Original Research

To quantify and evaluate the impact of various eating habits and physical activity habits on the development of overweight and obesity among rural school-aged adolescents

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ABSTRACT:
Aim: The purpose of this research was to quantify and evaluate the impact of various eating habits and physical activity habits on the development of overweight and obesity among rural school-aged adolescents. **Methods:** The Department of Nursing Conducted a prospective cross-sectional research. A prospective follow-up research was done among teenagers (14–18 years old) enrolled in secondary and higher-secondary schools (Classes IX–XII). Participants who were permanent inhabitants of rural regions were questioned at the start, and a 6-month follow-up evaluation was performed. As a result, each individual subject had two repeated measurements. This survey eventually had 200 participants (80 male and 120 female respondents). **Results:** Among the dietary habits indicated by the students, 12 percent went hungry most of the time, 50 percent ate fruits less than once a day, and 25 percent ate vegetables less than once a day. At the time of start, the prevalence of soft drink and fast food consumption was 46 percent and 54 percent, respectively. However, on a follow-up visit, all of the prevalences were found to be greater, with the exception of regular junk food consumption, which reduced to 50%. Vegetable consumption was infrequent among 30% of the subjects during follow-up. This difference was now statistically significant. While the general prevalence of bad eating behaviours was observed to be 70% at the outset, there was a modest decline to 68 percent. However, this difference was not statistically significant. Risk factors for physical activity among teenagers, such as not walking or cycling to school, climbed to 33 percent on follow-up from 30 percent at the baseline. However, the proportion of sitting activities decreased somewhat from 15% to 14% at the baseline. Similarly, the incidence of insufficient other daily physical labour reduced from 25% to 24%. However, the total prevalence of insufficient physical activity rose from 48 percent to 51 percent. The risk estimate for fast food consumption leading to obesity was likewise greatest among the females (4.59, 95 percent CI: 1.80–10.74). Those who consumed soft drinks on a regular basis were 2.41 (95 percent CI: 1.51–3.87) times more likely to become overweight. Older age has no statistically significant influence in the GEE model for boys. The highest risk was reported in boys who ate less vegetables (4.74, 95 percent CI: 1.94–11.79). In the case of older females, the risk of being overweight was 5.11 (95 percent CI: 1.81–14.68). While none of the physical activity factors were statistically significant in any of the models, insufficient daily labour was shown to have a statistically significant risk of 2.58 (95 percent CI: 1.21–5.65). Girls' consumption of less vegetables was not statistically significant. However, soft drink consumption exhibited a risk (4.50, 95 percent CI: 1.94–10.60) equivalent to fast food consumption. **Conclusions:** There is strong evidence that eating behaviours are more strictly connected to overweight among teenagers. To reduce the risk of obesity, healthy eating habits and physical exercise should be encouraged.
Keywords: Adolescents, food, nutrition, obesity, overeating, physical activity, risk factors, rural

INTRODUCTION

Adolescence is a transitional stage from infancy to adulthood marked by fast physical growth and development, as well as behavioural, emotional, and socio-psychological changes.[1] Adolescents are more susceptible to harmful behaviours, poor dietary habits and nutritional compromises, physical inactivity, and psychosocial pressures, all of which form their personalities and lifestyle patterns. Rapid physiological changes impact their body's nutritional

