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Exploring the Association between Energy Dense Food Consumption, Physical Activity, and Sleep Duration and BMI in Adolescents

Yasmeen Nazia[1*] and Tanveer Fatima[2]

[1]Student of M.Sc Nutrition and Dietetics, [2]Assistant Professor,

Department of Nutrition and Dietetics, Anwar Ul Uloom, PG College,

Affiliated to Osmania University, Hyderabad, India

*Corresponding Author E-mail: ynazia7@gmail.com

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ABSTRACT

Adolescence is a period of development where factors like pubertal circadian shift, early school start times, social pressures and the prevalence of technological devices lead to decrease in the amount of sleep on school nights. One possible consequence of reduced duration of sleep is an increased risk of weight gain. BMI also increases with less physical activity and unhealthy eating habits or eating energy dense food. Adolescents in the world are becoming less physically active and are increasingly adopting a sedentary lifestyle in front of computers and television screens. Against the above background, a study was conducted of the associations between eating energy dense food consumption, physical activity, sleep duration and overweight/obesity in a sample of Indians 12 to 19 years old adolescents. The aim of this study was to explore the associations between sleep duration, physical activity, eating habits and overweight/obesity in adolescents. Dietary intake was measured by food frequency questionnaire; body mass index was calculated according to IOTF. Boys were found to be more physically active and high percentage of normal BMI when compared to girls. Among 200 adolescents 124 were of normal weight (5th percentile), 30 overweight (23 kg/m2) 85th percentile, 3 obese (28 kg/m2) 95th percentile, 2 were grade 1 obese (>95th percentile, 35 kg/m2). Statistical significance was observed between physical activity, junk food, BMI, intake of beverages at p<0.05

Key words: *Body mass index, Physical activity, Sleep duration, Overweight, Obesity.*

INTRODUCTION

Poor lifestyle factors are thought to account for an increase in BMI, indirectly affecting the clustering of CHD risk factors. Lifestyle factors such as eating unhealthy foods and physical inactivity may contribute to the development of overweight status in adolescents[1]. High-fat convenience foods such as French fries and inexpensive high-calorie foods such as muffins and potato chips are thought to contribute to the increased prevalence of overweight status in youth. Furthermore, there are few opportunities and little encouragement for youth to be physically active to counterbalance the excess calories and fat consumed from foods and beverages[2].

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Fewer students are attending daily physical education classes, and walking or biking to school. Therefore, youth today are largely physically inactive and aerobically unfit. Together, over-consumption of high fat and high-calorie foods and beverages, physical inactivity, and low aerobic fitness may contribute to the development of overweight status in youth[4]. The proportion of adolescents who are overweight and obese has increased dramatically in developed and some developing countries during the past few decades[5].

The prevention of overweight/obesity conventionally focuses on nutrition and physical activity[6]. Recently, the concentration has been shifted to sleep, a newly recognized modifiable factor. Previous epidemiologic studies in Western countries have obtained evidence of associations between sleep duration and overweight/obesity in adolescents. However, little is known in non-Western settings, in which the social patterning of both sleep and overweight/obesity of adolescents could be divergent[8].

Longitudinal data from a large cohort of adolescents showed that girls who reported higher energy intakes, less physical activity, and more television viewing had larger increases in BMI over 1 year. An increase in the consumption of foods with added sweeteners is also of concern. National data indicate that the majority of added sweeteners in the diets of boys and girls 12 to 17 years of age comes from soda and fruit drinks. Therefore, the objective of this study was to describe the pattern of energy-dense food intake, physical activity and sleep duration in adolescents, and their association with body mass Index (BMI).

OBJECTIVES

- To study the associations between energy-dense foods, physical activity, sleep duration and BMI among adolescents aged 12-19 years.
- To understand the inter-relationship between lifestyle factors in adolescents and its effect on Body Mass Index.
- To investigate the association of underweight and overweight with eating habits, physical activity, sleep among adolescents in India.
- To compare the diet quality indications and anthropometric measures between short and long sleepers.
- To investigate the associations between sleep duration and obesity rate among adolescents.

