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Research Article

Prevalence of Overweight and Obesity among School Going Children of Lucknow

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Abstract

Aim and Objectives: To assess the prevalence of overweight and obesity among urban school going children aged 10 - 15 years and identify associated risk factors.

Materials and Methods: A descriptive cross sectional study was carried out among 1000 school children in the targeted age group. Data was collected using structured proforma. Demographic details were noted, weight and height of children were measured and BMI was calculated. The nutritional status of children was evaluated using gender-specific BMI for age criteria. Overweight was classified as > 85th percentile and Obesity was classified as > 95th percentile value and prevalence of metabolic syndrome components in high risk (overweight/obese) children was assessed.

Results: Prevalence of Overweight and obesity among children aged 10 - 15 years was found to be 11.30% and 1.10% respectively with higher proportion of males being obese (63.64%). The study confirmed positive association of obesity with outdoor eating, consumption of bakery/confectionary, soft drinks, ice-cream and sedentary life style. Although no significant association of components of metabolic syndrome was found in high risk students.

Conclusion: The present study highlighted association of dietary factors and physical activity with overweight and obesity. Creating awareness among school goers on negative health effect of obesity is the key for maintaining good health.

Keywords: *Overweight; Obesity; Children*

Introduction

Childhood obesity is a condition where excess body fat negatively affects a child's health or wellbeing. Due to the rising prevalence of obesity in children and its various adverse health effects it is being recognized as a serious public health concern of 21st century [1]. The prevalence of obesity has increased at an alarming rate. Globally in 2010 the number of overweight children under the age of five is estimated to be over 42 million. Close to 35 million of these are living in developing countries [2]. Obesity is a precursor of many physical and psychological problems that a child has to cope with. It can also lead to life-threatening conditions including diabetes, high blood pressure, heart disease, sleep problems, cancer, and other disorders. Recent research has shown a significant relationship between childhood obesity and metabolic syndrome in adulthood in longitudinal studies [3] as well as prevalence of metabolic syndrome in childhood itself [4]. Considering the menace of obesity and its possible linkage with much serious disorders like metabolic syndrome, it is essential

to understand the problem and discuss its various aspects. Identification of obesity and components of metabolic syndrome in its inception among school children will help in starting the lifestyle modifications at an early stage and ultimately help in reducing the burden of morbidity owing to obesity and metabolic syndrome. The present study shall aim to investigate this problem in urban school children in Lucknow.

Aim of the Study

The present study was carried out with the aim to assess the prevalence of overweight and obesity among urban school going children aged 10-15 years.

Objectives of the Study

This aim was fulfilled with the help of following objectives.

Primary Objective

To assess the prevalence of overweight and obesity among urban school going children aged 10 - 15 years.

Secondary objectives

1. To identify the gender based prevalence of overweight and obesity among 10 - 15 years old school children.
2. To assess dietary pattern and activity level among children and to find out an association between these variables and overweight and obesity.
3. To find out an association of socioeconomic and demographic characteristics with overweight and obesity.
4. To screen the overweight and obese children for different components of metabolic syndrome *viz.* BMI, blood pressure, fasting glucose levels, triglyceride and high density lipoprotein levels.
5. To assess the prevalence of metabolic syndrome in overweight and obese children.

Materials and Methods

This cross sectional study was carried out among school going children of Central school, Aliganj, Lucknow city. The investigations and further work-up of study was done at Department of Pediatrics, Vivekananda Polyclinic and Institute of Medical Sciences, Lucknow. Study duration was one and half year from September 2015 to May 2017.

Sample size with justification

As in a previous study by Friend., *et al.* [5], prevalence of metabolic syndrome in obese school children has been reported to be 29.2%. We also targeted a similar prevalence in the targeted population. The sample size was calculated using the following formula:

$$n = C^2 \frac{p(1-p)}{e^2}$$

Thus at 95% confidence and 80% power, the calculated sample size was 80 for obese children. Considering the fact that obese children form nearly 10% of total sample, we required a sample size 80*10 = 800. Considering a dropout rate of around 20% for the Part II of study, we carried out the study in nearly 1000 school children in the targeted age group of 10 - 15 years studying within the municipal limits of Lucknow city. Children/parents not willing to participate were excluded from the study. A self-designed questionnaire was used to interview the study participants to elicit information on socio demographic profile, physical activity pattern, dietary intake and anthropometric measurements. Average dietary intake was estimated by 3-day 24-hr dietary recall method. The study was carried out in two parts as follows:

Part I: Screening for overweight and obesity

Evaluation of overweight and obesity was done using anthropometric measurements. Body weight, waist circumference and height of the children was measured. BMI was calculated. Children having BMI > 85th percentile of gender-specific BMI for age value were defined as overweight and those having BMI > 95th percentile were defined as obese. The overweight and obese children thus screened as per WHO criteria were recruited for Part II of the study.

Part II: Screening for metabolic syndrome

All the overweight and obese children were further evaluated for prevalence of metabolic syndrome factors:

- Blood pressure
- Fasting blood sugar
- Triglyceride levels
- High density lipoprotein levels.