requirements, while their lifestyles, attitudes, and perceptions regarding body size and form influence their dietary choices and habits. Adolescent nutrient requirements increase due to accelerated growth and development, hormonal, physical, and behavioural changes, and are frequently unmet due to inappropriate food choices, peer pressure, unhealthy attitudes, and lifestyle practises that make adolescents more vulnerable to nutritional deficiencies.[2] Good diet is critical for preventing nutritional abnormalities and avoiding the onset of acute and chronic illnesses later in life.[3-5] Failure to eat a nutritionally adequate diet at this critical juncture in life not only halts linear development but also has an impact on teenagers' psychomotor skills. [6] Countless research and reports [7-11] indicated that teenagers are more likely to suffer from nutritional deficiencies and diseases as a result of their fast body development, bad eating habits, psychological, mental, and emotional pressures connected with body dissatisfaction, and temptations to have a thinner body. Adolescents are also prone to eating disorders such as anorexia nervosa and bulimia nervosa, as well as depression, anxiety, and psychological stress.[12] Adolescent health and nutrition are largely under-researched and ignored in developing countries, including India, due to the silent nature of nutritional problems, undocumented evidence of life-threatening epidemics, adolescents' less assertive attitude, muted political interest, and financial constraints. The lack of data on adolescents' nutritional status, dietary practises, and physical activities also makes it difficult to attract the attention of government officials, programme managers, and policymakers in order to formulate and develop appropriate adolescent-specific strategies for addressing their nutritional and socio-psychological needs. The relationship between age-specific nutrition and long-term health impacts has always been of interest; hence the present research compared the nutritional status, dietary behaviours, and physical activity of school-aged boys and girls.

METHODS AND MATERIALS
The prospective cross-sectional research conducted at the Department of Nursing with the consent of the protocol review committee and the institutional ethics committee. A prospective follow-up research was done among teenagers (14–18 years old) enrolled in secondary and higher-secondary schools (Classes IX–XII). Participants who were permanent inhabitants of rural regions were questioned at the start, and a 6-month follow-up evaluation was performed. As a result, each individual subject had two repeated measurements. This survey eventually had 200 participants (80 male and 120 female respondents).

VARIABLES UNDER INVESTIGATION AND DATA COLLECTING
A predesigned, pretested questionnaire was created after evaluating the GSHS instrument[13] and the WHO-STEPS instrument[14], and it included sections on physical activity and food preferences. There was also a question about family history. During the first visit, participants' sociodemographic information was gathered. Two distinct specialists translated the questionnaire into Bengali and then backtranslated it into English. The questionnaire's validity was tested using statistical methods, the explanation of which is outside the scope of this article (Cronbach's alpha [15] was calculated to be 0.82, indicating high statistical reliability). [16] [This instrument was given to pupils in a certain section all at once during a single time. After being assigned an identification number based on their roll numbers and names, they were measured for height and weight using a standardised stadiometer (IndoSurgicals® Height Measuring Scale) and a bathroom type weighing machine (MCP® Analog Mechanical Weighing Scale), respectively, according to standard protocol. BMI was determined as weight (in kilos) divided by height (in meters). The nutritional status of the youngsters was classified using the WHO teenage BMI percentile table. [17-19] after 6 months, a follow-up visit was made to the chosen schools, and the same procedure was performed on those who had already been assigned an identifying number from the prior visit.

RESULTS
The participants' average age was 16.2 (1.66) years (range: 14–18 years). The majority of responders (55 percent) were 16 or younger. The majority of participants (60 percent) were female, Hindu (78 percent), and came from a nuclear household (77 percent). The majority of participants (55 percent) were in secondary school (Classes IX and X). The remaining teenagers were in upper secondary school. While 14% of respondents belonged to the BG Prasad socioeconomic status categorization (December, 2016 modification),20 32% belonged to Class IV. The majority of dads educated up to the upper secondary level were among those who replied about their father's education (28 percent). On the contrary, the majority of mothers (45 percent) had earned elementary level education, while 21 percent had received secondary level education. While the majority of students claimed that their dads were farmers (49 percent), the majority of their moms were housewives (71 percent). Initially, 86 percent of individuals had normal nutritional status; however, after 6 months, the percentage had dropped to 78 percent. The percentage of overweight people increased dramatically from 1% to 7%, with obesity increasing from 1% to 2%. Interestingly, the prevalence of the second spectrum of teenage malnutrition — thinness – rose from 12% to 14%, but not as sharply as that of overweight. While females' thinness status improved with time, boys reported a larger burden of thinness as well. These differences were also found to be statistically significant (P 0.001).

