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ORIGINAL ARTICLE

Echocardiographic Measurements of Epicardial Adipose Tissue Among Obese Children.

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ABSTRACT

Background: The epicardial adipose tissue (EAT) plays an important role in the cardiac functions. Childhood obesity has significant effect on the circulatory system. However, till now the effect of obesity on cardiac function is not detected, but evaluation of visceral adipose tissue may be done by echocardiographic measurement and its relationship with cardiometabolic risk.
Objectives: To detect measurements of EAT thickness among children with obesity and to correlate them with other cardiometabolic, anthropometric, clinical and laboratory variables.
Methods: Target sample comprised 12 overweight and obese children (study group) of age ranged from (6-12 years) selected from the outpatient obesity clinic and all have Body Mass Index above 85th percentile for their corresponding age and sex. Twelve apparently healthy averagely weighted children (control group) matched with the study group for age and sex. A questionnaire performed for collection of personal, sociodemographic and clinical data, clinical examination, laboratory investigations for fasting blood sugar and plasma lipids with echocardiographic measurement of EAT thickness.
Results: In overweight and obese children, the epicardial adipose tissue was significantly higher compared to normal weight children. Overweight and obese children had significantly higher body mass index, waist/hip ratio, blood pressure, triglycerides. EAT thickness correlated significantly with blood pressure and triglycerides.
Conclusion: Overweight and obese children exhibit an increase in echocardiographic epicardial adipose tissue thickness. Changes in epicardial adipose tissue thickness are associated with increase in blood pressure and serum triglycerides. For assessment of cardiometabolic risk EAT is an easy and practical accurate parameter for assessing visceral obesity.
Key words: Echocardiographic, epicardial adipose tissue, obese children.

INTRODUCTION

The epicardial adipose tissue (EAT) is part of the visceral fat deposited between the visceral layers of the pericardium and the outer wall of the myocardium in the epicardial sac around the heart. Epicardial adipose tissue has a common embryological origin with the visceral adipose tissue in the abdomen and is therefore a metabolically active adipose tissue. **[1]**

Obese children are at risk for both short-term and long-term health effects. Some studies suggested that the prevalence of obesity among children would reach 30% by 2030. **[2]** Various studies have shown that obesity is associated with subclinical markers of atherosclerosis in children and adolescents, along with other cardiometabolic risk factors (CRFs), and early mortality in adulthood. **[3]**

In 2010, World Health Organization (WHO) statistics revealed that the level of childhood obesity is increasing all over the world, which affect life expectancies, as well as increasing the risk of morbidities related to obesity as cardio-vascular illnesses and cancers. **[4]**

Many obesity-related parameters have been correlated with epicardial adipose tissue, echocardiography of this tissue is a simple and effective marker for cardiometabolic risk. **[5]**

PATIENTS AND METHODS

Type of the study: This was a cross sectional case control study.

Study setting: The study was conducted in the outpatient obesity clinic and Pediatric cardiology unit Pediatric Department, Zagazig University Hospitals.

Study period: From March 2017 to February 2018**.**

Sample size: Total sample size included 24 school aged children (6-12 years).

Study group: 12 school aged overweight and obese children selected randomly from those attending the outpatient obesity clinic and everyone has a Body Mass Index (BMI) above the 85th percentile for their age and sex was included in the study.

Control group: 12 apparently healthy average weight children.

The sample size was calculated using Open EPI, info package version 6.04, confidence interval C.I 95%, and power 80%.

Inclusion criteria: School aged children 6-12 years, both sexes are included also overweight and obese children with stable vital signs were included in the study.

