Subject Area: Pediatrics

Assessment of carotid intima-media thickness and its relation to cardiovascular risk factors in obese children

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ORIGINAL STUDY

Assessment of carotid intima-media thickness and its relation to cardiovascular risk factors in obese children

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Abstract

Background: Childhood obesity is one of the most critical public health problems today. This study aims to assess the relation between carotid intima-media thickness (CIMT) and cardiovascular risk factors in obese children.

Patients and methods: This is a case–control study conducted on 80 Egyptian children aged 6–18 years; 40 children with simple obesity as defined by WHO (2011) and 40 healthy children age matched and sex matched were taken as a control group. Cases were selected from the National Nutritional Institute randomly from December 2017 to March 2018. All patients and control groups were subjected to the following: full history taking, complete clinical examination including blood pressure, anthropometric measurements, and detailed systemic examination. Laboratory investigations included lipid profile, fasting blood sugar, and radiological investigation (carotid ultrasound).

Results: There was a statistically significant increase in both right and left CIMT in the patients’ group than controls. There was a statistically significant positive correlation between left CIMT and weight Z score in the patients’ group compared with the control group.

Conclusion: Both right and left CIMT were significantly increased in the studied obese children than in the control. This can reflect the importance of CIMT measurement as a marker of early atherosclerosis in obese children, especially after 10 years of age.

Keywords: Atherosclerosis, Carotid intima-media thickness, Children, Obesity

1. Introduction

Childhood obesity is one of the most critical public health issues that need more attention today [1]. Associated factors may play a role in the development of obesity, including genetics, environmental, metabolic, and eating habits [2].

Obesity in children is associated with comorbidities such as type 2 diabetes, hypertension, dyslipidemia, accelerated bone maturation, ovarian hyperandrogenism and gynecomastia, cholecystitis, pancreatitis, and pseudotumor cerebri [3].

Carotid intima—media thickness (CIMT) is the area of tissue starting at the luminal edge of the artery and ending in boundary at the media and adventitia. B-mode ultrasound is used to measure the composite thickness of the intima and the media [4].

CIMT is a reliable, feasible, and inexpensive method used for early diagnosis of atherosclerosis. It holds a promise for the noninvasive detection of atherosclerosis [5].

The ‘double-line’ pattern is the distance between the two echogenic lines representing the lumen—intima and media—adventitia interfaces. CIMT in healthy
middle-aged adults measures 0.6–0.7 mm and greater than 1.20 mm is considered abnormal [6]. Since the late 1970s, CIMT has been known as a sensitive tool to diagnose atherosclerosis and predict its progression and regression [7]. A CIMT of greater than 1.00 mm in a younger individual would determine abnormal findings [8].

In a study of 100 healthy children, color Doppler ultrasound was used to determine the normal values of the CIMT and the measures were listed, respectively, as 0.39 ± 0.04 mm in the 3–6 years group, 0.41 ± 0.03 mm in the 7–9 years group, 0.44 ± 0.06 mm in the 10–12 years group, 0.45 ± 0.07 mm in the 13–15 years group, and 0.48 ± 0.04 mm in the 16–18 years group. It is recommended to take the following figures as the average IMT of the common carotid artery; 0.45 mm for children under 10 years and 0.55 mm for adolescents aged 11–18 years. An exceeding figure can be treated as the abnormal thickness of the carotid wall [9].

Early detection and intervention for atherosclerosis and other cardiovascular risk factors become more critical in preventing obese children and adolescents from cardiovascular disease [38]. This study aims to assess CMIT and its relation to cardiovascular risk factors in obese children.

2. Patients and methods

This is a case–control study that was conducted on 80 Egyptian children aged up to 18 years. They were classified into the following two groups:

Group I included 40 children included with simple obesity as defined by WHO (2011) [39]. Group II included 40 apparently healthy children age matched and sex matched taken as a control group. Cases were randomly selected from the National Nutritional Institute during the period from December 2017 to March 2018. Inclusion criteria for patients: children from 6 to 18 years of both sexes that fulfill the diagnostic criteria of obesity according to the BMI percentile for age and sex [39]. Exclusion criteria for patients: nonobese children, children less than 6 years, children with endocrinial, syndromatic and medication affected CVS, children with past history or evidence of relevant disease that may affect the carotid intima thickness, for example, familial hyperlipidemia, diabetes, hypothyroidism, positive family history of cardiac or renal disease.