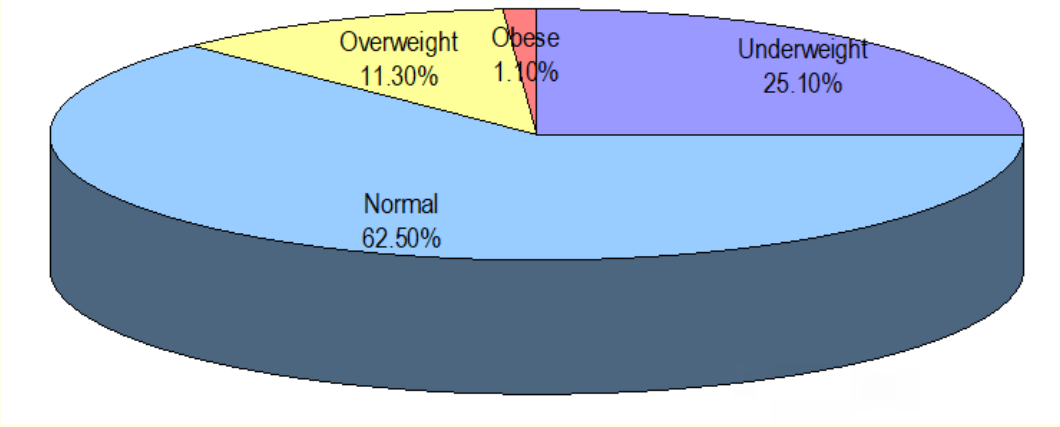
Metabolic syndrome was defined using modified International Diabetic Federation (IDF) criteria with either waist circumference > 90th percentile or > 85th percentile BMI taken as indicator of obesity. > 90th percentile waist circumference was evaluated against the age- and gender specific waist circumference for Indian children and adolescents. For BMI, WHO gender specific BMI for age charts were consulted.

The study protocol was approved by ethical committee of Vivekananda Polyclinic and Institute of Medical Sciences, Lucknow. Prior consent for the study was taken from the school administration and from the parents. At the time of the initiating the study the parents of each participant were informed about the study protocol and written consent was obtained to their child's participation.

Statistical analysis

Data was analyzed by using descriptive and inferential statistics. Statistical Package for Social Sciences version 21.0 was used for analyzing the data. Mean, median, standard deviation and percentage distribution were calculated to describe the demographic variables. Chi-square test, 't'-test and ANOVA were used to find out association between different variables.

Results



Graph 1: *Distribution of study population according to nutritional status [3].*

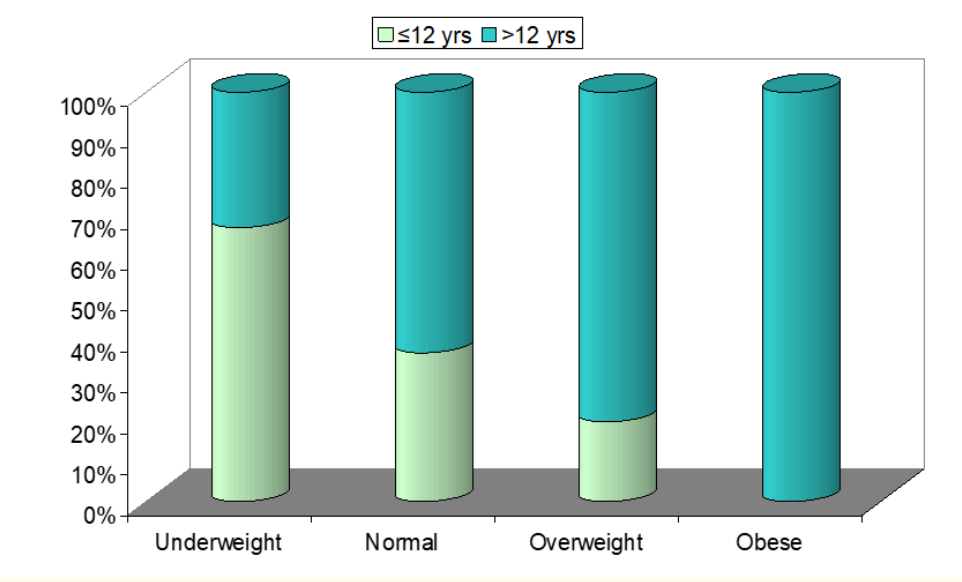
Nutritional Status	Description	No. of Subjects	Percentage
Underweight	BMI < 5th percentile	251	25.10
Normal	BMI 5th to 85th percentile	625	62.50
Overweight	BMI > 85th to 95th percentile	113	11.30
Obese	BMI > 95th percentile	11	1.10

Table 1: *Distribution of study population according to nutritional status [3].*

Out of 1000 students enrolled in the study, majority (62.50%) had normal nutritional status. Approximately one-fourth students were found to be underweight (25.10%). Prevalence of overweight and obesity was 11.30% and 1.10% respectively.

Age Group	Total (N = 1000)	Underweight (n = 251)		Normal (n = 625)		Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%	No.	%	No.	%
≤12 yrs	417	168	66.93	227	36.32	22	19.47	0	0.00
>12 yrs	583	83	33.07	398	63.68	91	80.53	11	100.00
		$\chi^2 = 104.013$ (df = 3); $p < 0.001$							
Mean ± SD	12.73 ± 1.72	11.87 ± 1.59		12.90 ± 1.70		13.53 ± 1.33		14.26 ± 0.65	

