by WHO (Onis *et al.*, 2007; WHO, 2015).

93

94

## 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:

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

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 ( $\pm 0.98$ )  
115 years, mean height was 1.563 meters ( $\pm 0.087$ ), mean weight was 45.88 kilograms ( $\pm 7.868$ )  
116 and mean calculated BMI was 18.78 kg/m<sup>2</sup> ( $\pm 2.87$ ). The prevalence of being overweight and  
117 obese was 9.9% for males and 7.4% for females. (**Table 2**)

118 Table 3 illustrates the association between being overweight and obesity and  
119 selected explanatory variables were pursued by applying a Chi-square test to observe the  
120 significance. In this study, the frequency of respondents to experience hunger, fruit and  
121 vegetable eating, consumption of soft drinks, fast food eating, sleep disturbance, physical  
122 activity (PA), physical education (PE) attendance were significantly related to being  
123 overweight or obesity for adolescents of both sexes. A high consumption of fast food had the  
124 highest prevalence of being overweight and obesity for males (25.3%), while the highest  
125 prevalence observed for females (13.1%) was among those that never attended PE classes.  
126 Male respondents with higher fruit (2.4%) and vegetable (5.4%) eating habits displayed a  
127 lower prevalence of being overweight or obese. Similarly, there were only 2.5% and 4.6% of  
128 females with high fruit and vegetable eating habits that were either overweight or obese.  
129 Alternatively, 18.7% of males and 12.4% of females who consumed soft drinks at a high  
130 frequency were overweight and obese. Only 5.9% of male and 4.9% of female respondents  
131 who were vigorously physically active were found to be overweight or obese. The frequency  
132 of being overweight and obese was lower among male and female respondents who walked  
133 or cycled to school (male: 5.5% and female: 4.8%) and attended PE classes regularly (male:  
134 8.2% and female: 7.4%). There was a significant association among male respondents  
135 between a high amount of sitting or sedentary activities leading to a high prevalence of being  
136 overweight and obesity (19.2%). (**Table 3**)

### 137 *Effect of food habits and physical activities on being overweight and obesity*

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

143 of fruit (AOR = 0.454, CI: 0.205-0.997) and vegetables (AOR = 0.475, CI: 0.294-0.768)  
144 significantly diminished the risk of adolescents being overweight or obese. However, a high  
145 consumption of soft drinks (AOR = 2.357, CI: 1.544-3.597) and fast food (AOR = 2.777, CI:  
146 1.755-4.392) significantly increased the risks. Adolescents with frequent sleep disturbances  
147 (AOR = 0.675, CI: 0.481-0.947) were found less likely to be overweight or obese. This was  
148 also the case for those adolescents that walked or cycled to school (AOR = 0.472, CI: 0.327-  
149 0.682) and attended regular PE classes (AOR = 0.592, CI: 0.327-0.682) when compared to  
150 those that never walked or cycled or attended PE.

151 The fitted model of Cox and Snell  $R^2$ , and Nagelkerke  $R^2$  was shown to be 61.0%  
152 and 81.3%, respectively and was estimated from the linear relationship between the  
153 independent variables. The overall model was significant when all independent variables  
154 were controlled for age. (Table 4)

#### 155 *Gender differential effect of food habits on being overweight and obesity*

156 Table 5 shows the results of the logistic regression model of the gender differential  
157 influence of food patterns on being overweight and obesity among school-aged adolescents in  
158 Bangladesh. The likelihood of either of these states was decreased for males who sometimes  
159 went hungry (AOR = 1.399, CI: 1.036-1.891) or went hungry most of the time (AOR =  
160 2.759, CI: 1.846-4.125) than it was for respondents that never went hungry. The risk of being  
161 overweight or obese was also decreased for males that ate a lot of fruit (AOR = 0.372, CI:  
162 0.203-0.683). The occurrence was decreased for males with a high frequency of vegetable  
163 (AOR = 0.504, CI: 0.333-0.764) eating and reduced for females with an average (AOR =  
164 0.582, CI: 0.372-0.910) or high vegetable eating habit (AOR = 0.432, CI: 0.248-0.753)  
165 compared to males and females with a low vegetable eating habit. However, males with an  
166 average soft drink consumption habit were at a higher risk of being overweight or obese  
167 (AOR = 2.583, CI: 1.855-3.597) as were adolescents with a high soft drinks' consumption