Informed consent was obtained from all patients and control or their families before getting them involved in the study and confidentiality of all data was ensured. Any of the patients and controls had the right to withdraw from the study any time without giving any reason.

All patients and control group were subjected to the following:

(1) Full history taking according to a predesigned questionnaire including personal history, history of obesity, dietary history (number of meals, fast food, vegetables and fruits), physical activity (type of sport, times per week, duration), family history of obesity, diabetes, hypertension, and cardiac diseases.

(2) Complete clinical examination including blood pressure (BP), percentiles matched for age and sex [10].

Anthropometric measurements of the following indices (weight, height, BMI, waist, and hip circumferences).

2.1. Measuring the weight

Weighing scale was used. The weight was measured to the nearest 0.1 kg [11]. Weight was plotted against growth charts of the WHO Growth Charts for Boys and Girls aged from 5 to 19 years [12].

2.2. Measuring the height

The following procedure was applied to take all our participants’ height using a wall-mounted stadiometer. Height was plotted against growth charts of the WHO Growth Charts for Boys and Girls aged from 5 to 19 years [12].

The BMI was calculated using the following standard formula: \( BMI = \frac{\text{weight (kg)}}{\text{[height (m^2)]}} \). BMI was plotted against BMI for age percentile charts [13].

The patients were categorized based on the following expert committee recommendations:

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>Less than 5th percentile</td>
</tr>
<tr>
<td>Healthy</td>
<td>5th percentile to less than 85th percentile</td>
</tr>
<tr>
<td>Overweight</td>
<td>85th to less than 95th percentile</td>
</tr>
<tr>
<td>Obese</td>
<td>Equal to or greater than 95th percentile</td>
</tr>
</tbody>
</table>

Waist and hip circumferences: the waist circumference was measured at the minimum circumference between the iliac and the ribcage. Hip circumference was measured at the maximum protuberance of the buttock [14]. Calculation of Z-scores was done according to the following formula:

\[ Z\text{-score (or SD-score)} = \frac{\text{observed value} - \text{median value of the reference population}}{\text{SD value of reference population}} \]
2.2.1. Detailed clinical examination of all body systems

(1) Investigations:

(a) Laboratory investigation: blood samples were obtained after 8–12 h of fasting.

(i) Lipid profile including:

Serum cholesterol: expected values in children are 120–200 mg/dl [15]. Normal value in children is less than 170 mg/dl. Serum triglyceride (TG): expected values in children are 30–150 mg/dl [16]. Normal value in children aged 0–9 years is less than 75 mg/dl and 10–18 years less than 90 mg/dl.

High-density lipoprotein (HDL): male: 30–70 mg/dl – female: 30–85 mg/dl [17]. Normal value in children is more than 45 mg/dl.

Low-density lipoprotein was calculated through this equation: total cholesterol–HDL–TG/5 (normal range: 150–190 mg/dl) [18]. Normal value in children is less than 110 mg/dl.

(ii) Fasting blood sugar (FBS): was done by using the glucose oxidase enzyme. Normal range 70–100 mg/dl [19].

(2) Radiological investigation (carotid ultrasound):

Measurement of carotid intima thickness was performed using an ‘asus on’ machine and a ‘5–8 MHz’ probe with a high-resolution B-mode ultrasound scanner. All studies were performed according to a standardized scanning protocol for the right and left common carotid arteries.

The technique of measurement of CIMT: patients were examined in supine position with the head in a slightly bended position toward the opposite side of the one being scanned. The ultrasound transducer was placed at an angle of 90° of the vessel walls (to obtain parallel echo lines of the lumen and media in both near and far wall). The common carotid artery bulb was identified, and the segments of the common carotid arteries 1–2 cm proximal to the bulb region were scanned.

The IMT can be measured in the common carotid artery (CCA), the bifurcation (bulb), and either of the branch vessels (usually internal carotid artery (ICA)). Because of its tubular shape, perpendicular location relative to the transducer beam, and virtually universal accessibility, measurement yield and reproducibility of the CCA IMT are higher than for the ICA or bulb IMT [20].

The technique by which CIMT is determined consists of two steps: the first is the ‘scanning procedure,’ that is, ultrasound scanning of the carotid artery with storage pictures/dynamic sequence. IMT is measured by the distance between the lumen—intima interface’s leading edge and the media—adventitia interface.

One single, experienced ultrasonographer blinded to the patient’s metabolic state obtained all images. The images were stored digitally for subsequent off-line analysis.