Table 2: *Association of age with nutritional status.*

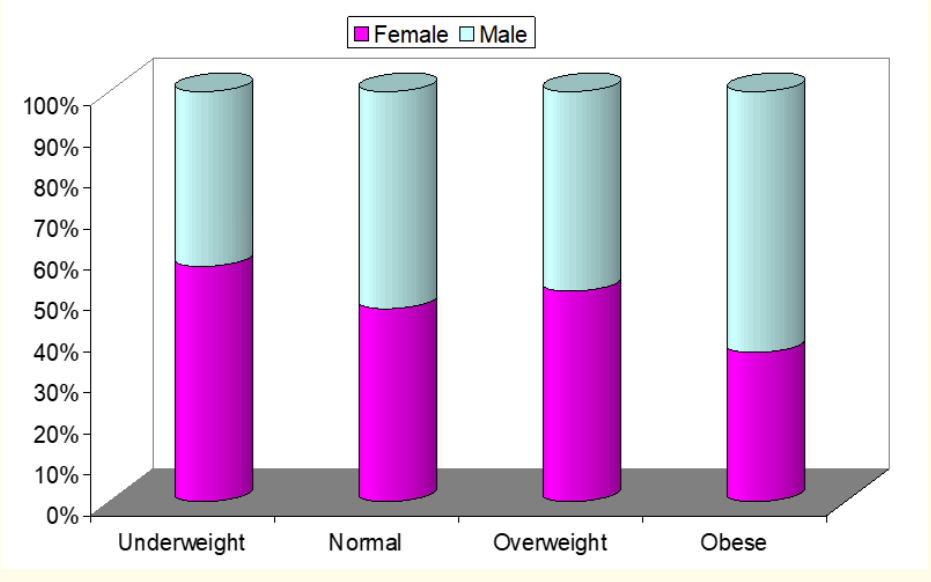


Graph 2: *Association of age with nutritional status.*

Proportion of students aged ≤ 12 years was higher among underweight (66.93%) compared to normal (36.32%), overweight (19.47%) and obese (0.00%), difference being statistically significant. All the obese students were aged > 12 years. Mean age of obese students (14.26 ± 0.65 years) was found to be higher than that of overweight (13.53 ± 1.33 years), normal (12.90 ± 1.70 years) and underweight (11.87 ± 1.59 years).

Gender	Total (N = 1000)	Underweight (n = 251)		Normal (n = 625)		Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%	No.	%	No.	%
Female	500	144	57.37	294	47.04	58	51.33	4	36.36
Male	500	107	42.63	331	52.96	55	48.67	7	63.64
		χ^2 = 8.542 (df = 3); p = 0.036							

Table 3: *Association of gender with nutritional status.*

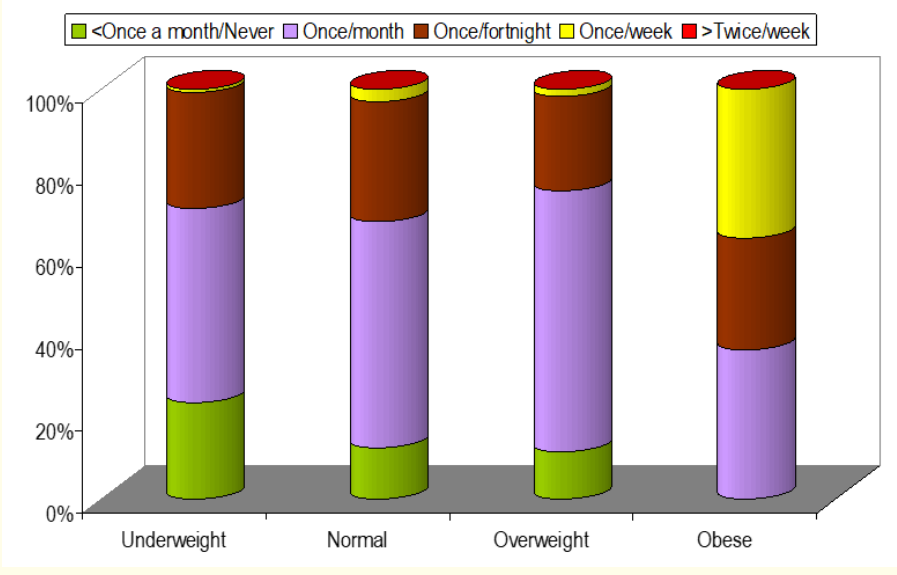


Graph 3: *Association of gender with nutritional status.*

Out of 1000 students, proportion of male: female was one: one. 63.64% boys were obese compared with only 36.6% of girls, p = 0.03.

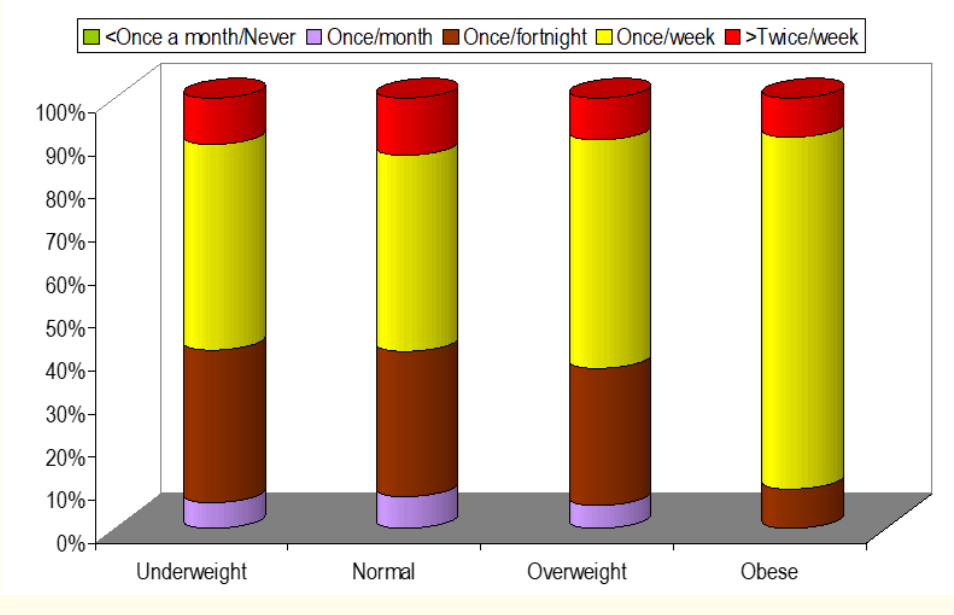
Frequency of Eating Outside	Total (N = 1000)	Underweight (N = 251)		Normal (N = 625)		Overweight (N = 113)		Obese (N = 11)	
		No.	%	No	%	No	%	No	%
< Once a month/Never	150	59	23.51	78	12.48	13	11.50	0	0.00
Once/month	540	119	47.41	345	55.20	72	63.72	4	36.36
Once/fortnight	283	71	28.29	183	29.28	26	23.01	3	27.27
Once/week	27	2	0.80	19	3.04	2	1.77	4	36.36
> Twice/week	0	0	0.00	0	0.00	0	0.00	0	0.00
		χ^2 = 73.618 (df = 9); p < 0.001							

Table 4: *Association of frequency of eating outside with nutritional status.*



Graph 4: *Association of frequency of eating outside with nutritional status.*

Proportion of obese students was higher compared to underweight, normal and overweight students who had increased frequency of outside eating once/week (36.36% vs. 0.80%, 3.04% and 1.77%). Association of frequency of visits for outside eating and nutritional status of students was found to be statistically significant ($p < 0.001$).