168 habit (male: AOR = 2.929, CI: 2.086-4.112; female: AOR = 1.677, CI: 1.022-2.753)  
169 compared to adolescents whose weekly consumption of soft drinks was lower. High  
170 consumption of fast food significantly increased the chances of ending up overweight or  
171 obese for both sexes (male: AOR = 6.064, CI: 4.327-8.499; and female: AOR = 1.695, CI:  
172 1.011-3.174) as it was for males with an average fast food eating habit (AOR = 1.503, CI:  
173 1.084-2.083).

174 The fitted model of Cox and Snell  $R^2$ , and Nagelkerke  $R^2$  was shown to be 56.1%  
175 and 74.7% respectively of the variance for males, and 58.9% and 78.6% respectively of the  
176 variance for females and was estimated from the linear relationship between the independent  
177 variables. The overall model was significant when all independent variables were controlled  
178 for age. (**Table 5**)

#### 179 ***Gender differential effect of physical activities on being overweight and obesity***

180 The results of the logistic regression model shown in Table 6 illustrate the effect of  
181 PA on being overweight and obesity among school-aged adolescents. Sleep disturbance was  
182 found to have a significantly decreased association with obesity (male: AOR = 0.590, CI:  
183 0.455-0.766; and female: AOR = 0.555, CI: 0.369-0.837). As would be expected, being  
184 overweight or obese decreased among vigorously physically active males (AOR = 0.751, CI:  
185 0.592-0.991) as it was for respondents who took part in moderate PA. The risk of being  
186 overweight or obese was reduced for both males and females who occasionally walked or  
187 cycled to school (male: AOR = 0.265, CI: 0.171-0.410; and female: AOR = 0.453, CI: 0.205-  
188 0.924) or who regularly walked or cycled to school (male: AOR = 0.430, CI: 0.322-0.576;  
189 and female: AOR = 0.557, CI: 0.359-0.866) compared to respondents that never walked or  
190 cycled to school. The likelihood of being overweight or obese decreased among males and  
191 females that occasionally attended PE classes (male: AOR = 0.420, CI: 0.281-0.627; and  
192 female: AOR = 0.445, CI: 0.266-0.745) or for males that regularly attended such classes

193 (male: AOR = 0.488, CI: 0.330-0.722) compared to males and females that never attended  
194 PE. The risk of being overweight or obese was increased by 3.404 (AOR = 3.404, CI: 2.343-  
195 4.945) times higher for males with high sitting or sedentary activities compared to males with  
196 moderate sitting activities.

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

## 201 Discussion

202 The prevalence of being overweight and obesity is showing an increasing trend in  
203 Bangladesh (Biswas *et al.*, 2017). It has not yet become an alarming situation for adolescents  
204 but it is increasing day-by-day. The findings of this study indicate that the risk of males being  
205 overweight or obese is notably higher than it is for females. This study findings also show  
206 that male adolescents with high food insecurity are at an increased risk of being overweight  
207 or obese that is consistent with earlier studies (Robaina & Martin, 2013; Sanjeevi *et al.*,  
208 2018). As well as Sanjeevi *et al.* (2018) showing a uniformity with the results of our study,  
209 these authors concluded that food insecurity is associated with a less conducive  
210 multidimensional home environmental subscale score and poor diet quality that, in turn, is  
211 related to greater BMI. Lohman *et al.* (2016) also identified a gender differential outcome of  
212 household food insecurity for being overweight or obese. In Bangladesh, less importance is  
213 generally given to female children than to males in all sectors.

214 Dietary behavior and different food patterns have a diverse impact on being  
215 overweight or obesity (Rautiainen *et al.*, 2015; Virtanen *et al.*, 2015). This study has  
216 identified a significantly lower risk of both these states in adolescents with a high fruit and  
217 vegetable eating habit. A gender differential effect was seen again when such eating habits

218 significantly decreased the risk for male adolescents, but in the case of females, no significant  
219 effect due to fruit-eating was found but a highly significant effect was identified with average  
220 to higher vegetable consumption. Previous research supports this hypothesis by identifying  
221 that there is a significant positive impact of regular fruit and vegetable intake among children  
222 and adolescents (Epstein *et al.*, 2012; Field *et al.*, 2003). According to Rohde *et al.* (2017),  
223 responsible intake of macronutrients, energy, fruit and vegetables can help restrain excessive  
224 weight gain among children. More precisely, fruit and vegetables provide fiber, are low in  
225 calories and rich in minerals and vitamins that help to keep a person healthy and energized.