MATERIAL AND METHODS

Sample

The sample comprises 200 adolescents (85 boys, 115 girls), aged 12-19 years, from different schools and colleges from Hyderabad. This is a convenience sample. A cross-sectional.

Physical Activity

In order to assess the level of physical activity of children, the questionnaire included: the time spent watching TV/video during most days of the week and practice of sports activities besides the physical education classes at school.

Sleep Duration

Sleeping duration (recorded in hours per day, and classified for the analysis into four categories: less than 8 h/day; 9 h/day; and 10 h/day or more). Sleep duration during school days and during holidays were included in the questionnaire.

Dietary Intake

Respondents were asked to report the frequency of their food consumption by completing a self-administered, food frequency questionnaire (FFQ).

Anthropometric Measurements

Anthropometric measurements were recorded according to standardized procedures. Height was measured using a standiometer, and weight was measured using an electronic scale, without shoes and using light indoor clothing. BMI was computed and the prevalence of underweight, normal weight, overweight and obesity were calculated.

Sedentary behaviors

Questions on sedentary behaviors were aimed to determine important information from

adolescents related to the typical daily time spent on sedentary activities, including time spent viewing TV, playing video games, mobile phone and computer and Internet use.

Data analysis:

Data was collected, consolidated and subjected to statistical analysis using statistical measures such as standard deviation, chi- square test ($p<.05$), linear regression, graphical representation.

Chi square was applied, whose formula is given below:

$$X^2 = \sum_{i=1}^{r}\sum_{j=1}^{c} \frac{(O_{i,j} - E_{i,j})^2}{E_{i,j}}.$$

Where,

O = observed value

E = expected value

Eij = R × C ÷ N

RESULTS AND DISCUSSION

Table 1: Gender Percentages

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MALE	85	42.5	42.5	42.5
	FEMALE	115	57.5	57.5	100.0
	Total	200	100.0	100.0	

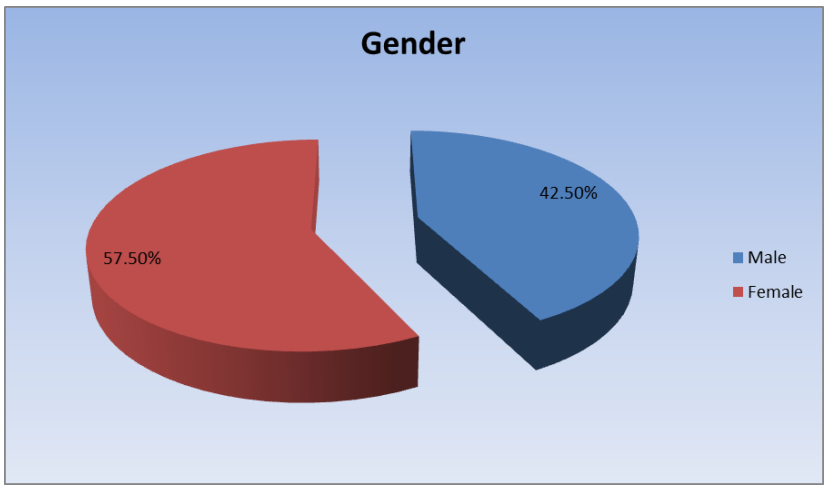

Fig. 1: Genders

The study was conducted with 200 samples which included 85 (42.5%) respondents were Male and 115 (57.5%) were Female (figure 1) above table shows the detail percentages.

