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Original Research Article

A study of body fat distribution-in childhood obesity and its associated metabolic risk factors

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ABSTRACT

Background: The Objective of the present study was to find out fat distribution pattern in obese children between 6 to 12 years of age as compared to non-obese children of same age.
Methods: A case control study was done between 1st July 2023 to 1st July 2024 on 138 children between 6 to 12 years of age group in Deccan College of Medical Sciences, Hyderabad, Telangana state. Ultra-sonographic measurement of fat thickness including maximum and minimum preperitoneal fat thickness, maximum and minimum abdominal subcutaneous fat, thickness at triceps and subscapular regions were determined in all participants. Fasting blood glucose was measured using enzymatic assay. Total cholesterol was measured by enzymatic assays.
Results: Total 138 children were enrolled in the study. Out of 138 children included in study, the study population included 69 obese (35 females and 34 males) and 69 non-obese children (33 females and 36 males). When both groups were compared, weight, Body mass Index (BMI) and ultra-sonographic measurement of body fat thickness differed significantly.
Conclusions: Obese children have high serum cholesterol, high serum triglyceride and high serum LDL levels as compared to non-obese children. In obese children, higher the fasting serum insulin level, more is the preperitoneal fat layer 5cm above the umbilicus with p-value of <0.05 which is significant.

Keywords: Body mass index, Lipid profile and serum fasting glucose level, Systolic and diastolic blood pressure

INTRODUCTION

Obesity is an increasingly common condition in childhood and adolescence and had emerged as one of the most serious public health concerns in 21" century. With the growing prevalence of childhood obesity. There was also an increasing in the incidence of obesity related comorbid diseases prior to childhood.[1] Current prevalence of overweight and obese children ranges from 12% to 30% in developed Nations and from 2% to 12% in the developing world and that had become one of the most common health problems in childhood.[2] The most recent national health and nutrition examination survey data indicated that 33.6% of American children and adolescents aged 2 to 19 years had a BMI more than 85% percentile.[3] Multiple different indices and techniques can be used to estimate the degree of adiposity. The most common used measured is body mass index defined as kilograms of body weight/per height in square meter (m^2). It is generally recognized as the most reliable method to determine obesity.

Children adiposity rises in the 1 year of life, reaches nadir around 5-6 years of life and then increases again throughout childhood. Obesity mainly results from the dysregulation of caloric intake and energy expenditure. A complex interplay between individual's genetic predisposition and the environment effects on intricate system that controls appetite and energy expenditure.[4] Many children consume excessive calories with the

intake of large amounts of sweetened beverages including soda, juices and drinks, sweetened beverages had been linked to higher weight increased risk of obesity and increased caloric intake. Obesity can lead to both immediate complications in children and adolescents and long-term health consequences as adult.[5] Insulin resistance most always accompanies obesity and is directly related to the degree of obesity.[6]

The main objective of the study was to asses fat distribution pattern in obese children between six to twelve years of age group in comparison with non-obese children of the same age.

METHODS

Study place

A study was conducted in the paediatric unit of Deccan College of Medical Sciences, Hyderabad, Telangana state, India.

Study duration

The study duration was from 1st June 2023 to 1st June 2024.

Ethical approval

On 138 children 6 to 12 years of age group. The study protocol was approved by the ethical committee of the institute.

Study design

A case control study was studied in Deccan College of Medical Sciences. Sixty-nine obese children (35 females, 34 males) and sixty-nine non-obese children were selected as study and control group respectively. Anthropometric parameters like weight, heights were measured and compared with ideal measurement of same sex and same age. Ultra-sonographic measurement of fat thickness including maximum and minimum preperitoneal fat thickness, maximum and minimum abdominal subcutaneous fat thickness at triceps and subscapular regions were determined in all participants.

A 7.5 MHz linear array probe was used for measurement of subcutaneous and preperitoneal fat layers. Fasting blood glucose were measured using enzymatic assays. Fasting serum insulin was done by using solid phase radio immune assay. Serum triglyceride measurement performed by using enzymatic colorimetric method.

Inclusion criteria

Children between 6 to 12 years of age and children having Body mass index more than 97th percentile for age and sex were included in the study.

Exclusion criteria

Children below 6 years or more than 12 years of age, Body mass index less than 97th percentile for age and sex, children with dysmorphic features, visual and auditory symptoms, developmental delay, mental retardation children taking any medication giving rise to obesity as adverse effect and children with oedema like nephrotic syndrome were excluded from the study.

RESULTS

Total 138 children enrolled in this study. Out of 138 children included in study. The study population included 69 obese (35 females, 34 males) and 69 non-obese children (33 females and 36 males). When both groups were compared, weight, body mass index and all ultrasonographic measurements of body fat thickness differed significantly.