226 This study shows that a high consumption of soft drinks and fast food increases the  
227 risk for both male and female adolescents of becoming overweight or obese. As a  
228 consequence, adolescents are at a high risk of experiencing problems with their weight  
229 regardless of their intake of junk food. A number of previous studies have shown that high  
230 consumption of soft drinks and fast food has a highly negative effect on obesity in  
231 adolescents and young children (Davis & Carpenter, 2009; Moore *et al.*, 2009; Rosenheck,  
232 2008). These types of food and drink contain more fat and sugar, and fewer vitamins and  
233 minerals than healthier alternatives and therefore can lead to poor weight management and  
234 body metabolism leading further to a risk of obesity (Lucan & DiNicolantonio, 2015). In  
235 recent experiments, researchers have shown that reducing soft drink and fast food  
236 consumption in adolescents has been successful in lessening the prevalence of obesity  
237 (Cantoral *et al.*, 2016; Hu, 2013; Laxy *et al.*, 2015). In addition, a high intake of artificially  
238 sweetened soft beverages enhances the risk of obesity-related cancers (Hodge *et al.*, 2018). In  
239 Bangladesh, the quality of soft drinks and fast food is much poorer than in developed  
240 countries that is perhaps a similar situation in other developing countries.

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

243 several previous studies (Brug *et al.*, 2012; Mannan *et al.*, 2016; Nielsen *et al.*, 2011). In  
244 addition, (Nielsen *et al.*, 2011) observed a significant link between short duration of sleep and  
245 being overweight or obesity among young adults including children. A meta-analysis and  
246 systematic review of longitudinal studies conducted by Mannan *et al.* (2016) revealed a 70%  
247 greater risk of depressed male and female adolescents being overweight or obese.

248 Physical activity (PA) is an emerging determinant of weight for both children and  
249 adults. The study found there was a much lower risk of male adolescents being overweight or  
250 obese if they were vigorously active compared to those who were moderately active. This  
251 hypothesis is supported by a few earlier studies such as Ogden *et al.* (2016). Also showing a  
252 consistency with the study findings, Chaput *et al.* (2018) noticed there was a lower risk of  
253 obesity by level of sedentary behavior in children who were vigorously physically active but  
254 found no significant effect of PA in case of overweight or obese males or females. Males and  
255 females that regularly walked or cycled to school were at a very low risk of being overweight  
256 or obese. Walking and cycling carry twofold advantages: they help protect the environment  
257 and prevent excessive weight gain by increasing body metabolism. Responsible parents  
258 should therefore encourage their children to regularly walk or cycle to school.

259 The attendance of adolescents at PE has also been identified as a feasible predictor of  
260 being overweight and obesity in Bangladesh. The respondents of both sexes that regularly  
261 attended PE had a very low risk of developing weight problems compared to those that never  
262 attended PE (Naiman *et al.*, 2015). Spending time at PE can help reduce the gap between  
263 actual and recommended physical activity for children and adolescents (Fernandes & Sturm,  
264 2010) and also help increase the number of days per week spent in vigorous PA (Jinsook,  
265 2012). So, it can be seen that PE indirectly affects excessive weight gain among adolescents  
266 and children. Unfortunately, however, PE facilities in Bangladesh are very poor and there is  
267 poor awareness of the benefits of PE among parents plus a lack of strict regulations.

