International Journal of Home Science

ISSN: 2395-7476
IJHS 2023; 9(1): 126-132

www.homesciencejournal.com
Received: 13-11-2022
Accepted: 19-12-2022

Sikandra Devi
Assistant Professor, Govt. College for Girls, Gurugram, Haryana, India

Priti Dhankhar
(Assistant professor), DAV Girls College Kosli, Haryana, India

Corresponding Author:
Sikandra Devi
Assistant Professor, Govt. College for Girls, Gurugram, Haryana, India

Correlation of anthropometric indices with blood profile of school going adolescents

Sikandra Devi and Priti Dhankhar

Abstract
Obesity results from a chronic imbalance between energy intake and energy expenditure for metabolic purposes and physical activity and tends to increase with advancing age. Childhood obesity has become a serious public health problem in many countries. The incidence of childhoosd obesity among school going children is on the rise. Diseases normally seen in adults because of obesity are now being seen with increasing frequency in children. About 50% of obese children will become obese adults. The prevalence of hypertension, dyslipidaemia, high cholesterol level, type 2 diabetes and non-alcoholic fatty liver disease in children is also increasing parallelly. In the present study data regarding BMI categories revealed that majority of obese respondents from Hisar and Gurgaon city were in Obese Grade-I category. Values of all the blood parameters analyzed were within normal range in both obese as well as non-obese group respondents however values of blood parameters of obese respondents were on slightly upper side. Prevention of childhood obesity is vital in order to live a healthy lifestyle. A healthy diet and an active lifestyle should be followed by adolescents to get rid of several lifestyle based health issues.

Keywords: Childhood obesity, cholesterol, energy intake, healthy lifestyle

1. Introduction

Overweight and obesity are among the most prevalent nutritional problems in the developed and developing countries. The increasing prevalence of obesity in children and adolescents is considered as one of the most series public health concerns in this century (Güngör, 2014) [11]. The problem of obesity is confined not only to adults but also to children and adolescents. The prevalence of overweight and obesity among children and adolescents aged 5-19 has risen dramatically from just 4% in 1975 to just over 18% in 2016. The rise has occurred similarly among both boys and girls: in 2016, 18% of girls and 19% of boys were overweight (WHO, 2020) [30]. Obesity results from a chronic imbalance between energy intake and energy expenditure for metabolic purposes and physical activity and tends to increase with advancing age. Genetic, environmental and behavioral factors (poor appetite control, unhealthy eating habits, lack of exercise) influence the balance between energy intake and output. Overweight in children/adolescents is caused by lack of physical activity, unhealthy eating patterns, or a combination of both with genetics and lifestyle playing important roles in determining a child’s weight. The incidence of childhood obesity among school going children is on the rise. Diseases normally seen in adults because of obesity are now being seen with increasing frequency in children, particularly type 2 diabetes. It is notable that overweight children and adolescents have a higher likelihood of becoming obese adults and to present health-related problems early in life including diabetes, cardiovascular disease (CVD) and dyslipidemias (Lissau *et al.* 2004) [16]. Overweight during childhood predicts adult obesity, which is associated in turn with several chronic diseases, including coronary heart disease, hypertension, abdominal hernia and psychological stress (Hanley *et al*., 2000) [13]. This study aimed to verify the relationship between the hematologic profiles with obesity in adolescent’s school going children.

2. Materials and Methods

The present study was conducted purposively on school going children in Hisar and Gurgaon city of Haryana State. The study was conducted on school children. For the selection of respondents, Govt. and Private schools from different areas of the Hisar (n=17) and Gurgaon (n=14) city were selected. In these schools, the children in the age group of 9-15 years representing different socio-economic status were approached for baseline survey. A total of 400 obese children were selected randomly (200 each from both cities). Hundred healthy school going children having no history of obesity and matching the same age as those of obese children were taken as non-obese (50 each from both cities). The information on socio-economic status, food consumption pattern, food habits and physical activity of the children was gathered using self-developed questionnaire.