Exclusion criteria: Children with diseases of brain, gut, liver, congenital malformation or genetic syndromes, secondary hyperlipidemia and endocrine disorders such as diabetes mellitus, hypothyroidism and condition of Cushing, children who are receiving medication (glucocorticoids, lipid lowering, antiepileptic) that may interfere with lipid metabolism and may affect the study variables, or medications known to affect heart function, antihypertensive drugs, hormone replacement therapy, obese children who achieved a nutritional status of normal weight also major concomitant infection, and clear clinical signs of heart disease

Operational design: Included a questionnaire interview with care taking for collection of personal data, sociodemographic data and complete history taking with particular emphasis on age, sex, initial clinical presentation and associated co- morbidities. Full clinical examinations as anthropometric measurements for body weight, height, and body mass index (BMI), vital signs including heart rate, blood pressure and respiratory rate, echocardiographic examination using Vivid 7 GE systems for calculating EAT use 5 MHZ transducer while the patient is lying on the left side. The long and short parasternal axis views used where the epicardial fat is positioned in front of the right ventricle as an echo-free or hyper-echoic room. Also, laboratory investigations were done for fasting blood glucose and plasma lipid profile of total cholesterol, low density lipoproteins (LDL), high density lipoproteins (HDL) and triglycerides (TG) by colorimetric method and HB1C by direct enzymatic assay.

The studied children were classified according to BMI. The BMI above the 85th percentile but less than 95th percentile for age and sex is defined as overweight. Obesity is defined if BMI is at least the 95th percentile but less than 97th percentile for age and sex, and morbid obesity if BMI is more than 97th percentile for age and sex.

Cardiometabolic risk was diagnosed by the Metabolic risk score in children (MetS score). The presence of MetS, as a categorical variable, was verified by a body mass index (BMI) > 90th percentile for age and sex and presence of two or more of the following findings: (1) fasting blood glucose >110 mg/dL; (2) systolic and or diastolic blood pressure >95th percentile for age, sex and height, (3) HDL-cholesterol <5th percentile for age and sex; (4) TG >95th percentile for age and sex. **[6]**

Administrative and ethical design: Written informed consent was obtained from parents of all participants and the study was approved by the research ethical committee and the institutional review board (IRB) of Faculty of Medicine, Zagazig University. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis: Data were entered checked and analyzed using Mini-tab 17.0 Software for statistical purposes. The mean and standard deviation (mean±SD) of quantitative data was presented.

Using the unpaired "t" test of Student, correlations between patients and controls are made. Mann Whitney U test has been used for data that are not normally distributed. The statistical significance was set at $p < 0.05$ and was highly significant when p was below 0.01.

RESULTS

Total sample size included 24 school aged children (6-12 years). Obese children were 58.3% females and their mean age was 8.75 years.

In terms of age and gender, all cases and controls are balanced properly. Between the two classes there were no statistically significant differences

(P>0.05), as shown in table 1.
The cases had higher weight, BMI and waist-hip ratio in comparison to controls (P<0.05), as shown in table 2.
The cases had higher systolic and diastolic blood pressure in comparison to controls (P<0.001), as shown in table 3.
The cases had higher serum triglyceride levels in comparison to controls (P<0.05). However, there were no significant differences regarding fasting blood glucose, HbA1C, HDL and LDL, as shown in table 4.
There was high statistically significant increase in EAT thickness in cases when compared to the controls (P<0.001), as shown in table 5.
The studied cases were classified according to the BMI; 42% were overweight, 41% were obese and 17% had morbid obesity, as shown in figure 1.
Obese cases showed highly significant values regarding fasting blood sugar, waist/hip ratio, blood pressure and HDL. However, morbid obese children showed the highest value of LDL, as shown in figure 2.
Obese cases showed the highest value of serum HDL, while overweight cases showed the highest value of blood pressure and morbid obese cases showed the highest value of BMI, as shown in figure 3.

Table 1: Distribution of the studied groups as regard some demographic data

Demographic data	Cases (N=12) Mean ± SD Median (Range)		Control (N=12) Mean ± SD Median (Range)		Test	P-value (Sig.)
Age (Y)						
	8.75 ± 2.13 8.5 (6-12)		8.66 ± 2.01 8.5 (6-12)		151.5•	0.954 (NS)
	No.	**%**	**No.**	**%**		
Sex						
Male	5	41.6	7	58.3	162.0•	0.5067 (NS)
Female	7	58.3	5	41.6		

• Mann-Whitney test.