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

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

285 In conclusion, findings from the study suggest that the levels of being overweight or  
286 obesity among school-aged adolescents in Bangladesh have yet to be improved. This research  
287 discovered gender differences in food practice and physical activity among adolescents that  
288 affect their overweight or obesity levels and therefore indicates improvements are needed in  
289 their behavior around eating and physical activity. A regular consumption of healthy food,  
290 particularly a diet rich in fruit and vegetables and avoidance of soft drinks and fast food  
291 especially for males, are necessary components for helping to lessen the risk of adolescents in  
292 Bangladesh being overweight or obese. Increasing levels of physical activity, cutting back on

293 high levels of leisure time sitting activities, especially among males, and encouraging  
294 adolescents of both sexes to regularly walk or cycle to school, can all help to cut the risk of  
295 developing weight problems. Policy in this area should focus on the need for regular  
296 attendance at PE classes to help improve the health of school-age adolescents. The  
297 implementation of such policies would help decrease the risk of adolescent obesity in  
298 Bangladesh and, in turn, be helpful for prolonging their good health.

### 299 **Abbreviations**

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

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307 for this analysis.

### 308 **Ethical Approval**

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

### 314 **Conflicts of interest**

315 The authors have no competing interests to declare.

316

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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	1 = Never	0 days	During the past 7 days	
	2 = occasionally	1-3 days		
Physical education attendance	3 = Regularly	> 3 days		
	1 = Moderate	< 5 hours per day		
Sitting activities (includes TV watching, playing computer games etc.)	2 = High	≥ 5 hours per day		

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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 to their food habits and physical activities.  
464

Risk Factors	Overweight or obese					
	Male		$\chi^2_{cal}$ (p-value)	Female		$\chi^2_{cal}$ (p-value)
No (%)	Yes (%)	No (%)		Yes (%)		
<b>How often went hungry:</b>						
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%)	
<b>Fruit eating:</b>						
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%)	
<b>Vegetable eating:</b>						
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%)	

<b>Soft drinks:</b>						
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%)	
<b>Fast food eating:</b>						
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%)	
<b>Sleep disturbance:</b>						
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)
<b>Physical activity:</b>						
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)
<b>Walk or bike to school:</b>						
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%)	
<b>PE attendance:</b>						
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%)	
<b>Sitting activities:</b>						
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)

465 **Note:** Significant at  $p < 0.05$  level; PE, Physical Education

466

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

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

<b>Sleep disturbance:</b>		
Never <sup>(RC)</sup>	1.00	.....
Often	0.675*	(0.481-0.947)
<b>Physical activity:</b>		
Moderate <sup>(RC)</sup>	1.00	.....
Vigorous	0.850	(0.597-1.209)
<b>Walk or bike to school:</b>		
Never <sup>(RC)</sup>	1.00	.....
Occasionally	0.334**	(0.185-0.601)
Regularly	0.472**	(0.327-0.682)
<b>PE attendance:</b>		
Never <sup>(RC)</sup>	1.00	.....
Occasionally	0.483**	(0.284-0.822)
Regularly	0.592*	(0.327-0.682)
<b>Sitting activities:</b>		
Moderate <sup>(RC)</sup>	1.00	.....
High	1.551	(0.860-2.797)
<b>Model summary:</b>		
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	

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

471

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

Risk Factors	Male		Female	
	AOR	95% CI	AOR	95% CI
<b>How often went hungry:</b>				
Never <sup>(RC)</sup>	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)
<b>Fruit eating:</b>				
Low <sup>(RC)</sup>	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)
<b>Vegetable eating:</b>				
Low <sup>(RC)</sup>	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)
<b>Soft drinks:</b>				
Low <sup>(RC)</sup>	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)
<b>Fast food eating:</b>				
Low <sup>(RC)</sup>	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)
<b>Model summary:</b>				
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
<b>Sleep disturbance:</b>				
Never <sup>(RC)</sup>	1.00	.....	1.00	.....
Often	0.590**	(0.455-0.766)	0.555**	(0.369-0.837)
<b>Physical activity:</b>				
Moderate <sup>(RC)</sup>	1.00	.....	1.00	.....
Vigorous	0.751*	(0.562-0.991)	0.809	(0.532-1.229)
<b>Walk or bike to school:</b>				
Never <sup>(RC)</sup>	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)
<b>PE attendance:</b>				
Never <sup>(RC)</sup>	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)
<b>Sitting activities:</b>				
Moderate <sup>(RC)</sup>	1.00	.....	1.00	.....
High	3.404**	(2.343-4.945)	0.469	(0.154-1.427)
<b>Model summary:</b>				
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.