2.1 Biochemical assessment

Biochemical assessment was carried out to measure blood glucose and lipid profile. Ten per cent of the obese respondents not having obesity related degenerative diseases were selected and their fasting blood samples were collected and analysed for glucose, serum triglycerides, serum cholesterol, HDL and LDL-cholesterol. Same numbers of non-obese respondents were matched to age, sex and socio-economic status and their fasting blood samples were collected and analysed for above mentioned parameters. Glucose concentration in blood was analysed by glucose oxidase peroxidase method, colorimetrically using Autopak Kit supplied by Bayer Diagnostics, Gujrat, India.

3. Statistical analysis

The data were analyzed statistically using percentage, mean, standard error, Duncan's multiple range test and 'Z' test. The coefficient of correlation was computed to test the relationship between variables.

4. Results and Discussion

Table 1: Anthropometric measurements of respondents

Parameters	Hisar		Gurgaon	
	Non-obese (n=50)	Obese (n=200)	Non-obese (n=50)	Obese (n=200)
Height (cm)	151.38±1.16[a]	147.12±0.77[b]	148.44±1.53[ab]	147.78±0.74[b]
Weight (kg)	51.86±1.35[c]	62.53±1.71[b]	50.20±1.81[c]	69.64±1.70[a]
BMI	23.01±0.21[c]	28.94±0.96[b]	22.53±0.18[c]	30.92±1.06[a]
Waist circumference (cm)	63.46±1.82[b]	76.93±1.77[a]	60.50±1.90[b]	80.79±1.87[a]
Hip circumference (cm)	79.12±1.96[b]	86.73±1.84[a]	74.50±1.80[b]	89.86±1.91[a]
Waist hip ratio	0.79±0.01[b]	0.88±0.01[a]	0.79±0.01[b]	0.89±0.01[a]
Biceps skinfold thickness (mm)	10.69±1.10[b]	18.00±1.13[a]	10.56±1.10[b]	18.07±1.13[a]
Triceps skinfold thickness (mm)	14.79±1.23[b]	29.69±1.34[a]	13.93±1.27[b]	29.09±1.36[a]

n = Number of respondents

Mean with same superscript are not significantly different

From this table 1, it can be concluded that mean values for most of the parameters (weight, BMI, waist circumference, hip circumference, waist hip ratio, biceps and triceps skinfold thickness) for obese respondents were significantly higher than non-obese group respondents except mean value for height which was significantly higher in non-obese group respondents in both the cities. Mean values for weight and BMI of obese respondents from Gurgaon city were also significantly higher than weight and BMI of the obese respondents from Hisar city. According to Srilakshmi (2006) [27] a person weighing 10% more than the standard weight is overweight and 20% more is obese. Nearly Overweight and obesity are now on the rise in low- and middle-income countries, particularly in urban settings and 38.2 million children under the age of 5 years were found overweight or obese (WHO, 2020) [30].

Menon *et al* (2007) [19] conducted a study on 36 children (26 boys and 10 girls, aged 1.5 to 15 years) and 37 adults (21 men and 16 women, age 25 to 69 years) with obesity and 29 non-obese (15 children and 14 adults). They reported that all anthropometric parameters were higher in obese subjects compared to non-obese subjects. McGloin *et al.* (2002) [18] reported that obese subjects were significantly heavier and had a greater BMI than the non-obese subjects.

Table 2: Type and frequency of food consumed by respondents

Variables	Hisar		Gurgaon	
	Non-obese (n=50)	Obese (n=200)	Non-obese (n=50)	Obese (n=200)
Type of food consumed				
Fried	2 (4.00)	84 (42.00)	2 (4.00)	88 (44.00)
Boiled	3 (6.00)	---	4 (8.00)	---
Baked	2 (4.00)	4 (2.0)	1 (2.00)	6 (3.00)
All above (fried, boiled and baked)	43 (86.00)	112 (56.00)	43 (86.00)	106 (53.00)
Frequency of food consumed outside home				
Once in a week	1 (2.00)	106 (53.00)	2 (4.00)	118 (59.00)
Once in a month	5 (10.00)	56 (28.00)	6 (12.00)	58 (29.00)
Occasionally	44 (88.00)	38 (19.00)	42 (84.00)	24 (12.00)

n = Number of respondents

Values in parentheses indicate percentages

Data in Table 2 depicts that only 4% of non-obese group respondents from Hisar as well as Gurgaon city consumed fried foods and 42% obese respondents from Hisar city and 44% from Gurgaon city consumed fried foods. Earlier it was observed that obese children enjoy fatty foods and eat them in large quantities (Kiess *et al.*, 2004) [14]