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DIET AND PHYSICAL ACTIVITY-RELATED RISK FACTORS ARE ON THE RISE

Table 1 compares the distribution of risk variables for NCDs and risk factors linked to food choices, physical activity, and family history between the two observation sites. Among the dietary habits indicated by the students, 12 percent went hungry most of the time, 50 percent ate fruits less than once a day, and 25 percent ate vegetables less than once a day. At the time of start, the prevalence of soft drink and fast food consumption was 46 percent and 54 percent, respectively. However, on a follow-up visit, all of the prevalences were found to be greater, with the exception of regular junk food consumption, which reduced to 50%. Vegetable consumption was infrequent among 30% of the subjects during follow-up. This difference was now statistically significant. While the general prevalence of bad eating behaviours was observed to be 70% at the outset, there was a modest decline to 68 percent. However, this difference was not statistically significant. Risk factors for physical activity among teenagers, such as not walking or cycling to school, climbed to 33 percent on follow-up from 30 percent at the baseline. However, the proportion of sitting activities decreased somewhat from 15% to 14% at the baseline. Similarly, the incidence of insufficient other daily physical labour reduced from 25% to 24%. However, the total prevalence of insufficient physical activity rose from 48 percent to 51 percent. None of these changes, however, were statistically significant. Following the end of the follow-up, 10% of the pupils were found to have reported the existence of a family history. It is crucial to highlight that, although there is a statistical difference in the outcome variable (overweight and obesity) over time, similar changes are not always present for the risk variables of relevance. Although the influence of predictors on outcome cannot be simply written off based on this gap, it is clear that the explanation of the disparity is most likely buried in the effect of risk variables over time (i.e., the time interaction)

OVERWEIGHT AND OBESITY RISK FACTORS

Table 2 displays the GEE models developed for various dietary risk variables and physical inactivity risk factors. Females and those above the age of 16 were at a greater risk of acquiring overweight and obesity. In the cumulative (overall) model, rapid consumption was associated with the greatest risk of developing obesity (3.14, 95 percent CI: 1.96–4.85). The risk estimate for fast food consumption leading to obesity was likewise greatest among the females (4.59, 95 percent CI: 1.80–10.74). Consumption of less fruits and vegetables has been connected statistically to overweight and obesity. Those who consumed soft drinks on a regular basis were 2.41 (95 percent CI: 1.51–3.87) times more likely to become overweight. Older age has no statistically significant influence in the GEE model for boys. However, similar to the cumulative model, consumption of fruits and vegetables, soft drinks, and fast food had a statistically significant relationship. The highest risk was reported in boys who ate less vegetables (4.74, 95 percent CI: 1.94–11.79). In the case of older females, the risk of being overweight was 5.11 (95 percent CI: 1.81–14.68). While none of the physical activity factors were statistically significant in any of the models, insufficient daily labour was shown to have a statistically significant risk of 2.58 (95 percent CI: 1.21–5.65). Girls' consumption of less vegetables was not statistically significant. However, soft drink consumption exhibited a risk (4.50, 95 percent CI: 1.94–10.60) equivalent to fast food consumption.

Table 3 highlights the impacts of overall food habits and physical activity after controlling for the respondents' gender and age group. Table 3 incorporates two-way interaction terms to detect significant interactions between the modifiable and nonmodifiable risk variables presented in Table 3. Overall, bad eating habits were shown to provide a risk of 8.72 (95% CI: 5.48–13.90), which was greater than the risk caused by insufficient physical exercise (6.68, 95% CI: 3.82–10.93). Both of these dangers are more prevalent in males than in girls. Unhealthy food habits result in Girls have a cumulative risk that is 14.90 times (95 percent CI: 8.67–25.65) greater than males. Inadequate physical exercise, on the other hand, increases the cumulative risk of acquiring obese in boys. Along with the main effects, the interactions were statistically significant in the aforementioned models. This statistical significance, however, suggests a link between modifiable and nonmodifiable risk variables.