Table 2: Classification of BMI According To Gender

		Classification of BMI					Total
		underweight	Normal	Overweight	Obese	Class 1 Obese	
GENDER	MALE	16	54	14	1	0	85
	FEMALE	25	70	16	4	2	115
Total		41	124	30	3	2	200

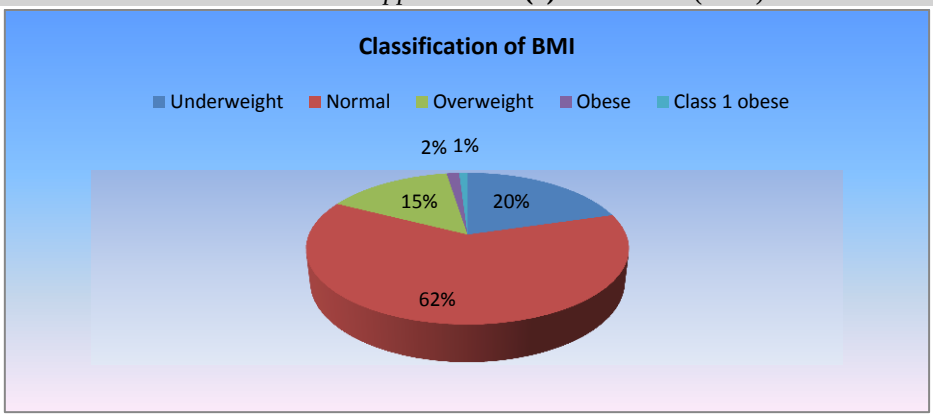

Fig. 2: Classification of BMI

Among 200 respondents only 2% (3) students were obese and 15% were overweight 23 kg/ m^2 and 20% underweight and 62% were of normal weight. According to gender 54 boys were of normal weight, 16 underweight, 14 were overweight and none of the boys were found to be obese. On the other hand 2 girls were found to be obese, 2 class 1 obese 35 kg/m^2 16 overweight, 70 of normal weight and 32 underweight.

Table 3: Physical Activities

	Frequency	Percent	Valid Percent	Cumulative Percent
never	18	9.0	9.0	9.0
once a week	33	16.5	16.5	25.5
4-5 times a week	24	12.0	12.0	37.5
2-3 times a week	42	21.0	21.0	58.5
everyday	83	41.5	41.5	100.0
Total	200	100.0	100.0	

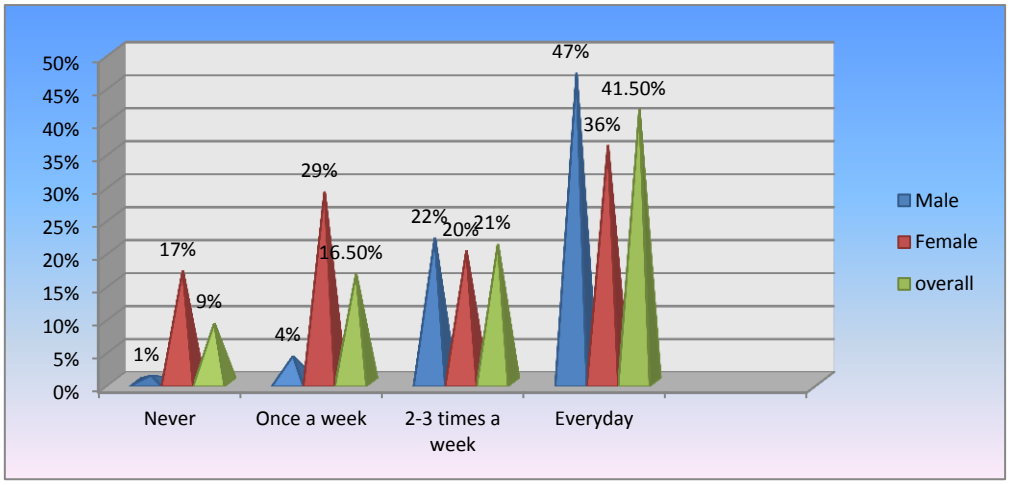

Fig. 3: Physical activities

Eight three percent respondents did physical activity everyday while others participated in physical activity 4-5 times a week (24%) 2-3 times a week (42%) or once a week (33%). Eighteen percent never did any physical activity. (Table: 3) 47 boys did physical activity every day while 22 boys did physical activity 2-3 times a week, 11 boys 4-5 times a week, 4 boys once a week and only 1 boy never did any physical activity. On the other hand girls have low level of physical activity with 17 girls never did any physical activity, 29 girls did once a week, 13 girls 4-5 times a week, 20 girls 2-3 times a week and 36 girls did physical activity every day.