Graph 5: *Association of frequency of fast food intake with nutritional status.*

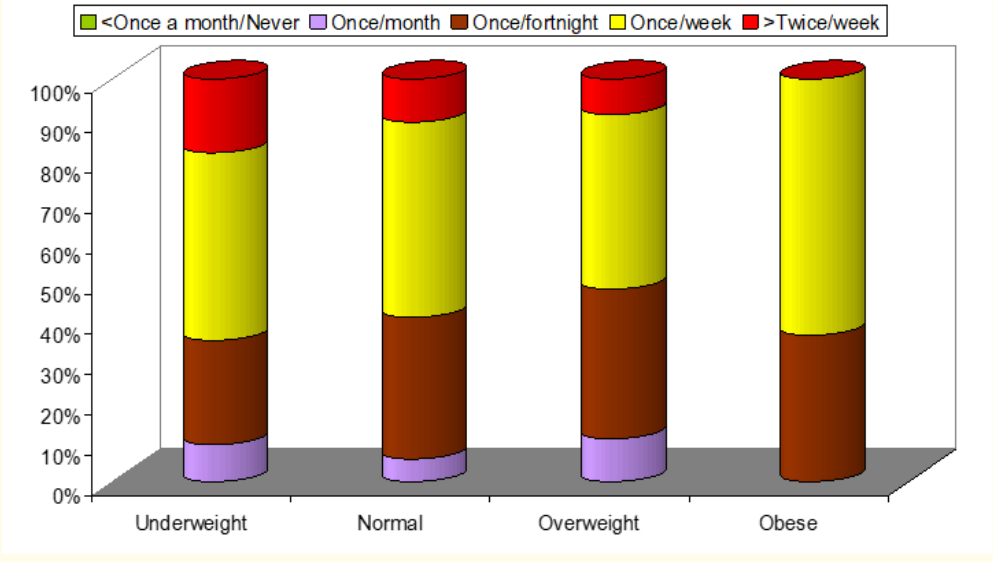
Frequency of Fast Food Intake	Total (N = 1000)	Underweight (n = 251)		Normal (n = 625)		Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%	No.	%	No.	%
< Once a month/ Never	0	0	0.00	0	0.00	0	0.00	0	0.00
Once/month	67	15	5.98	46	7.36	6	5.31	0	0.00
Once/fortnight	337	89	35.46	211	33.76	36	31.86	1	9.09
Once/week	474	120	47.81	285	45.60	60	53.10	9	81.82
> Twice/week	122	27	10.76	83	13.28	11	9.73	1	9.09
		χ^2 = 9.622 (df = 9); p = 0.382							

Table 5: *Association of frequency of fast food intake with nutritional status.*

Though proportion of obese was higher than that of underweight, normal and overweight students having increased frequency of fast food intake once/week (81.82% vs. 47.81%, 45.60% and 53.10%) but association was not found to be statistically significant.

Frequency of Softdrinks/ Icecream	Total (N = 1000)	Underweight (n = 251)		Normal (n = 625)		Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%	No.	%	No.	%
< Once a month/Never	0	0	0.00	0	0.00	0	0.00	0	0.00
Once/month	70	23	9.16	35	5.60	12	10.62	0	0.00
Once/fortnight	334	65	25.90	220	35.20	42	37.17	4	36.36
Once/week	473	117	46.61	303	48.48	49	43.36	7	63.64
> Twice/week	123	46	18.33	67	10.72	10	8.85	0	0.00
		χ^2 = 23.982 (df = 9); p = 0.004							

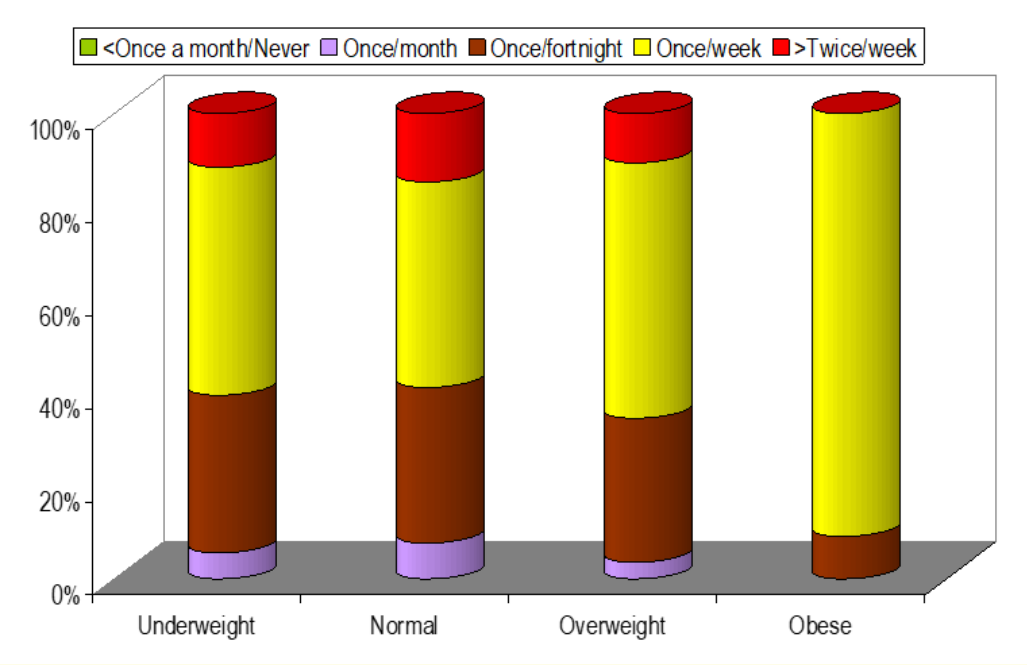
Table 6: *Association of frequency of softdrinks/icecream consumption with nutritional status.*