Table 2: Distribution of the studied groups as regard anthropometric measurements

	Cases (N=12) Mean ± SD Median (Range)	Control (N=12) Mean ± SD Median (Range)	Test	P-value (Sig.)
Weight (kg)				
	43.33 ± 17.08 39 (24-78)	29.75 ± 8.13 26.5 (22-49.5)	2.49 *	0.025 (Sig.)
Height (cm)				
	137.08 ± 15.23 135 (116-160)	130.75 ± 12.19 128 (118-157)	167•	0.34 (NS)
BMI (kg/m^2)				
	22.12 ± 3.96 21.13 (17.84-31.24)	17.06 ± 1.36 16.93 (15.02-19.87)	214•	<0.001 (HS)
Waist-hip ratio (cm/cm)				
	0.9 ± 0.03 0.9 (0.86-0.97)	0.87 ± 0.02 0.88 (0.81-0.89)	201•	0.002 (Sig.)

* Independent Student's t-test.
• Mann-Whitney test

Table 3: Distribution of the studied groups as regard vital signs

	Case (N=12) Mean ± SD Median (Range)	Control (N=12) Mean ± SD Median (Range)	Test	P-value (Sig.)
Heart rate				
	88.33 ± 12.62	85.5 ± 12.52	0.55*	0.587 (NS)

	Case (N=12) Mean ± SD Median (Range)	Control (N=12) Mean ± SD Median (Range)	Test	P-value (Sig.)
	88.5 (61-110)	85.5 (67-107)		
Respiratory rate				
	29.83 ± 3.12 30 (24-32)	28.67 ± 3.55 29 (24-34)	0.85*	0.403 (NS)
Systolic blood pressure				
	96.67 ± 5.37 100 (90-105)	85 ± 5.22 85 (80-90)	210•	0.0006 (HS)
Diastolic blood pressure				
	70.42 ± 2.17 70 (60-80)	50.42 ± 6.89 50 (40-60)	217.5•	0.0001 (HS)

* Independent Student's t-test.
• Mann-Whitney test

Table 4: Distribution of the studied groups as regard laboratory data

	Case (N=12) Mean ± SD Median (Range)	Control (N=12) Mean ± SD Median (Range)	Test	P-value (Sig.)
Fasting blood glucose (FBG) (mg/dl)				
	83 ± 10.8 82.5 (70.1-105.5)	84.67 ± 4.8 84.75 (75.3-92.5)	0.48*	0.637 (NS)
HbA1C %				
	5.283 ± 0.252 5.3 (4.8-5.8)	5.208 ± 0.227 5.2 (4.8-5.5)	0.77*	0.452 (NS)
Total cholesterol (mg/dl)				
	166.5 ± 23.6 165.15 (135.2-218.9)	160.6 ± 21.8 157.15 (128.4-200.3)	0.64*	0.528 (NS)
HDL (mg/dl)				
	50.20 ± 9.38 48.8 (35.1-73.3)	49.9 ± 13.4 47.9 (30.7-71.8)	0.06*	0.953 (NS)
LDL(mg/dl)				
	107.1 ± 21.4 103.9 (71.6-158)	106.9 ± 26.2 99.1 (68.2-163.8)	0.02*	0.987 (NS)
TG (mg/dl)				
	120.4 ± 45.1 119.2 (44.4-211)	79.3 ± 21.7 74.4 (47.5-115.6)	2.85*	0.012 (Sig.)

* Independent Student's t-test.

Table 5: Mean ± SD of Epicardial Adipose Tissue (EAT) thickness among studied groups

	Case (N=12) Mean ± SD Median (Range)	Control (N=12) Mean ± SD Median (Range)	Test	P-value (Sig.)
EAT (mm)				
	9.17 ± 2.34 8.25 (6.5-13.5)	5.92 ± 1.08 5.5 (4.5-8.5)	4.36*	0.001 (HS)

* Independent Student's t-test..