Table 4: Standard Deviation Age, Gender and BMI

			Statistic	Bootstrap[a]			
				Bias	Std. Error	95% Confidence Interval	
						Lower	Upper
N	Valid	AGE	200	0	0	200	200
		GENDER	200	0	0	200	200
		BMI	200	0	0	200	200
	Missing	AGE	0	0	0	0	0
		GENDER	0	0	0	0	0
		BMI	0	0	0	0	0
Mean		AGE	14.98	.00	.15	14.69	15.27
		GENDER	1.58	.00	.04	1.51	1.65
		BMI	20.380	.003	.256	19.895	20.887
Median		AGE	14.00	.08	.26	14.00	15.00
		GENDER	2.00	-.02	.14	2.00	2.00
		BMI	19.900	-.056	.313	19.100	20.300
Std. Deviation		AGE	2.096	-.005	.077	1.936	2.248
		GENDER	.496	-.001	.006	.480	.501
		BMI	3.5726	-.0188	.2876	3.0299	4.1497
Percentiles	100	AGE	19.00	.00	.00	19.00	19.00
		GENDER	2.00	.00	.00	2.00	2.00
		BMI	35.500	-.468	1.336	32.270	35.500

The study included a sample of 200 adolescents, school and college students aged 12-19 years. Sample contains 42.5% Boys and 57.5% girls, Median age was 14.98 and mean age was 14 overall 51(26%) children were underweight, 127 (63.5) were of normal weight, 17(8.5%) overweight and 4 (2%) were obese. Mean (SD) BMI was 20.3, Median BMI was 19.9.

Table 5: Associations between Gender and Physical Activities

*GENDER * Physical activity Cross tabulation*

		never	once a week	4-5 times a week	2-3 times a week	everyday	
GENDER	MALE	1	4	11	22	47	85
	FEMALE	17	29	13	20	36	115
Total		18	33	24	42	83	200

Category	Never	Once a week	4-5 times a week	2-3 times a week	Everyday	Row total
Male	1 (7.65) [5.78]	4 (14.02) [7.17]	11 (10.20) [0.06]	22 (17.85) [0.96]	47 (35.28) [3.90]	85
Female	17 (10.35) [4.27]	29 (18.98) [5.30]	13 (13.80) [0.05]	20 (24.15) [0.71]	36 (47.72) [2.88]	115
Column total	18	33	24	42	83	200

200 students were sampled and there physical activity was evaluated. A chi- square test was performed and there is statistical significance. The chi-square statistic is 31.0807. The *p*-value is < 0.00001. The result is significant at $p < .05$.