Table 1: Comparison of respondents' eating patterns, physical activity, and family history at baseline and 6 months afterwards (n=200)

Risk factors	Baseline, n (%)	After 6 months, n (%)	P
Most of the times going hungry at home	24 (12)	28(14)	0.517
Eating fruits less than once a day	100 (50)	104 (52)	0.331
Eating vegetables less than once a day	50 (25)	60(30)	0.042
Intake of soft drinks more than thrice a week	82 (46)	98 (49)	0.873
Intake of fast food more than thrice a week	108 (54)	100 (50)	0.084
Unhealthy dietary habits	140 (70)	136 (68)	0.433
Usually not walking or cycling to-and-from school	60 (30)	66(33)	0.341
≥4 h of sitting activity	30 (15)	28 (14)	0.790

Inadequate other daily physical work (including outdoor sports)	50(25)	48 (24)	0.503
Inadequate physical activity (overall)	96(48)	102 (51)	0.698

Table 2: Factors affecting development of overweight and obesity

Factors affecting development of overweight and obesity	Overall (*n*=200)		Female (*n*=120)		Male (*n*=80)	
	Risk ratio (95% CI)	*P*	Risk ratio (95% CI)	*P*	Risk ratio (95% CI)	*P*
Sex: Female	2.21 (1.51-3.77)	0.001	-	-	-	-
Age group: Older (>16 years)	2.77 (1.68-4.64)	<0.001	1.62 (0.91-3.08)	0.077	5.11 (1.81-14.68)	0.002
Family history	1.87 (0.68-4.66)	0.256	1.98 (0.47-8.43)	0.353	1.82 (0.517.51)	0.331
Usually not walking or cycling to-and-from school	1.66 (0.95-2.72)	0.077	1.92 (0.82-4.33)	0.130	1.77 (0.98-3.83)	0.057
≥4 h of sitting activity	1.37 (0.65-2.61)	0.301	1.43 (0.59-3.47)	0.335	1.13 (0.33-3.33)	0.854
Inadequate other daily physical work (including outdoor sports)	1.81 (0.95-3.55)	0.078	2.38 (0.86-6.41)	0.093	2.58 (1.21-5.65)	0.023
Most of the times going hungry at home	1.42 (0.72-2.89)	0.331	1.35 (0.55-3.36)	0.614	2.51 (0.78-8.21)	0.111
Eating fruits less than once a day	2.41 (1.62-3.77)	<0.001	3.53 (1.97-6.28)	<0.001	3.15 (1.70-5.27)	<0.001
Eating vegetables less than once a day	1.97 (1.19-3.54)	0.020	4.74 (1.94-11.79)	0.001	1.28 (0.53-3.04)	0.324
Intake of soft drinks more than thrice a week	2.41 (1.51-3.87)	0.001	2.37 (1.31-4.11)	0.003	4.50 (1.94-10.60)	0.001
Intake of fast food more than thrice a week	3.14 (1.96-4.85)	<0.001	3.13 (1.74-5.44)	<0.001	4.59 (1.80-10.74)	<0.001
CI: Confidence interval						

Factors affecting development of overweight and obesity	Overall (*n*=200)		Female (*n*=120)		Male (*n*=80)	
	Risk ratio (95% CI)	*P*	Risk ratio (95% CI)	*P*	Risk ratio (95% CI)	*P*
Main effects						
Sex: Female	7.56 (3.83-14.25)	<0.001	-	-	-	-
Age group: Older (>16-years)	9.65 (4.64-18.51)	<0.001	10.66 (5.63-21.46)	<0.001	20.44 (5.87-72.21)	<0.001
Overall physical activity: Inadequate	6.68 (3.82-10.93)	<0.001	13.85 (6.67-28.56)	<0.001	8.58 (4.82-15.22)	<0.001
Overall dietary habit: Unhealthy	8.72 (5.48-13.90)	<0.001	10.77 (5.79-19.40)	<0.001	14.90 (8.67-25.65)	<0.001
Interactions						
Inadequate physical activity and unhealthy diet	0.38 (0.16-0.81)	0.017	0.22 (0.05-0.72)	0.012	0.13 (0.04-0.37)	<0.001
Female and inadequate physical activity	0.32 (0.14-0.89)	0.013	-	-	-	-
F-emale and unhealthy dietary habits	0.37 (0.16-0.71)	0.014	-	-	-	-
Older age and Inadequate physical activity	0.25 (0.11-0.63)	0.002	0.10 (0.03-0.43)	0.001	0.78 (0.16-5.17)	0.786
Older age and unhealthy dietary habits	0.22 (0.08-0.62)	0.002	0.22 (0.06-0.69)	0.011	0.13 (0.03-0.55)	0.008