Six to eight percent of non-obese group respondents were taking boiled food whereas none of the obese respondents from Hisar as well as Gurgaon city were taking boiled food. Liking for baked food was almost similar for non-obese group respondents (2-4%) and of obese respondents (2-3%) from both cities. Majority of non-obese group respondents (86%)

and obese respondents (53-56%) consumed all types of food like fried, boiled and baked food in Hisar as well as in Gurgaon City.

Frequency of food consumed by respondents outside home revealed that only 2-4% of non-obese group respondents were taking food outside home once a week in both cities, where as majority (53-59%) of obese respondents consumed food outside home weekly. Ten to twelve percent of non-obese group respondents and 28-29% of obese respondents consumed food outside home in a month in Hisar as well as Gurgaon city. Majority (84-88%) of non-obese group respondents and only 12-19% of obese respondents were taking food outside home occasionally in both cities. It is apparent that frequency of food consumption outside home, weekly or monthly, was higher in obese respondents as compared to non-obese group respondents. Kumar *et al.* (2007) [15] reported that 55.5% children were taking energy rich foods daily and 61.7% children were taking energy rich foods 2-3 times a week which was significantly higher as compared to non-obese respondents. Amin *et al* (2008) [2] reported that frequency of eating food outside home was high among overweight and obese children and that was 5 times per week or more (P<0.001).

Blood profile of respondents

Blood samples of respondents were analysed for blood glucose and serum samples were analysed for total cholesterol, HDL-cholesterol and triglycerides (Table 3). A non-significant difference was observed in the mean values of blood glucose of obese and non-obese group respondents of both cities. Menon *et al.* (2007) [19] observed no difference in fasting blood glucose levels of obese and non-obese children.

Table 3: Blood profile of respondents

Blood parameters (mg/100ml)	Normal values	Hisar Gurgaon			
		Non-obese (n=5)	Obese (n=20)	Non-obese (n=5)	Obese (n=20)
Blood glucose	70-110	89.60±1.78^a	91.00±0.91^a	88.20±1.83^a	89.50±1.00^a
Triglycerides	40-165	75.60±3.50^b	91.11±3.39^a	77.50±3.40^b	92.90±3.77^a
Total cholesterol	150-260	155.10±6.41^b	180.20±6.03^a	146.40±6.19^b	184.80±5.84^a
HDL-cholesterol	30-70	47.70±2.04^a	35.40±2.69^b	48.60±1.10^a	34.00±1.75^b
LDL-cholesterol	60-180	90.28±8.74^b	125.60±6.20^a	77.56±7.02^b	129.80±5.41^a
VLDL- cholesterol	Upto 40	17.12±1.81^a	19.20±1.85^a	20.24±1.66^a	21.00±1.82^a

n = Number of respondents

Mean with same superscript are not significantly different

Mean values of serum triglycerides were found to be higher in obese respondents (91.11 mg/100ml) of Hisar city as compared to non-obese group respondents (75.60 mg/100ml). Same trend was noticed in the values of triglycerides of respondents from Gurgaon city. However, a non-significant difference was observed between the values of triglycerides of the obese respondents from Hisar and Gurgaon city.

Though the level of total cholesterol was significantly higher (180.20mg/100ml) in obese respondents of Hisar city as compared to non-obese group respondents (155.10 mg/100ml), but the values of total cholesterol of non-obese as well as obese respondents were within the normal range. In Gurgaon city, mean values of total cholesterol in obese respondents (184.80 mg/100ml) and non-obese group (146.40 mg/100ml) were significantly different from each other but were within the normal range. It was noticed that HDL-cholesterol in non-obese group respondents was higher (47.70 and 48.60 mg/100ml) as compared to obese respondents (35.40 and 34.00 mg/100ml) from Hisar and Gurgaon city, respectively. According to Misra *et al.* (2002) [20] obesity appears to be associated consistently with decrease in HDL-cholesterol.