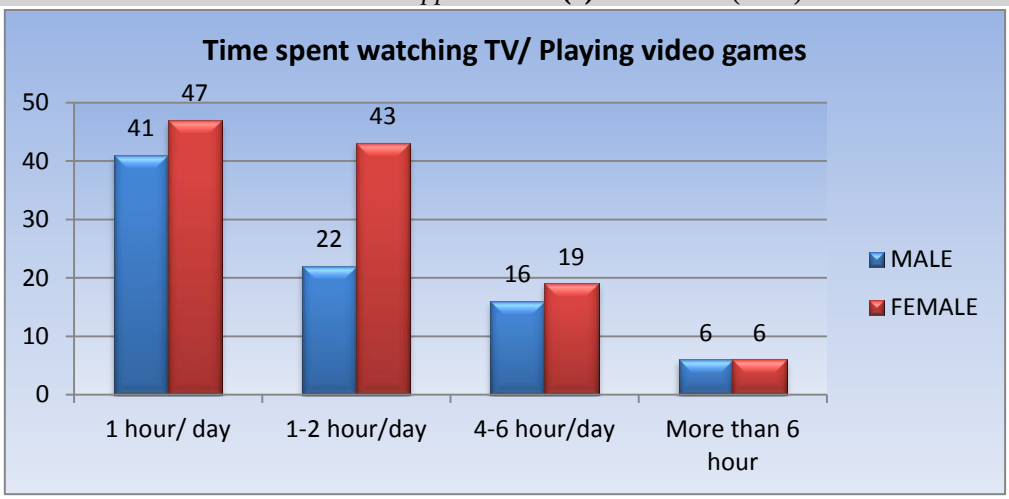

Fig. 6: Time spent watching TV/ playing video games

Forty four percent (88) respondents used to watch TV or play video games for 1 hour daily while 32.5% (65) for 1-2 hours/day and 17.5% (35) for 4-6 hours/ day, 6% (12) watched TV for more than 6 hours daily. (Figure 7) more percentage of females spent their time watching TV or playing video games (47, 43 for 1 hour and 1-2 hours respectively). Watching TV or playing games are considered as sedentary behavior which could affect BMI and sleep habits.

Table 7: Time Spent Using Mobile Phone

		Time spent using Mobile phone				Total
		1 h/day	1-2 h/day	4-6 h/day	more than 6 h /day	
GENDER	MALE	37	26	6	16	85
	FEMALE	46	33	22	14	115
Total		83	59	28	30	200

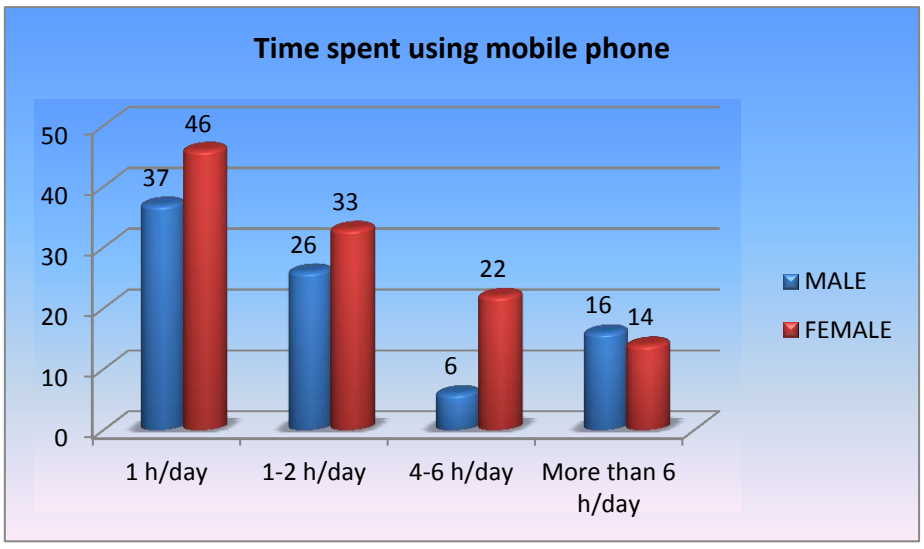

Fig. 7: Time spent using mobile phone

Girls compared to boys spent more time using mobile phone with 46 girls using mobile for 1 hour daily, 33 for 1-2 hours, 22 for 4-6 hours and 14 for more than 6 hours. On the other hand 37 boys used mobile phone for 1 hour, 26 for 1-2 hours, 6 for 4-6 hours, and 16 for more than 6 hours. (figure 7) when sedentary behavior of girls is compared with boys, girls

spent more time watching TV and using mobile phone and was also less physically active in comparison with boys.(figure 6)