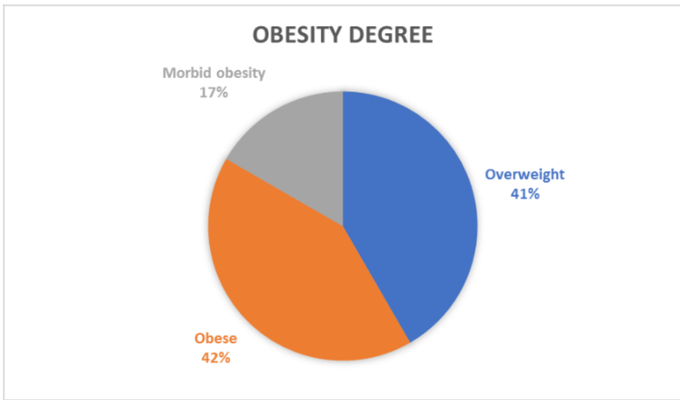

Figure 1: Distribution of studied patients regarding degree of obesity; 42% of studied patients were overweight, 41% were obese & 17% were morbid obesity.

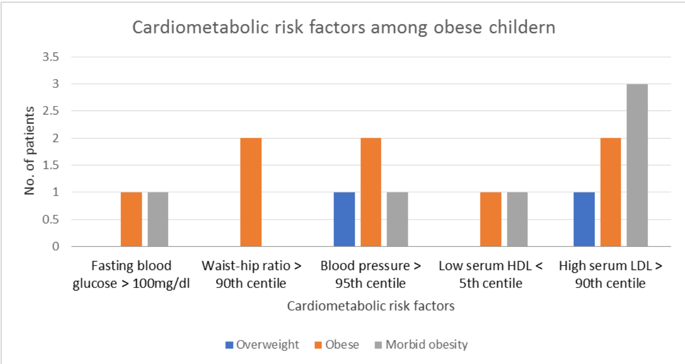

Figure 2: Distribution of cardiometabolic risk factors in different obesity degrees.
Obese children showed highly significant values regarding fasting blood sugar (FBS), waist/hip ratio, blood pressure and low high-density lipoprotein (HDL). However, morbid obese children showed the highest value of low-density lipoprotein (LDL).

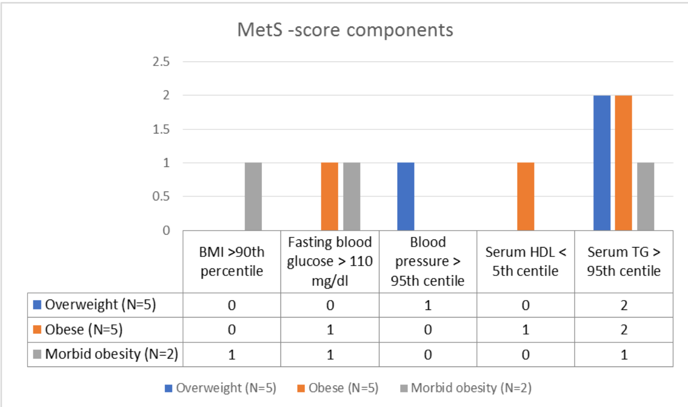

Figure 3: Occurrence of components of MetS-score.
Obese children showed the highest value of serum high density lipoprotein(HDL) ,overweight children showed the highest value of blood pressure and morbid obese children showed the highest value of body mass index.

DISCUSSION

Obesity is considered as the most common childhood condition in the developed world, and it continues to increase its prevalence. A wide range of high-quality and reliable evidence shows that body mass index (BMI) percentile is best defined relative to national body mass index data. **[7]**

Obesity in childhood and adulthood causes ill health. An emerging risk factor for cardiovascular risk is increased visceral adiposity. Visceral adipose tissue now needs to be quantified not only for diagnostic purposes, but also for therapeutic interventions with weight reduction drugs or pharmaceuticals targeted at adipose tissue, as well as for anti-obesity medications. Growing evidence suggests that cardiac adiposity can play a significant role in developing an unfavorable cardiovascular risk profile among visceral adipose tissues. Recent papers suggest that epicardial fat, cardiac and visceral adiposity index, could modulate the heart's morphology and function locally. The near anatomical relationship between the epicardial adipose tissue and the adjacent myocardium will promote local paracrine interactions among these tissues. Recently, echocardiography was proposed for direct evaluation of epicardial adipose tissue. Echocardiographic assessment of epicardial fat can be a useful tool not only for diagnostic purposes as an indicator of visceral adiposity and inflammation, but also for therapeutic interventions with drugs which can modulate the adipose tissue. **[8]**