Table 1, shows that obese children have significantly elevated body fat thickness including maximum subcutaneous abdominal fat thickness was 15.42+/-2.71, minimum subcutaneous abdominal fat thickness was 11.28+/-1.82, maximum preperitoneal fat thickness was 23.43/-5.37 and minimum preperitoneal fat thickness were 3.16+/-1.04, subcutaneous fat thickness at triceps region were showed 9.48+/-1.68 and subcutaneous fat thickness at subscapular region were 8.96+/-2.47 as compared to non-obese children. However, when both groups were compared using unpair T-test, no significant relation was found in between both groups with p-value>0.05.

Table 2, shows that in test obese group, fasting serum insulin was correlated to diastolic blood pressure, fasting blood glucose, serum cholesterol, serum triglyceride, serum HDL, serum LDL, serum VLDL level with p-value at 0.01 level and with minimum preperitoneal fat thickness, subcutaneous fat thickness at Triceps region and subcutaneous fat thickness, subscapular region were less significant with p-value was 0.05, but fasting serum insulin showed no correlation with maximum and minimum abdominal subcutaneous fat thickness and maximum preperitoneal fat thickness. Test groups showed that these children had higher fasting serum insulin and also showed that higher fasting serum glucose suggesting possibility of insulin resistance in obese children.

Table 3, shows that in control group, fasting serum insulin level was correlated with subcutaneous fat thickness at triceps region, but there was no correlation with other parameters including fasting serum glucose, serum cholesterol, serum triglycerides, serum HDL, serum LDL, serum VLDL, maximum and minimum abdominal subcutaneous fat thickness, maximum and minimum preperitoneal fat thickness and subcutaneous fat thickness at subscapular region.

Table 4 Shows that the test group simple linear regression analysis model using ultra-sonographic measurement of fat thickness as dependent variable and systolic and diastolic blood pressure, fasting blood glucose, fasting serum insulin and lipid profile levels as independent predictor variables shows no linear relationship in both test and control groups.

Table 1: A comparison of mean and standard deviation in test and control group.

Parameter	Test group		Control group	
	Mean	SD	Mean	SD
Abdominal subcutaneous fat thickness-maximum	15.42	2.71	8.45	2.44
Abdominal subcutaneous fat thickness- minimum	11.28	1.82	4.52	1.27
Preperitoneal fat thickness-maximum	23.43	5.37	5.32	1.77
Preperitoneal fat thickness- minimum	3.16	1.04	2.57	1.01
Subcutaneous fat thickness at triceps region	9.48	1.68	5.02	1.07
Subcutaneous fat thickness at subscapular region	8.96	2.47	3.67	0.77

Table 2: Corelation between fasting serum insulin and various variables in test group.

Variable		Fasting serum insulin
Systolic blood pressure	Pearson correlation	0.075
	P value	0.867
Diastolic blood pressure	Pearson correlation	0.426
	P value	0.00025
Fasting serum glucose	Pearson correlation	0.844
	P value	8.27E-20
Serum cholesterol	Pearson correlation	0.413
	P value	0.00042
Serum triglyceride	Pearson correlation	0.371
	P value	0.00172
Serum HDL	Pearson correlation	0.373
	P value	0.00158
Serum LDL	Pearson correlation	0.303
	P value	0.0114
Serum VLDL	Pearson correlation	0.420
	P value	0.00033
Maximal abdominal subcutaneous fat thickness	Pearson correlation	0.065
	P value	0.59379
Minimum abdominal subcutaneous fat thickness	Pearson correlation	0.004
	P value	0.97401
Maximum preperitoneal fat thickness	Pearson correlation	0.214
	P value	0.07754
Minimum preperitoneal fat thickness	Pearson correlation	0.273
	P value	0.02299
Subcutaneous fat thickness at triceps-region	Pearson correlation	0.260
	P value	0.03098
Subcutaneous fat thickness at subscapular-region	Pearson correlation	0.276
	P value	0.642

Table 3: Correlation between Fasting serum insulin and various variables in control groups.

Variable		Fasting serum insulin
Systolic blood pressure	Pearson correlation	-0.265
	P value	0.0832
Diastolic blood pressure	Pearson correlation	-0.062
	P value	0.61100
Fasting serum glucose	Pearson correlation	0.250
	P value	0.03800

Continued.