Mean values of serum LDL-cholesteral in obese respondents from Hisar (125.60 mg) and Gurgaon city (129.80 mg) were significantly higher than non-obese group respondents from Hisar (90.28 mg) as well as Gurgaon city (77.56 mg). However, a non-significant difference was observed between the mean values of LDL- cholesterol of non-obese group respondents and also between obese respondents from Hisar and Gurgaon city. Mean values of serum VLDL-cholesterol in non-obese group (17.12 and 20.24 mg) and obese (19.20 and 21.00 mg) respondents were similar in Hisar and Gurgaon city, respectively.

From this table it can be concluded that values of triglycerides, total cholesterol and LDL-cholesterol were significantly higher in obese respondents when compared to non-obese group respondents in both the cities. Mean value of HDL-cholesterol in obese respondents was significantly lower as compared to non-obese group respondents in Hisar as well as in Gurgaon city. Values of blood glucose and serum VLDL-cholesterol were similar for non-obese and obese respondents from both the cities. Similar findings were reported by Abdullah *et al.* (1999). They reported that values of blood glucose, total cholesterol and triglycerides in obese respondents were within normal range. Menon *et al.* (2007) [19] reported that serum total cholesterol, triglycerides and LDL-cholesterol levels were significantly higher in obese children compared to non-obese. Saffari et al (2012) [25] also reported that overweight and obese male had higher systolic and diastolic blood pressures than lean controls.

Table 4: Average daily energy intake, energy expenditure and energy balance (Kcal/day) of respondents

Variables	Hisar Gurgaon			
	Non-obese (n=50)	Obese (n=200)	Non-obese (n=50)	Obese (n=200)
Energy intake	2031.20±14.72^c	2752.59±43.74^b	2066.68±14.70^c	2936.55±50.90^a
Energy expenditure	2174.46±13.92^a	2113.70±15.11^b	2193.90±13.28^a	2107.78±16.18^b
Energy balance	-143.26±3.65^c	638.89±7.16^b	-127.22±3.66^c	828.77±6.22^a

n = Number of respondents

Mean with same superscript are not significantly different

From table 4 it can be concluded that average daily energy intake by obese respondents was significantly higher than that of non-obese group respondents in both the cities. Energy expenditure by obese respondents was significantly lower than that of non-obese group respondents that might have led to higher energy balance in obese respondents from Hisar and Gurgaon city. Less amount of time spent for physical activity might be a contributing factor in less energy expenditure and high energy balance by obese respondents in both the cities. Contrary to these finding, Caballero *et al.* (2003) [3] reported that in a study of 5106 children, energy expenditure was found same between obese and non-obese subjects. However, earlier workers reported higher energy expenditure in obese subjects than that of non-obese subjects (Goran *et al.*, 1998, Delany *et al.*, 1995 and Treuth *et al.*, 1998) [10, 6, 28].

Table 5: Correlation coefficient of weight with blood parameters of respondents

Correlation	Hisar		Gurgaon	
	Non-obese (n=50)	Obese (n=200)	Non-obese (n=50)	Obese (n=200)
Blood glucose	0.28	0.17	0.21	0.09
Total cholesterol	0.02	0.39*	0.15	0.31*
S. triglycerides	0.24	0.07	0.17	0.04
Serum HDL-cholesterol	0.19	-0.31	0.15	-0.54*
Serum LDL-cholesterol	0.16	0.30*	0.08	0.51*
Serum VLDL-cholesterol	0.15	0.12	0.11	0.05