Table 8: Linear Regression Analyses of Physical Activity, BMI and Gender

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.906	2	1.953	4.967	.008[b]
	Residual	77.449	197	.393		
	Total	81.355	199			

a. Dependent Variable: Classification of BMI

b. Predictors: (Constant), Physical activity, GENDER

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.285	.211		6.102	.000
	GENDER	-.082	.097	-.063	-.844	.400
	Physical activity	-.108	.035	-.235	-3.133	.002

a. Dependent Variable: Classification of BMI

A simple linear regression was calculated to predict BMI based on physical activity, gender b= -.063, -.235, t=6.102, , p<.001. A significant regression equation was found (F(2,197)= 4.967, p<.008, with an R2 of .048

Table 9: Sleep Duartion during School Nights

Hours of sleep on school days

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 8 h/day	155	77.5	77.5	77.5
	9 h/day	35	17.5	17.5	95.0
	10 h/day	8	4.0	4.0	99.0
	More than 10 h/day	2	1.0	1.0	100.0
	Total	200	100.0	100.0	

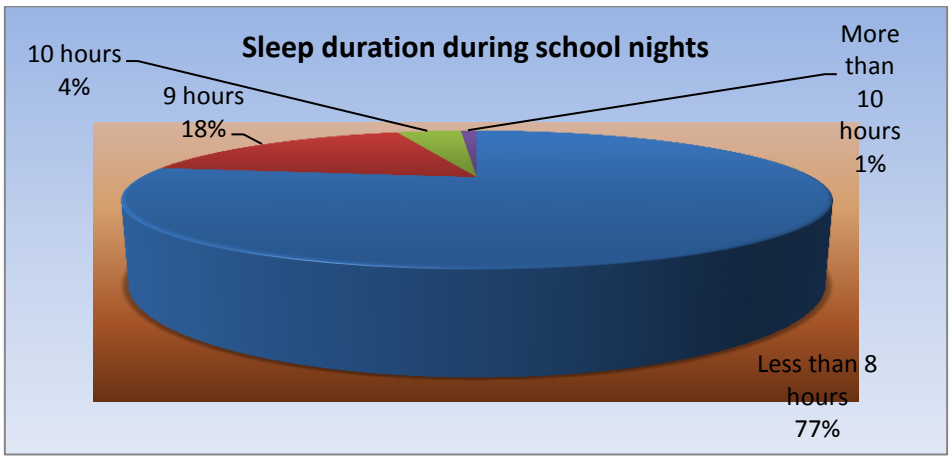

Fig. 9: Sleep duration during school nights

According to the data collected about 155 students get less than 8 hours of sleep during school night, 35 students get 9 hours of sleep and 8 students get 10 hours of sleep. Only 2 students used to sleep more than 10 hours during school nights. Less than 8 hours of sleep could affect the circadian rhythm.

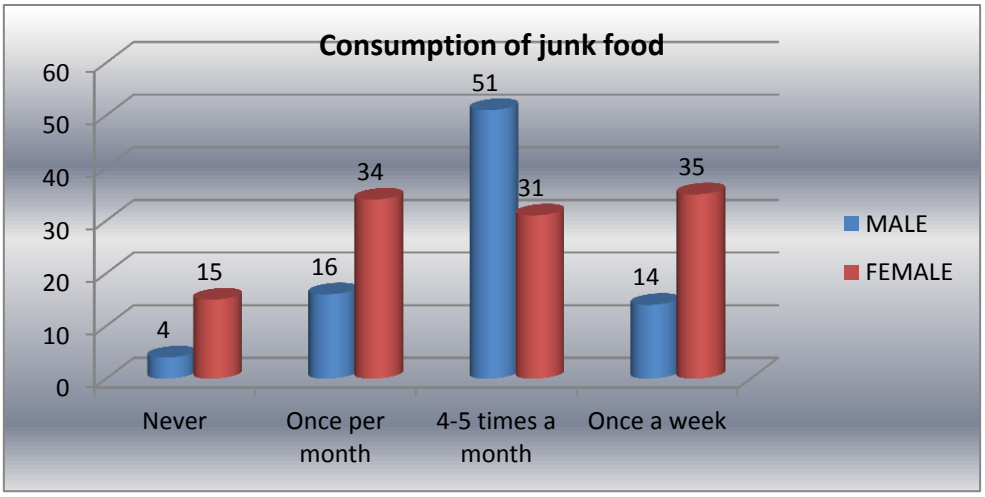

Fig. 10: Consumption of junk food

About 51 boys used to consume junk food 4-5 times a month, 16 once per month, 14 once a week, 4 boys never consume junk food. On the other hand 35 girls used to have junk food once a week, 31 4-5 times a month, 34 once per month, 15 never consume junk food.