Graph 6: *Association of frequency of softdrinks/icecream consumption with nutritional status.*

Frequency of Bakery product consumption	Total (N = 1000)	Underweight (n = 251)		Normal (n = 625)		Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%	No.	%	No.	%
< Once a month/Never	0	0	0.00	0	0.00	0	0.00	0	0.00
Once/month	66	14	5.58	48	7.68	4	3.54	0	0.00
Once/fortnight	330	85	33.86	209	33.44	35	30.97	1	9.09
Once/week	471	123	49.00	276	44.16	62	54.87	10	90.91
> Twice/week	133	29	11.55	92	14.72	12	10.62	0	0.00
		χ^2 = 16.837 (df = 9); p = 0.051							

Table 7: *Association of frequency of consumption of bakery/confectionery products with nutritional status.*



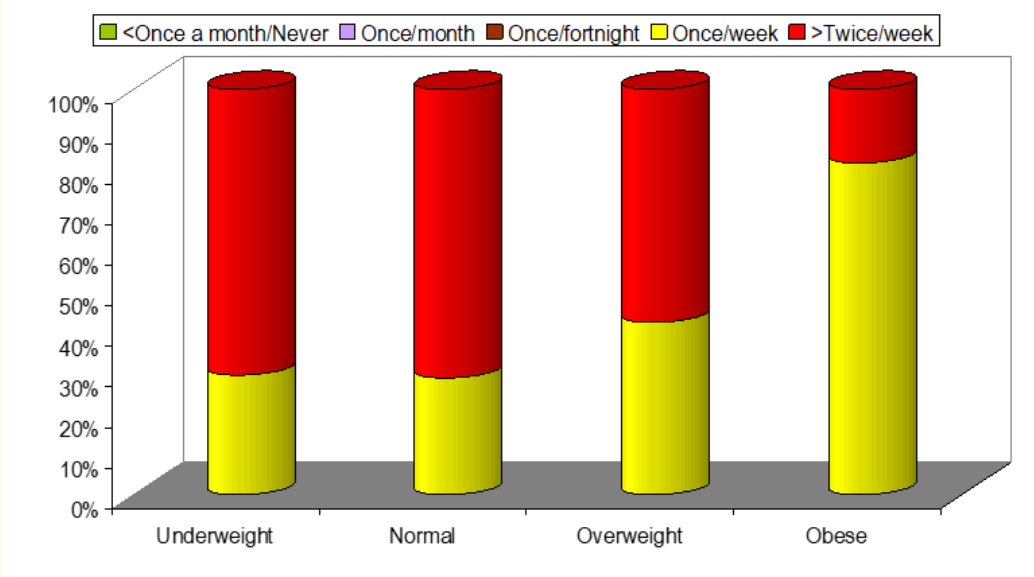
Graph 7: *Association of frequency of consumption of bakery/confectionery products with nutritional status.*

Proportion of obese students was higher as compared to underweight, normal and overweight students having frequent consumption of Bakery/Confectionery products once/week (90.91% vs. 49.00%, 44.16% and 54.87%), association being statistically significant p = 0.05.

Proportion of obese students was higher as compared to underweight, normal and overweight consuming green leafy vegetables/once a week (81.82% vs. 29.48%, 28.80% and 42.48%). Association of frequency of green leafy vegetables consumption and nutritional status was found to be statistically significant.

Frequency of Green Leafy Vegetable Consumption	Total (N = 1000)	Underweight (N = 251)		Normal (N = 625)		Overweight (N = 113)		Obese (N = 11)	
		No.	%	No.	%	No.	%	No.	%
< Once a month/Never	0	0	0.00	0	0.00	0	0.00	0	0.00
Once/month	0	0	0.00	0	0.00	0	0.00	0	0.00
Once/fortnight	0	0	0.00	0	0.00	0	0.00	0	0.00
Once/week	311	74	29.48	180	28.80	48	42.48	9	81.82
> Twice/week	689	177	70.52	445	71.20	65	57.52	2	18.18
		$\chi^2 = 21.882$ (df = 3); $p < 0.001$							

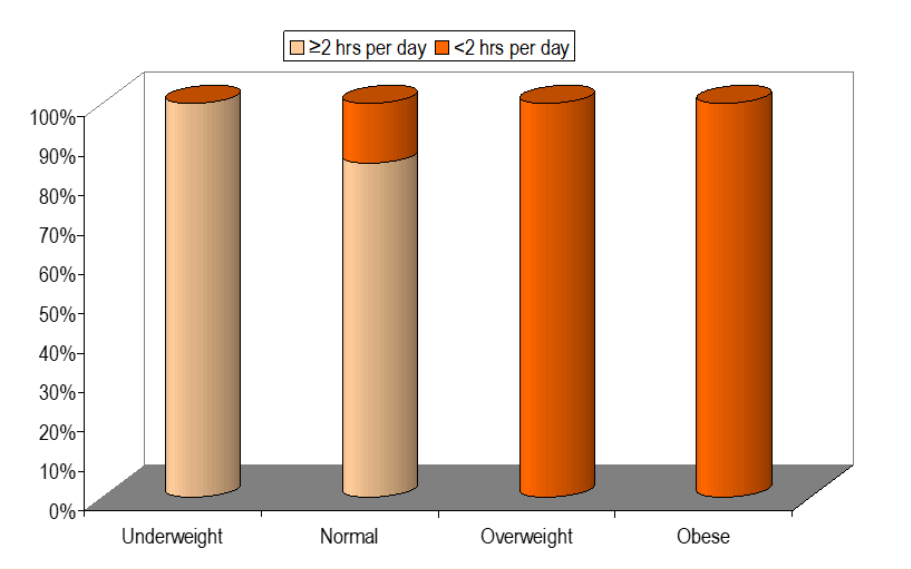
Table 8: *Association of frequency of consumption of green leafy vegetables with nutritional status.*