n = Number of respondents
* Values are significant at 5% level

Correlation coefficient of weight with all blood parameters was studied and it was noticed that weight was non-significantly correlated with blood glucose of all respondents from both cities (Table 5). Weight was positively and significantly correlated with total cholesterol level of obese respondents in Hisar (r=0.39) as well as in Gurgaon city (r=0.31). A non-significant correlation was observed between weight and serum triglycerides level of all respondents. Weight was positively correlated with serum HDL-cholesterol level of non-obese group respondents of both cities whereas negatively correlated with serum HDL-cholesterol level of obese respondents from Hisar city. A significant and negative correlation was observed between weight and serum HDL-cholesterol level of obese respondents (r=0.54) from Gurgaon city. Weight was found to be positively and significantly correlated with serum LDL-cholesterol level of obese respondents from Hisar as well as Gurgaon city. In a study done in Lagos, an urban area of Nigeria, higher BMI was significantly associated with hypertensive range systolic and diastolic Blood Pressure (Oduwole *et. al*. 2012) [22]. Whereas a non-significant correlation was observed between weight and serum-LDL-cholesterol level of non-obese group respondents from both cities. A non-significant correlation was also observed between weight and serum VLDL-cholesterol level of all respondents. Hence, it can be concluded that weight was significantly and positively correlated with total cholesterol and serum LDL-cholesterol level of obese respondents whereas negatively and significantly correlated with serum HDL- level cholesterol of obese respondents. Gong *et al*. (2013) revealed that overweight and obese adolescents have an increased incidence of high blood lipid levels. Change *et al*., (2015) [4] reported that compared with the lean control subjects, the obese subjects had obvious insulin resistance, abnormal lipid profiles, and low-grade inflammation. The overweight subjects only exhibited significant insulin resistance and low-grade inflammation. Sachdev *et al*. (2005) [24] reported positive correlation of weight with all the risk factors except HDL-cholesterol, for which the correlation was negative.

Table 6: Correlation coefficient of caloric intake with blood glucose and of fat intake with serum total cholesterol, HDL-cholesterol, LDL-cholesterol, VLDL cholesterol and triglycerides among obese and non obese respondents

Correlation	Hisar		Gurgaon	
	Non-obese (n=50)	Obese (n=200)	Non-obese (n=50)	Obese (n=200)
Caloric intake and blood glucose	0.14	0.26	0.19	0.20
Fat intake and total cholesterol	0.25	0.47*	0.17	0.33*
Fat intake and HDL-cholesterol	0.34	-0.52*	0.29	-0.68*
Fat intake and LDL-cholesterol	0.11	0.58*	0.13	0.59*
Fat intake and VLDL-cholesterol	0.12	0.29	0.15	0.23
Fat intake and Triglyceride	0.18	0.37*	0.19	0.38*

n = Number of respondents
* Values are significant at 5% level

A positive correlation was found between calorie intake and blood glucose level of obese and non-obese group respondents in both cities (Table 6). Similarly, positive correlation was found between fat intake and total cholesterol level of non-obese group respondents from both cities but a positive and significant correlation was observed between fat intake and total cholesterol level of obese respondents in Hisar as well as in Gurgaon city. Fat intake was also noticed to be positively correlated with HDL-cholesterol level of non-obese group respondents from both cities whereas a negative and significant ($P<0.05$) correlation was found between fat intake and HDL-cholesterol of obese respondents from Hisar and Gurgaon city. Though a positive correlation was found between fat intake and LDL-cholesterol level of non-obese group respondents but a positive and significant ($P<0.05$) correlation was observed between fat intake and LDL-cholesterol level of obese respondents in Hisar as well as in Gurgaon city. Data in Table 4 further shows the positive correlation between fat intake and VLDL-cholesterol level of all respondents (non-obese and obese) from Hisar and Gurgaon city. A positive correlation was noticed between fat intake and triglycerides level of non-obese group respondents but this correlation was found positive and significant (P<0.05) in case of obese respondents from Hisar as well as Gurgaon city. Similarly, high cholesterol level were seen in studies done among school going children by Shahid *et al*., (2017) [26] and Das *et al*., (2017) [5] and reported hypertension was 7.5 and 19.7% of the study population, respectively.