This study was held on 12 obese children with mean age of 8.75±2.13 years compared to age and sex matched control group composed of 12 non-obese children with mean age of 8.66±2.01 years. There was no significant difference in sex between both groups with 41.6% males in case group compared to 58.3% males in control group. As for anthropometric measurements in our sample, apart from the non-significant height difference between the two classes, there was an important differences in weight, BMI and waist-to-hip ratio between cases and conrtols.

Our study revealed that there were statistically significant differences between cases and controls in weight, BMI and waist-hip ratio. In agreement with our results, Ahmed and colleagues **[10]** found that in the obese band, BMI was significantly higher than control. Also, Ozdemir and colleagues **[9]** found that the difference between obese and non-obese children was significant. Also, Marinov and colleagues **[11]** agreed with our data on substantial body weight and non-significant height in obese and non-obese children.

Our study revealed a significant difference in systemic blood pressure (systolic & diastolic) both were higher in cases when compared to controls, although the heart rate and respiratory rate did not differ significantly.

Harada and colleagues **[12]** disagreed with us because he observed a significant difference in heart rate between patients who were obese and non-obese, with higher values in obese cases. Also, Ozdemir and colleagues **[9]** reported that there was a major difference between obese and non-obese patients regarding heart rate. On the other side, Marinov and colleagues **[11]** agreed about significant difference in breathing frequency between obese and non-obese patients.

Laboratory investigations were done for our included cases to evaluate the metabolic effect of obesity. These investigations included fasting blood sugar level, glycemic control (HbA1C %), total cholesterol, HDL, LDL and serum triglyceride. Our study showed no significant difference between both groups in these investigations except for serum triglyceride level, which was higher in cases in comparison to controls.

Ozdemir and colleagues **[9]** agreed with our data as he found non-significant difference in blood sugar levels and significant difference in serum triglyceride levels between the two classes. In the current study, the cases had higher serum triglyceride levels with mean of 120.4±45.1, compared to 79.3±21.7 in controls. Nonetheless, we disagreed with the same research in finding significant differences in serum levels of total cholesterol, HDL and LDL between the two groups. This difference can be excused to the larger sample size and higher age group with mean age 11±2.2 years in the study of Ozdemir and colleagues **[9]**. Also, the study of Weiss and colleagues **[6]** was against our results regarding significant difference between their included patients in HbA1C%, serum triglyceride and HDL.

Epicardial adipose tissue (EAT) is the accumulation of visceral fat around the heart and in obese subjects is typically increased. Epicardial adipose tissue is associated with cardiometabolic risk factors and non-alcoholic fatty liver disease (NAFLD) in adults, but this association in children is not well understood. **[13]** Echocardiographic evaluation of epicardial adipose tissue was performed to determine its association with cardiometabolic risk factors in overweight and obese children. Our study revealed highly significant increase in EAT among the cases with mean thickness 9.17 ± 2.34 mm than controls with mean thickness 5.92 ± 1.08 mm. Mazur and colleagues **[14]** and Ozdemir and colleagues **[9]** supported our results as they showed highly significant increase in EAT thickness among obese and non-obese patients.

According to the index of body mass if it is overweight for age and sex at least 85th percentile but less than 95th percentile. If BMI is at least > 95th percentile for age and sex, it is overweight, if BMI is > 97th percentile, it is moderate obesity. The obese patients in the current study showed different degrees of obesity as 42% of studied obese patients were overweight, 41% were obese & 17% had morbid obesity. The previous results agreed with the study of Torun and colleagues. **[15]**

CONCLUSION

Overweight and obese children showed an increase in the tissue thickness of echocardiographic epicardiography. There is a risk of developing cardiometabolic syndrome among obese and morbid obese children. Change in the thickness of epicardial adipose tissue is associated with increased risk of increased blood pressure and increased levels of serum triglycerides.

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