Graph 8: *Association of frequency of consumption of green leafy vegetables with nutritional status.*

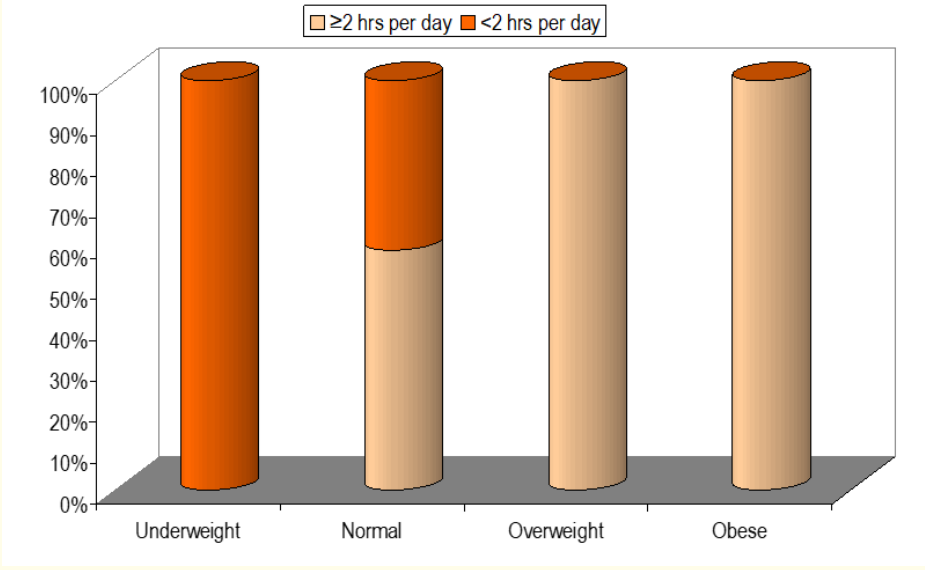
Duration of Outdoor Games	Total (N = 1000)	Underweight (N = 251)		Normal (N = 625)		Overweight (N = 113)		Obese (N = 11)	
		No.	%	No.	%	No.	%	No.	%
≥ 2 hrs per day	781	251	100.00	530	84.80	0	0.00	0	0.00
< 2 hrs per day	219	0	0.00	95	15.20	113	100.00	11	100.00
		$\chi^2 = 528.996$ (df = 3); $p < 0.001$							

Table 9: *Association of daily duration of outdoor games with nutritional status.*



Graph 9: *Association of daily duration of outdoor games with nutritional status.*

All the obese and overweight students spent < 2 hours per day on outdoor games. Association of nutritional status with physical activity was found to be statistically significant, $p < 0.001$.



Graph 10: *Association of daily duration of TV/video games with nutritional status.*

Duration of TV/ Video Games	Total (N = 1000)	Underweight (n = 251)		Normal (n = 625)		Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%	No.	%	No.	%
≥ 2 hrs per day	490	0	0.00	366	58.56	113	100.00	11	100.00
< 2 hrs per day	510	251	100.00	259	41.44	0	0.00	0	0.00
		χ^2 = 393.076 (df = 3); p < 0.001							

Table 10: *Association of daily duration of TV/video games with nutritional status.*

All the obese and overweight students spent ≥ 2 hours per day on TV/Video games. Positive association was found between duration of time spent on TV/ video games and obesity, p < 0.001.

Dietary Variables	Underweight (n = 251)		Normal (n = 625)		Overweight (n = 113)		Obese (n = 11)		ANOVA	
	Mn	SD	Mn	SD	Mn	SD	Mn	SD	F	p
Energy (Kcal)	1993.33	249.71	2273.64	225.54	2228.51	234.12	2231.45	97.83	88.063	<0.001
Protein	45.67	4.80	45.88	4.45	45.14	5.30	43.09	6.49	2.005	0.112
Fat	38.90	2.58	38.68	2.34	39.07	2.48	37.18	0.98	2.740	0.042
Iron	26.25	3.53	26.07	3.47	25.73	2.84	26.64	4.67	0.706	0.548
Calcium	798.82	86.36	805.69	92.49	805.58	89.52	714.09	72.22	3.935	0.008

Table 11: *Association of dietary intake with nutritional status.*

Energy intake of underweight students (1993.33 ± 249.71 kcal) was found to be significantly lower than that of normal (2273.64 ± 225.54 kcal), overweight (2228.51 ± 234.12 kcal) and obese (2231.45 ± 97.83 kcal), p < 0.001.

Calcium intake of normal (805.69 ± 92.49 mg) and overweight (805.58 ± 89.52 mg) was found to be statistically significantly higher than that of obese (714.09 ± 72.22 mg) and underweight (798.82 ± 86.36 mg) students.

No significant correlation was found between protein and fat intake with nutritional status.

Raised Waist circumference	Total Overweight and	Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%
Raised WC	0	0	0.00	0	0.00
Normal WC	124	113	100.00	11	100.00
		χ^2=–; p=–			

Table 12: *Components of metabolic disorder among high risk subjects (Overweight and obese).*
(A) Raised Waist Circumference: ≥ 90 cm (Males); ≥80 cm (Females).

None of the subjects included in the study had raised waist circumference either as per ATP-III criteria (≥ 102 cm of males and ≥88 cms of females) or IDF criteria (≥ 90 cm males and ≥ 80 cm females).

Fasting Blood sugar	Total Overweight and Obese (N = 124)	Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%
FBS > 100 mg/dl	2	2	1.77	0	0.00
FBS ≤ 100 mg/dl	122	111	98.23	11	100.00
		χ^2 = 0.198; p = 0.656			

Table 12B: *Raised fasting blood sugar levels (>100 mg/dl).*

Only 2 (1.77%) overweight subjects were found to have fasting blood sugar >100 mg/dl. Difference in fasting blood sugar levels of overweight and obese subjects was not found to be statistically significant.