Table 7: Correlation coefficient of weight with energy intake, energy expenditure, energy balance and fat intake

Correlation	Hisar		Gurgaon	
	Non-obese (n=50)	Obese (n=200)	Non-obese (n=50)	Obese (n=200)
Energy intake	0.02	0.42**	0.09	0.58**
Fat intake	0.12	0.41**	0.11	0.49**
Energy expenditure	0.02	0.04	0.07	0.08

n = Number of respondents
**Values are significant at 1% level

Correlation of weight with energy intake was studied and it was noticed that weight was positively correlated with energy intake by non-obese group respondents but this correlation was positive and significant (P<0.01) in case of obese respondents from Hisar (r=0.42) as well as Gurgaon (r=0.58) city (Table 7). Similarly, correlation between weight and fat intake was found to be significant (P<0.01) in case of obese respondents from both cities. However, a non-significant correlation was found between weight and energy expenditure of all respondents of Hisar as well as Gurgaon city. This showed that weight was significantly associated with fat and energy intake in case of obese respondents. In Bhopal, among the children aged 14-17 years, a highly significant association (P < 0.01) of sex, BMI status of the respondents, sedentary lifestyle, reduced physical activity and higher intake of junk foods was reported (Patnaik *et al*., 2015) [23].

Table 8: Correlation coefficient of BMI with energy intake, energy expenditure, energy balance and fat intake

Correlation	Hisar		Gurgaon	
	Non-obese (n=50)	Obese (n=200)	Non-obese (n=50)	Obese (n=200)
Energy intake	0.16	0.06	0.08	0.08
Fat intake	0.11	0.25*	0.15	0.27*
Energy expenditure	0.15	0.07	0.08	0.09

n = Number of respondents
* Values are significant at 5% level

Data is the Table 8 showed that body mass index was positively correlated with energy intake and energy expenditure of all respondents from Hisar as well as Gurgaon city, but the correlation was non-significant. In comparison to this, body mass index was found to be positively and significantly (P<0.05) correlated with fat intake by obese respondents from Hisar city (r=0.25) and Gurgaon city (r=0.27). A non-significant correlation was found between BMI and fat intake of non-obese group respondents in both cities. This is clear from the table that BMI was significantly and positively affected by fat intake of obese respondents.

Valiyaparambil *et al*., 2021 [29] reported that there is a high significant association p<0.001 of BMI and blood pressure was seen. There is a significantly positive correlation analyses revealed a strong positive relationship between hypertension and obesity in children of private schools (r=0.61), which indicates that as obesity increases, hypertension in children increases.

5. Conclusion

Recent studies have shown that hypertension and obesity-related metabolic disorders are increasingly prevalent among overweight and obese children (Guo *et al*., 2012) [12]. Anthropometric measurements of the respondents from both the cities showed significant differences in all the parameters of non-obese and obese respondents except that a non-significant difference was observed in height of non-obese group respondents from Gurgaon city. It was found that among the obese respondents, weight and BMI of respondents from Gurgaon city was significanty higher as compared to respondents from Hisar city. BMI categories revealed that majority of obese respondents from Hisar and Gurgaon city were in Obese Grade-I category. Percentage of obese respondents in Obese Grade- I I and I I I categories was higher in Gurgaon city than that of Hisar city. Various regional studies in Dubai, Kuwait and Jordan showed higher figures for overweight and obesity (EL-bayoumy *et al*., 2009, Mak *et al*., 2013) [7, 17], while lower rates were reported in Egypt. Those variations related to cultural and dietary habit differences (Nesrin *et al*., 2019) [21].

Data regarding blood profile of respondents revealed that values of triglycerides, total cholesterol and LDL-cholesterol were significantly higher in obese respondents when compared to non-obese group respondents in both the cities. Friedemann *et al*. (2012) [8]. High levels of LDL-c and TG, combined with low HDL-c levels, have been found in children with central obesity; these changes are dangerous and they have been correlated with cardiovascular disease in the general population. Mean value of HDL-cholesterol in obese respondents was significantly lower as compared to non-obese group respondents in Hisar as well as in Gurgaon city. Values of blood glucose and serum VLDL-cholesterol were similar for non-obese and obese respondents from both the cities. Positive correlation of weight was noticed with fat intake, total cholesterol and LDL-cholesterol. However weight was found negatively correlated with HDL-cholesterol level of obese respondents from both the cities. Positive correlation of weight was noticed with fat intake, total cholesterol and LDL-cholesterol. However weight was found negatively correlated with HDL-cholesterol level of obese respondents from both the cities.