Variable		Fasting serum insulin
Serum cholesterol	Pearson correlation	-0.117
	P value	0.33800
Serum triglyceride	Pearson correlation	0.087
	P value	0.47600
Serum HDL	Pearson correlation	-0.131
	P value	0.28300
Serum LDL	Pearson correlation	-0.232
	P value	0.05500
Serum VLDL	Pearson correlation	0.115
	P value	0.34800
Maximal abdominal subcutaneous fat thickness	Pearson correlation	0.073
	P value	0.55200
Minimum abdominal subcutaneous fat thickness	Pearson correlation	0.014
	P value	0.91200
Maximum preperitoneal fat thickness	Pearson correlation	0.033
	P value	0.78700
Minimum preperitoneal fat thickness	Pearson correlation	-0.219
	P value	0.07000
Subcutaneous fat thickness at triceps-region	Pearson correlation	0.259
	P value	0.03200
Subcutaneous fat thickness at subscapular-region	Pearson correlation	0.057
	P value	0.64200

Table 4: Linear regression with maximum abdominal subcutaneous fat thickness as dependent variable and a set independent (predictor) variables in test group.

Model 1	Unstandardized	Coefficients	Standardized coefficients	T-value	P value
	B	**Std error**	**Beta**		
(constant)	7.879	8.592		0.917	0.363
Systolic blood pressure	0.049	0.114		0.431	0.668
Diastolic blood pressure	0.036	0.13	0.057	0.274	0.785
Diastolic blood pressure	0.033	0.03	-0.258	-1.094	0.278
Fasting serum insulin	0.128	0.231	0.133	0.553	0.582
Serum cholesterol	-0.012	0.065	-0.12	-0.183	0.856
Serum triglyceride	0.014	0.013	0.172	1.038	0.304
Serum HDL	0.069	0.091	0.171	0.764	0.448
Serum LDL	-0.02	0.064	-0.176	-0.305	0.762
Serum VLDL	0.109	0.107	0.181	1.019	0.313

DISCUSSION

The present study was carried out to study the body fat distribution in childhood obesity and its metabolic risk factors in 138 children between 6 to 12 years of age in Deccan College of Medical Sciences, Hyd. Obesity was important factor development of hypertension.[7]

Our study showed that the systolic and diastolic blood pressure measurements did not differ significantly in obese and non-obese group. It was inappropriate to compare the mean blood pressure measurements in such a group with a wide age distribution. Blood pressure measurements were compared with reference values prepared according to age and sex. Systolic hypertension was detected in 53%, diastolic hypertension in 69% subjects in obese group, which was comparable with the studies of Ender Semiz et al, who found that blood pressure measurement did not differ significantly in both groups, but when these blood pressure measurements were compared with reference values prepared according to age and sex, systolic hypertension was detected in 6 (11.6%), diastolic hypertension in 10 (19.6%) subjects in the obese group.[8] Taruis et al, who reported that obese children had a significantly high blood pressure than non-obese children (systolic blood pressure 121+/-14 mmHg in obese children vs 112 +/-11 mmHg in non-obese children, p value less than 0.001, diastolic blood pressure 72+/-9 mmHg in obese children vs 66+/-7mm Hg in non-obese children, p value less than 0.001.[9] When both

groups were compared, obese children had significantly elevated fasting blood glucose, fasting serum insulin, total cholesterol, serum triglyceride and serum LDL as compared to non-obese children. There was no significant difference with respect to serum HDL and serum VLDL levels.[10] Uchiyama metal reported the correlation between systolic blood pressure, serum insulin was found in both obese and non-obese group, systolic blood pressure was associated with insulin level.

Tershakovec et al, reported that visceral abdominal and subcutaneous fat thickness were not correlated with insulin level in the obese children and adolescents. Asayama et al, reported that there were relation between total subcutaneous, visceral fat thickness and insulin, lipid values and visceral fat thickness was more sensitive index to predict metabolic risk.[11,12] Our study showed that the obese children had multiple linear regression analysis model using diastolic blood pressure as dependent variable and fasting serum insulin and ultra-sonographic measurement of fat thickness including maximum and minimum abdominal subcutaneous fat thickness, maximum and minimum preperitoneal fat thickness, subcutaneous fat at triceps and subscapular region as independent predictor of diastolic blood pressure with adjusted Rz value 0.182.

The study also showed that in non-obese children simple linear regression analysis model using diastolic blood pressure as dependent variable and fasting serum insulin and ultra sonographic measurement of fat thickness including maximum and minimum abdominal subcutaneous fat thickness, maximum and minimum preperitoneal fat thickness, subcutaneous fat thickness at triceps and subscapular region as independent predictor variables shows that maximum preperitoneal fat thickness was the best predictor of diastolic blood pressure with adjusted R2 value 0.236. The study showed that the findings of higher systolic and diastolic blood pressure, higher fasting serum insulin levels with higher fasting glucose level, raised serum cholesterol, raised serum LDL, raised serum triglyceride level may predispose those children to cardiovascular disease, diabetes and other co-morbid conditions at an early age.[13-16]

Apparently, while the study was being conducted, following limitations were faced by the researcher: sample size for the given study was limited, details of daily activity and dietary pattern of the participants could not be included in the study.