DISCUSSION

In line with the results of the other researchers, 21-26 the prevalence of obesity and overweight was found to be on the rise in the present study, with a dramatic increase of roughly 8% among the participants. Because overweight and obesity are time-varying

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dynamic conditions, the difference observed is actually a net increase (newly developing overweight – those returning below overweight BMI category); thus, this can be regarded as a "net incidence," which is a proxy marker for morbidity incidence under discussion. Ghosh22 discovered that the incidence of overweight and obesity was greater in urban areas in a comparative research in West Bengal. However, the proportions represented in that research in rural regions were remarkably similar to the current study's baseline results. Craig et al.27 discovered that female sex had a significant impact on the development of obesity in rural South Africa. The present study's conclusions were corroborated by the generated risk estimations, which were certainly high. This was also the case in numerous India studies21,25,26, and it is consistent with the NFHS-4 findings. Several writers researching obesity risk factors have concluded that behavioural change, nutrition, and physical activity have a role,23,24,26 but have not been able to distinguish the impact magnitude or relative risk of these behavioural variables. The present research provided risk estimates for multiple modifiable variables while controlling for nonmodifiable factors due to its longitudinal approach.

There is substantial evidence that eating behaviours are more strictly associated to teenage obesity. Although theoretically conflicting, the physical activity variables did not demonstrate statistical significance separately in the core model. However, the interaction model was used to determine the relevance of the cumulative impact. Age was shown to be a more relevant predictor of overweight and obesity in females than in boys. Fast food consumption, followed by soft drink use, was found as the most important risk factor among the dietary variables investigated. These are especially crucial in the case of females. The reason for this might be because females in rural areas consume more of these products than boys. However, the research found that reduced vegetable consumption was more harmful in males. The most plausible reason for this is that males consume less vegetables than girls, while enjoying a higher calorie and protein-rich diet. Goyal et al.26 shown that lifestyle variables have a large impact on overweight and obesity, which are comparable across socioeconomic categories. However, the invariance of impact across groups was not investigated at this time; rather, the cumulative or crude measure of effect was observed.

The risk factors for NCDs are widely established to comprise a spectrum with complicated interrelationships. The present research tried to capture the influence of two chosen obesity-related variables while controlling for several nonmodifiable confounders. However, one of the study's limitations is the use of questionnaires, since deliberate fabrication by respondents will always result in a biassed result. Because portions of a class were chosen, the research may have experienced selection bias during the early phase. Despite being a school-based research, an individual-level longitudinal study was done, addressing the likely cause of ecological fallacy. In the future, a higher power interventional design (bigger sample size) will aid in obtaining a more exact outcome. The study's suggestions were that good food behaviours and physical exercise be encouraged to reduce the risk of obesity. It is also necessary to raise awareness among females about the dangers of junk food and soft drinks. Because farming is still the prevalent vocation in rural regions, teenagers should be encouraged to eat more fruits and vegetables; nevertheless, this is especially important for male children. Teachers and parents should be taught and motivated about adolescent behavioural change training. With the pandemic proportions of overweight and obesity, frequent school-based health exams are a universal need.

CONCLUSIONS

There was strong evidence that eating patterns were more strictly associated to overweight among teenagers. To reduce the risk of obesity, healthy eating habits and physical exercise should be encouraged.

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