Recommendations

- Intake of fried foods and junk foods should be limited.
- Children must be encouraged to go for outdoor activities rather than spending their time in indoor activities like watching T.V. play with computer, video games school intervention programmes are the best approach to

advocate and encourage methods to prevent overweight/obesity.
- Nutrition education must be provided for the school children, their parents and teachers in order to prevent and solve major nutritional problems.

6. Acknowledgments
We would like to thank all the students who participated in this study and special thanks to all teachers and the authorities of the schools for their help during data collection.

7. References
1. Abdullah AHS, Nasir AJ, Abiodun O, Abdullah AMA, Abdulrahman AAN. Childhood obesity: Referred cases to a tertiary health center in Riyadh, Saudi Arabia. Saudi Journal of Gastroenterology. 1999;5(2):85-88.
2. Amin TA, Sultan AI, Ali A. Overweight and obesity and their association with dietary habits. Journal of Saudi Arebia. 2008;33(3):172-181.
3. Caballero B, Clay T, Davis SM. Pathway: a school-based, randomized non-obeseled trial for the prevention of obesity in American Indian school children. American Journal of Clinical Nutrition. 2003;78(5):1030-8.
4. Chang CJ, Deng-YJ, Ming-WL, Jun-ZZ, Low-TH, Chi-CJ. Evidence in Obese Children: Contribution of Hyperlipidemia, Obesity-Inflammation, and Insulin Sensitivity. PLoS One. 2015;10(5):e0125935.Published online 2015 May 26. doi: 10.1371/journal.pone.0125935.
5. Das MK, Bhatia V, Sibal A. Prevalence of HTN in urban school children aged 5 to 10 years in North India. International Journal of Contemporary Pediatrics. 2017;4(6):2055.
6. Delany JP. Energy expenditure in lean and obese prepubertal children. Obesity Reviews. 1995;3:67.
7. EL-bayoumy I, Shady I, Lotfy H. Prevalence of obesity among adolescents (10-14 years) in Kuwait. Asia Pac J Public Health. 2009;21:153-159.
8. Friedemann C, Heneghan C, Mahtani K, Thompson M, Perera R, Ward AM. Cardiovascular disease risk in healthy children and its association with body mass index: systematic review and meta-analysis. BMJ. 2012;345:e4759 10.1136/bmj.e4759 [PMC free article] [PubMed] [CrossRef] [Google Scholar] [Ref list]
9. Gong CD, Wu QL, Chen Z, Zhang D, Zhao ZY, Peng YM. Glycolipid metabolic status of overweight/obese adolescents aged 9- to 15-year-old and the BMI-SDS/BMI cut-off value of predicting dyslipidemia in boys, Shanghai, China: a cross-sectional study. *Lipids* Health Dis. 2013;12:129. 10.1186/1476-511X-12-129 [PMC free article] [PubMed] [CrossRef] [Google Scholar] [Ref list]
10. Goran MI, Shewchuk R, Gower BA, Nagy TR, Carpenter WH, Johnson RK. Longitudinal changes in fatness in white children: no effect of childhood energy expenditure. American Journal of Clinical Nutrition. 1998;67:309-16.
11. Güngör NK. Overweight and obesity in children and adolescents. J Clin Res Pediatr Endocrinol. 2014;6:129-43. DOI: 10.4274/jcrpe.1471. [PMC free article] [PubMed] [CrossRef] [Google Scholar] [Ref list]
12. Guo X, Li Y, Sun G, Yang Y, Zheng L, Zhang X, *et al.* Prehypertension in children and adolescents: association with body weight and neck circumference. Intern Med. 2012;51:23-27. [PubMed] [Google Scholar] [Ref list]
13. Hanley JG, Steward BH, Joel G, Thomas MS, Brits S, Bernard Z. Overweight among children and adolescents in native Canadian community: Prevalence and associated factors. American Journal of Clinical Nutrition. 2000;71:693-700.