CONCLUSION

Obese children had higher fasting serum insulin level, higher was the diastolic blood pressure with p-value<0.01 which was highly significant and suggested that obesity was high risk for hypertension and cardiovascular diseases at an early age. Obese children had high serum cholesterol, high serum triglyceride and high serum LDL levels as compared to non-obese children. Obese children had higher fat thickness in preperitoneal fat layer below xiphoid process, subcutaneous fat layer 5cm above umbilicus, subcutaneous fat in triceps region as compared to fat thickness in non-obese children in the same area. In obese children, higher the fasting serum insulin, more is the fasting serum glucose level with p value<0.01 suggesting highly significant correlation. This suggests the possibility of insulin resistance i.e. prediabetic state in obese children. In obese children, higher the fasting serum insulin level, more is the preperitoneal fat layer 5 cm above the umbilicus with p value of<0.05 which is significant. In obese children, higher the fasting serum insulin, more is the subcutaneous fat in triceps and subscapular region with p value of<0.05 which is significant. There is no significant difference between serum HDL and serum VLDL levels in obese and non-obese children.

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Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Sinha R, Fisch G, Teague B. Prevalence of impaired glucose tolerance among children and adolescents with marked obesity. N Engl J Med. 2002;346(11):802-10.
2. Popkin B. Global dynamics in childhood obesity: reflections on a life of work in the field. Pedia Obes: Etiol, Pathogen, and Treat. 2010:3-11.
3. Hayden-Wade HA, Stein RI, Ghaderi A, Saelens BE, Zabinski MF, Wilfley DE. Prevalence, characteristics and correlates of teasing experiences among overweight children vs. non-overweight peers. Obes Res. 2005;13(8):1381-92.
4. Duren DL, Sherwood RJ, Czerwinski SA, Lee M, Choh AC, Siervogel RM, et al. Body composition methods: comparisons and interpretation. J Diabetes Sci Technol. 2008;2(6):1139-46.
5. Xu S, Xue Y. Pediatric obesity: Causes, symptoms, prevention and treatment. Exp Ther Med. 2016;11(1):15-20.
6. Wills M. Orthopedic complications of childhood obesity. Pediatr Phys Ther. 2004;16(4):230-5.
7. Flynn JT. Pediatric hypertension: recent trends and accomplishments, future challenges. Am J Hypertens. 2008;21(6):605-12.
8. Semiz S, Ozgoren E, Sabir N, Semiz E. Body fat distribution in childhood obesity: association with metabolic risk factors. Indian Pediatr. 2008;45(6):457-62.
9. Kanai, H. and Matsuzawa, Yuji and Fujioka, S. and Tokunaga, Kan and Tarui, S.. (1992). A Close Correlation of Fasting Insulin Levels to Blood Pressure in Obese Children. 2007;10:-3512-3.
10. Nishina M, Kikuchi T, Yamazaki H, Kameda K, Hiura M, Uchiyama M. Relationship among Systolic Blood Pressure, Serum Insulin and Leptin

and Visceral Fat Accumulation in Obese Children, Hypertens Res. 2003;26:281-8.
11. Tershakovec AM, Kuppler KM, Zemel BS. Body composition and metabolic factors in obese children and adolescents. Int J Obes Relat Metab Disord. 2003;27(1):19-24.
12. Asayama K, Sato A, Ohkubo T. The association between masked hypertension and waist circumference as an obesity-related anthropometric index for metabolic syndrome: the Ohasama study. Hypertens Res. 2009;32,438–43.
13. Jafar TH. Children, obesity and high blood pressure: Asian populations at high risk. Am J Hypertens. 2009;22(1):6-7.
14. Steinberger J, Moorehead C, Katch V, Rocchini AP. Relationship between insulin resistance and abnormal lipid profile in obese adolescents. J Pediatr. 1995;126(5):690-5.
15. Patel A, Barzi F, Jamrozik K. Serum triglycerides as a risk factor for cardiovascular diseases in the Asia-Pacific region. Circulation. 2004;110(17):2678-86.
16. Pulgarón ER. Childhood obesity: a review of increased risk for physical and psychological comorbidities. Clin Ther. 2013;35(1):18-32.

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