Blood Pressure	Total Overweight and Obese (N = 124)	Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%
≥130/85 mm Hg	19	18	15.93	1	9.09
<130/85 mm Hg	105	95	84.07	10	90.91
		χ^2 = 0.198; p = 0.656			

Table 12C: *Raised blood pressure (>130/85 mm Hg).*

Though proportion of subjects with high blood pressure was higher in Overweights (15.93%) as compared to Obese (9.09%) but this difference was not found to be statistically significant (p = 0.656).

Triglycerides	Total Overweight and Obese (N = 124)	Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%
TG > 150 mg/dl	0	0	0.00	0	0.00
TG ≤ 150 mg/dl	124	113	100.00	11	100.00
		χ^2 = –; p = –			

Table 12D: *Raised triglycerides (>150 mg/dl).*

None of the overweight or obese subjects had triglyceride levels >150 mg/dl. Range of triglyceride levels among overweight subjects was 38-140 mg/dl while that of obese subjects was 77-119 mg/dl.

HDL	Total Overweight and Obese (N = 124)	Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%
Low HDL	12	12	10.62	0	0.00
Normal HDL	112	101	89.38	11	100.00
		χ^2 = 1.293; p = 0.255			

Table 12E: *Low HDL: < 40 mg/dl.*

Low HDL was found in 12 (9.68%) subjects. Difference in HDL levels of overweight and obese subjects was not found to be statistically significant.

Metabolic syndrome	Total Overweight and Obese (N = 124)	Overweight (n = 113)		Obese (n = 11)	
		No.	%	No.	%
MS Present	0	0	0.00	0	0.00
MS Absent	124	113	100.00	11	100.00
		χ^2 = –; p = –			

Table 12F: *Metabolic syndrome.*

None of the student fulfill criteria for metabolic syndrome.

Discussion and Conclusion

In present study, according to generally used BMI criteria, prevalence of overweight and obesity was 12.40% (11.30% overweight and 1.10% obese). An overview of prevalence of obesity and overweight in studies from different parts of India and the criteria used by them is being shown in table D1 below.

One of the striking similarity among different studies was a comparatively higher prevalence of overweight as compared to obesity among different studies. In present study, the overweight to obese ratio was 10.27. In most of the other studies this ratio has generally been in the range of 2 to 3. Thus, although our study did not validate the findings of Vohra., *et al.* [6] in terms of exact prevalence of overweight and obese but showed that school children in Lucknow generally tend to have problem of overweight, however, as far as problem of obesity is concerned, the rates were much lower in Lucknow.

In present study, though the age range of children spanned from 10 to 15 years, yet none of the children aged ≤ 12 years was obese. Thus, the prevalence of obesity and overweight was significantly higher in >12 years age group (17.5%) as compared to that in age group ≤ 12 years (5.3%). Similar to findings of our study, Eshwar., *et al.* [15] also observed the rate of overweight and obesity to be higher in 13-15 years age group as compared to 15 - 18 years age group in both boys (34% vs 37.8%) as well as girls (14% vs 20%). In another study, Prasad., *et al.* (2016) also noticed prevalence of overweight and obesity to be higher in 13 - 15 years age group (10.9% to 18%) as compared to that in 10 - 12 years age group (10.2% to 13). The findings in general support that during the transition from childhood to adolescence, the pattern of growth changes results in overweight and obesity. Generally, this is the time when physical activity profile of the children also gets a change. The activities like running, jumping, playing in the boundaries of home becomes difficult and children are often under the burden of studies and hence they do not have enough time for sports and play. In present study, prevalence of obesity and overweight was higher in Socioeconomic class III (10/62; 16.1%) as compared to class II (82/672; 12.2%) and Class I (32/266; 12.0%) yet this association was not significant statistically. This might be primarily due to the fact that in present study we selected a relatively more homogeneous study population. In order to determine the factors affecting nutritional status we also looked for association of dietary patterns and activity profile of the students to understand the role of modifiable factors that affect the prevalence of overweight and obesity in children. In present study, we could not find a significant association between dietary preference (vegetarian/nonvegetarian/eggarian diet), frequency of fast food intake, bakery/confectionary product intake and fruit/fruit juice intake with nutritional status of the children, however, habit of eating out, soft-drink/ice cream consumption, intake of green leafy vegetables, duration of participation in outdoor games and time spent in activities like television watching/video games showed a significant association with the nutritional status of the children. Relationship between dietary pattern and activity level with nutritional status, particularly in context with obesity and overweight has been studied extensively in different studies. In one such study, Kumar M., *et al.* [2] found that consumption of fried foods, energy drinks and bakery products had a positive correlation with overweight and obesity while regular physical activity was inversely associated with overweight and obesity. These findings are in agreement with the observations made in present study. In their study Babitha Rexlin., *et al.* [13] also reported that consumption of fruits and vegetables was significantly associated with lower odds of