14. Kiess W, Marcus C, Wabitch M. Obesity in childhood and adolescence. Pediatrics Adolscents Medicine Journal. 2004;9:194-206.
15. Kumar S, Mahabalaraju DK, Anuroopa MS. Prevalence of obesity and its influencing factor among affluent school children of davangere city. Indian Journal of Community Medicine, 2007, 32(1).
16. Lissau I, Overpeck MD, Ruan WJ, Due P, Holstein BE, Hediger ML. Health Behaviour in School-aged Children Obesity Working Group. Body mass index and overweight in adolescents in 13 European Countries, Israel, and the United States. Arch Pediatr Adolesc Med. 2004;158(1):27-33.
17. Mak TN, Prynne CJ, Cole D, Fitt E, Bates B, Stephen AM. Patterns of sociodemographic and food practice characteristics in relation to fruit and vegetable consumption in children: results from the U.K. National Diet and Nutrition Survey Rolling Programme (2008e2010). Public Health Nutr. 2013;16(11):1912e23.
18. McGloin AF, Livingstone MBE, Greene LC, Webb SE, Gibson JMA, Jebb SE, *et al*. Energy and fat intake in obese and lean children at varying risk of obesity. Journal of American Clinical Nutrition. 2002;26(2):200-207.
19. Menon PSN, Dubey S, Kabra M, Bajpai A, Pandey RM, Hasan M, *et al*. Serum leptin levels in obese Indian children: Relation to Clinical and Biochemical Parameters. Indian Pediatrics. 2007;44:257-262.
20. Misra A, Naval K Vikram. Insulin resistance syndrome (metabolic syndrome) and Asian Indians. Current Science. 2002;83(12):1483-1496.
21. Nesrin K, El-fatah ABD, Mira Abu-elenin M. Prevalence of Stunting, Overweight and Obesity among Egyptian Primary School Children in Behera Governorate: Food and Public Health. 2019;9(3):84-93.
22. Oduwole AA, Ladapo TA, Fajolu BI, Ekure EN, Adeniyi OF. Obesity and elevated blood pressure among adolescents in Lagos, Nigeria: a cross-sectional study. BMC Public Health. 2012;12:616. DOI: 10.1186/1471-2458-12-616. [PMC free article] [PubMed] [CrossRef] [Google Scholar] [Ref list]
23. Patnaik L, Pattanaik S, Sahu T, Rao EV. Overweight and obesity among adolescents- a comparative study between government and private schools. Indian pediatrics. 2015;52(9):779-81.
24. Sachdev HS, Fall CH, Osmond C, Lakshmy R, Dey Biswas SK, Leary SD. Anthropometric indicators of body composition in young adults: relation to size at birth and serial measurements of body mass index in childhood in the New Delhi birth cohort. American Journal of Clinical Nutrition. 2005;82:456-466.
25. Saffari F, Jalilolghadr S, Esmailzadehha N, Azinfar P. Metabolic syndrome in a sample of the 6- to 16-year-old overweight or obese pediatric population: a comparison of two definitions. Ther Clin Risk Manag. 2012;8:55-63. 10.2147/TCRM.S26673 [PMC free article] [PubMed] [CrossRef] [Google Scholar] [Ref list]
26. Shahid B, Jalal MA, Waseem M, Shahid H, Mehboob-Ur-Rehman M. Prevalence of obesity in school going adolescents and its association with HTN. Pakistan journal of medical & health sciences. 2017;11(3):1082-4.

27. Srilakshmi B. Dietetics. New Age International (P) Limited Publishers, Hyderabad; c2006. p. 173-186.
28. Treuth MS, Schmitz K, Catellier DJ, McMurray RG, Murray DM, Almeida MJ. Defining accelerometer thresholds for activity intensities in adolescent girls. Medicine and Science in Sports and Exercise. 1998;36:1259-1266.
29. Valiyaparambil AT, Katke S, Anthikat M *et al*. Prevalence of hypertension among obese children of private schools - a cross-sectional study. Int. J Health Sci. Res. 2021;11(7):31-36. DOI: https://doi.Org/10.52403/ijhsr.20210705.
30. WHO. Obesity and overweight; c2020. https://www.who.int/news-room/factsheets/detail/obesity-and-overweight