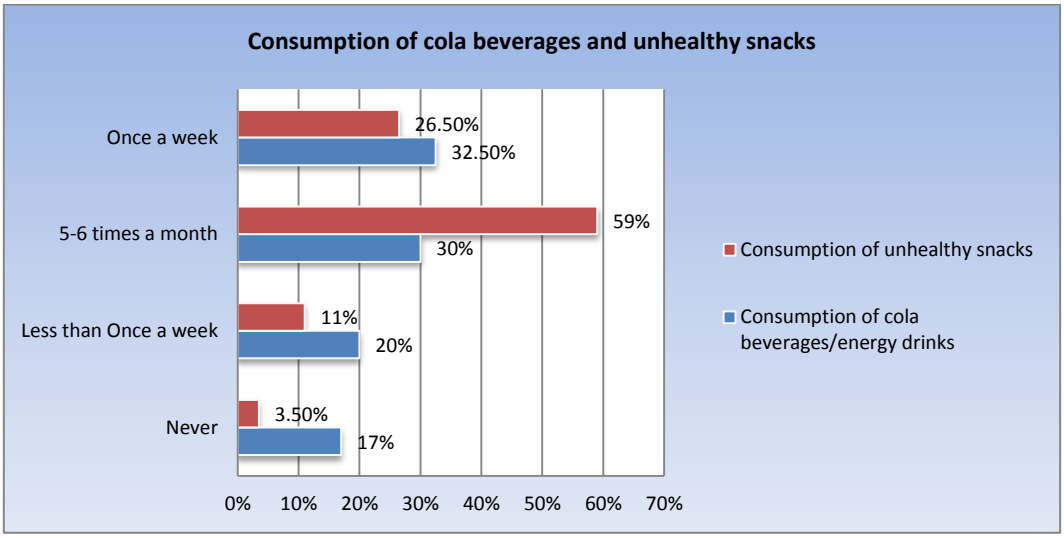

Fig. 11: Consumption of cola beverages and unhealthy snacks

Above figure represents the consumption of cola beverages and unhealthy snacks. 59% of respondents used to consume unhealthy snacks 5-6 times a month, 26.5% once a week, 11% once a week, 3.5% never consume snacks. While cola beverage is less at 32.5% once a week, 30 % 5-6 times a week, 20 % less than a week, 17% never drink any aerated beverages. (Table: 11) represents the detailed frequency and percentages for both snacks and cola beverages.

TABLE: 5.12 ASSOCIATION BETWEEN GENDER AND JUNK FOOD CONSUMPTION

	NEVER	LESS THAN ONCE A WEEK	5-6 TIMES A MONTH	ONCE A WEEK	*Row Totals*
1 HOUR	17 (14.96) [0.28]	19 (18.48) [0.01]	31 (25.96) [0.98]	21 (28.60) [2.02]	88
1-2 HOUR	7 (11.05) [1.48]	21 (13.65) [3.96]	16 (19.18) [0.53]	21 (21.12) [0.00]	65
4-6 HOUR	5 (5.95) [0.15]	1 (7.35) [5.49]	9 (10.32) [0.17]	20 (11.38) [6.54]	35
M0RE THAN 6 HOUR	5 (2.04) [4.29]	1 (2.52) [0.92]	3 (3.54) [0.08]	3 (3.90) [0.21]	12
Column Totals	34	42	59	65	**(Grand Total)200**