SN	Author (Year), Place	Sample size and characteristics	Criteria used	Prevalence rate	
1.	Vohra., *et al.* (2011) [6], Lucknow	407 (Class 5 to 12 students)	BMI > 25 kg/m^2 overweight, BMI > 30 kg/m^2 Obese	4.17% Overweight 0.73% Obese	
2.	Mahajan., *et al.* (2011) [7], Puducherry	12685 aged 6-12 years	CDC Growth charts > 85th Percentile Overweight, > 95th percentile Obese	4.41% Overweight, 2.12% Obese	
3.	Kumar M., *et al.* (2011) [2], Karnataka	500 students aged 12-15 years	BMI ≥ 23- Overweight, BMI ≥ 25 - Obesity	3.0% Overweight, 2.6% Obese	
4.	Cherian., *et al.* (2012) [8], Kochi, Kerala	1634 (856 boys, 778 girls_ 6-15 Years	WHO approved CDC age-specific BMI charts	Boys - 12.1% overweight, 3% obese, Girls - 12.1% Overweight, 5.3% Obese	
5.	Remesh (2012) [9], Trivandrum, Kerala	560 (15-17 Years)	BMI >22 kg/m^2 - Overweight, BMI>26 kg/m^2 - Obese	8,75% Overweight, 4.58% Obese	
6.	Singh., *et al.* (2013) [10], Jammu	1160 (658 boys, 502 girls) aged 10-18 years	Central obesity	5.2% Obese	
7.	Jiwane and Wadhva (2014) [11], Maharashtra	905 (5 Yrs-19 Yrs) Mean age 11.06 Yrs	WHO BMI for age	10-13 Yrs age group: 5.9%, 13-16 Yrs age group: 6.9%	
8.	Mishra., *et al.* (2015) [12], Sambalpur.	300 Children (178 boys, 120 girls)	ITOF	6.3% Overweight, 3.3% Obese	
9.	Prasad *et al.* (2016) [13], Pondicherry	2465 students (10-18 yrs)	IAP age- and gender-specific BMI guidelines	9.7% Overweight, 4.3% Obese	
10.	Babitha Rexlin., *et al.* (2016) [14], Madurai	2519 (Rural and Urban schools)	IAP-BMI, 2015	16.8% Overweight, 9.3% Obese	
11.	Tapnikar and Dhingra (2017) [15], Nagpur	150 (12 to 17 years)	WHO BMI for age	6.67% Girls, 7.33% Boys, overweight and obese	
12.	Eshwar., *et al.* (2017) [16], Rajkot	1496 (79.1% boys, 20.9% girls) aged 8-18 years	IAP, 2015, WHO, 2007 ITOF	Obese 14% 11.1% 5.1%	Overwt. 19.1% 15.8% 15.3%
13.	Present study (2017), Lucknow	1000 (500 boys, 500 girls), aged 10-15 years	WHO gender-specific BMI for age, 85th percentile overweight, 95th percentile obese	11.3% Overweight, 1.1% Obese	

Table D1: *Prevalence of obesity and overweight in some contemporary studies from different parts of India and the criteria used by them.*

overweight and obesity. They also showed that longer duration of participation in outdoor games, avoiding eating out and adequate sleep were significantly associated with lower odds of overweight and obesity. Tapniker *et al.* [14] in their study also found fast food and binge

eating to be significantly and positively associated with overweight and obesity. The findings thus clarify that inconsistency in energy balance have their effect on the nutritional status of the children. Bhardwaj., *et al.* [16] in his article on childhood obesity also held high fat, energy-dense fast foods to be responsible for childhood obesity. Vohra., *et al.* [6] in their study from Lucknow also found that shorter duration of outdoor games and consumption of fast food were the important correlates of overweight/obesity among children. Thus, the findings of present study are in agreement with the observations made in literature and emphasize upon the need to understand the energy balance scenario in terms of energy intake and its consumption in view of the activity profile of children. In present study, we established that energy and fat intake of obese and overweight children was significantly higher as compared to underweight and normal weight children, thus stressing on the need to understand the energy balance context. This finding indicates the need for a lifestyle modification in order to change the situation.

In the second part of study, we assessed the prevalence of different metabolic syndrome factors. In present study, none of the children had waist circumference above 90th percentile and hence the criteria of central obesity as specified in the IDF definition of metabolic syndrome for children and adolescents[17] was not met in any case. The present study was basically targeted to study the metabolic syndrome at component level and we were able to find a total of 11 children with BMI >95th percentile, thus fulfilling the first criteria of metabolic syndrome i.e. obesity, in present study, none of the obese children had hyperglycemia (defined as FBS >100 mg/dl), however, 2 (1.77%) of overweight children had hyperglycemia, a total of 19/124 (15.3%) overweight and obese children had hypertension (defined as SBP/DBP > 135/85 mmHg). None of the children had triglyceridemia (defined as TG > 150 mg/dl), however, 16/124 (12.9%) obese and overweight children had low HDL. As such, none of the children fulfilled the criteria of metabolic syndrome as per the original IDF criteria or the modified criteria (replacing central obesity with > 95th percentile BMI) used by us.

These findings are encouraging from the point of view that we were able to diagnose metabolic syndrome at factorial level only that too only in few cases. The most concerning issue apart from overweight and obesity was hypertension affecting the 15.3% of high risk population (overweight and obese) followed by low HDL (9.7%) and hyperglycemia (1.6%). None of the children in present study had triglyceridemia. The findings of present study seem to be justified, in view of the relatively lower prevalence of overweight and obesity as compared to several other studies that have reported a high prevalence of overweight and obesity. Although, Braunschweig., *et al.* [18] in their study reported a prevalence of metabolic syndrome to the extent of 5.6%, however, in their study the prevalence of overweight and obese children was as high as 44%. The present study was carried out in the Central School, where physical activity and participation in games and sports is part of the curriculum and is quite regular too, the high prevalence of overweight and obesity could be ruled out.

In context with Indian studies, although prevalence of MS has been reported to be 3.8% by Andrabi., *et al.* [19] in a population aged 8 - 18 years with obesity prevalence as high as 9.9%.The fact that obesity prevalence is higher in older adolescents as compared to younger adolescents might be responsible for both high prevalence of obesity as well as metabolic syndrome in their study population.

The findings of present study thus indicated that although childhood obesity and overweight is an imminent risk for complications in adulthood, however, as far as the risk of more severe cardiovascular complications like metabolic syndrome are concerned, it can be termed to have a stimulating role instead of the only dominant factor determining and steering it. The fact that present study was carried out in young children aged 10 - 15 years and continuance of obesity and overweight into adulthood might result in evolution of metabolic syndrome, it is essential that preventive steps should be initiated from the beginning itself. The present study highlighted the role of dietary factors and physical activity in increasing the risk of overweight and obesity. This is an important finding and suggests the need for early lifestyle modification and change of dietary habits in order to ensure a healthier future for the population.

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Volume 8 Issue 3 March 2021