A chi-square test was performed to examine the relationship between junk food consumption and gender. The chi-square statistic is 22.7381. The p-value is .000046. The result is significant at $p < .05$

Table 13: Assocaition Between Sedentry Behavior and Cola Beverage Intake

	Never	Once a month	4-5 times a month	once a week	***Row Totals***
Male	4 (8.07) [2.06]	16 (21.25) [1.30]	51 (34.85) [7.48]	14 (20.82) [2.24]	85
Female	15 (10.92) [1.52]	34 (28.75) [0.96]	31 (47.15) [5.53]	35 (28.18) [1.65]	115
Column Totals	19	50	82	49	200 (Grand Total)

A chi-square test was performed to know the association between sedentary behavior (watching TV/ playing video games and intake of cola beverages. The chi-square statistic is 27.1088. The *p*-value is .001342. The result is significant at $p < .0$

SUMMARY AND CONCLUSION

This was a cross-sectional, questionnaire based study on 200 otherwise healthy adolescents (male and female) aged 12 – 19 years. The aim of present study is to explore associations among a range of sedentary behaviors, sleep habits, healthy and unhealthy dietary intakes among adolescents. The findings suggested that screen based sedentary behavior like watching TV/ playing video games are more strongly associated with unhealthy dietary intake. Studies have found that TV viewing is positively associated with fast-food intake and inversely associated with fruit and vegetable intake. There could be a number of factors like mindless eating that could lead to overeating. Family and peers may also influence both screen time and dietary behavior among adolescents, although further research regarding peer influences on sedentary behaviors is required. According to the findings majority of the samples were physically active with 47% boys doing some form of physical activity every day, while 17% of girls never did any physical activity.

A cut-off point of 30 kg/m^2 and 25 kg/ m^2 are recognized internationally as a definition of obesity and overweight in adults. BMI equivalent of 23 and 28 kg/m2 as advised for Asian populations, to derive cut-offs for screening for risk of overweight and obesity for Indian children. However, BMI in children changes substantially with age, thus, age-specific cut-off points are needed. The 85th and 95th percentile have been used as cut-offs to define overweight and obesity, respectively in children.

Even when we look at the overweight and obese category among the respondents, 3 girls were found to be obese, 2 class1 obese 95^{th} percentile (35 kg/m^2) and 16 were overweight 85^{th} percentile, while only one boy was found to be obese 95^{th} percentile (35 kg/m^2)and 14 were overweight 85^{th} percentile (23 kg/m^2). Fifty four boys were of normal weight and 16 underweight. 70 girls were of normal weight and 25 underweight. Overall

when we look at the BMI so boys are more physically active and less overweight and obese. This is suggestive that physical activity helps in maintenance of healthy weight among adolescents. Females were significantly ($p < 0.05$) more sedentary, much less physically active, and they consumed unhealthy snacks and junk food more often than boys. While boys used to eat out more often than girls, 34 boys used to eat out 2-3 times a week. Screen time was significantly ($p < 0.05$) correlated with intake of sugar sweetened beverages.

In this study, children had a healthy intake of fruits and vegetables with frequency of 5-6 times a week for the majority. Parent's education has an impact on choice of healthy food intake, 131 parents were graduates and 44 were intermediate passed. There was a statistically significant association between consumption of junk food and gender ($p< 0.05$), BMI and physical activity ($p<0.05$)

In conclusion, this study has presented a relationship between physical activity, energy dense food consumption and sleep habits of Indian adolescents. While there were overweight and obese children but most of them were found to be physically active and had a good intake of fruits and vegetables. Beverage consumption and sedentary lifestyle (watching TV, Playing video games, using the mobile phone) have a significant association ($p<0.05$). This study also has limitations. Sleep duration was self-reported, and it was not possible to measure sleep quality. Since respondents of this study belonged to average socioeconomic status food consumption, physical activity and other lifestyle behavior could vary when compared to adolescents belonging to higher socioeconomic status.

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