2.3. Statistical analysis

Data were analyzed by SPSS (SPSS Inc. Released 2006. SPSS for Windows, Version 15.0. Chicago, SPSS Inc.) (the Statistical Package for the Social Sciences, version 15) and the results were tabulated by Harvard Graphics packages version 4 that were used for representing the result graphically.

Quantitative variables from normal distribution were expressed as mean ± SD, while qualitative variables were expressed as percentages and association measures available within crosstabs are used [21].

An independent t test was used to compare between the two sample means and F test (one-way analysis of variance) was used for comparing between groups; two assumptions are underlying the analysis of variance corresponding F test. The first is that the variable is normally distributed. The second is that the SD between individuals is the same in each group. If the Fratio is significant, then SPSS conducted post-hoc least significant difference test [22].

Person’s correlation coefficient (r) has also been applied in this study between two quantitative variables.

It measures the nature and strength between two quantitative variables of the quantitative type. The value of r ranges between −1 and +1. The sign of r denotes the nature of association, while the value of r denotes the strength of association. If the sign is positive, the relationship is direct, which indicates that an increase in one variable is associated with an increase in the other variable and a decrease in one variable is associated with a decrease in the other variable.

The value of r denotes the strength of the association as illustrated by the following:

\[
    r = 0 \text{ no correlation, } 0.25 \leq r \leq 0.50 \text{ weak correlation, } 0.50 \leq r \leq 0.75 \text{ moderate correlation, } 0.75 \leq r \leq 1.00 \text{ strong correlation, and } r = 1 \text{ perfect correlation} [23].
\]

To our knowledge, there is no cutoff reference value of CIMT in Egyptian children.

3. Results

The study population included 80 children: 40 of them had simple obesity as defined by WHO (2011)
[39] and 40 children were apparently healthy non-obese children.

Cases were randomly selected from the obesity clinic of the National Nutrition Institute during the period from December 2017 to March 2018.

As regards sex distribution in the present study, among the 40 obese children, 20 (50%) were males and 20 (50%) were females compared with 22 (55%) males and 18 (45%) females in the control group, respectively. Regarding sex, no statistically significant difference was found between the two studied groups (Table 1).

The age of the studied children ranged between 6 and 18 years, with a mean value of 10.8 ± 3.1 and 8.9 ± 2.3 for the control and obese groups, respectively, with no statistically significant difference between them (Table 1).

There was a statistically significant increase in the mean values of height, weight, and BMI Z-scores in the patients’ group compared with controls, as demonstrated in Table 2.

Regarding laboratory parameters in the studied groups, the mean serum TG was significantly higher among our obese children when compared with controls. Also, there was an increase in mean serum cholesterol, LDL, and FBS and a decrease in the mean HDL level in patients than controls, but differences were not significant, and all mean values were within the normal range (Table 2).

When we compared the distribution of the two studied groups as regards each of TG, LDL, and HDL, we found that 60% had hypertriglyceridemia compared with 15% in controls, 22.5% had high LDL levels compared with 7.5% in controls, 30% had lower HDL levels compared with 10% in controls as shown in Table 3.

The cutoff value of Rt CIMT was found to be more than 0.51 mm with a sensitivity of 86.7%, specificity of 100%, positive predictive value (PPV) of 100%, negative predictive value (NPV) of 97.1%, and with a diagnostic accuracy of 97.5% (Table 4), while the cutoff value of left CIMT more than 0.51 mm with a sensitivity of 86.9%, and PPV of 100%, and NPV of 96.1%, and with a diagnostic accuracy of 95% as in Table 4.

### Table 1. Comparison between the two studied groups as regards sex and age.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Patient group (N = 40)</th>
<th>Control group (N = 40)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female [%]</td>
<td>20 (50)</td>
<td>18 (45)</td>
<td></td>
</tr>
<tr>
<td>Male [%]</td>
<td>20 (50)</td>
<td>22 (55)</td>
<td></td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>8.9 ± 2.3</td>
<td>10.8 ± 3.1</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3. Distribution of the two studied groups as regards triglyceride, low-density lipoprotein, and high-density lipoprotein.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Patient group (N = 40) [%]</th>
<th>Control group (N = 40) [%]</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG (mg/dl) Normal</td>
<td>16 (40)</td>
<td>34 (85)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>24 (60)</td>
<td>6 (15)</td>
<td></td>
</tr>
<tr>
<td>LDL (mg/dl) Normal</td>
<td>31 (77.5)</td>
<td>37 (92.5)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>9 (22.5)</td>
<td>3 (7.5)</td>
<td></td>
</tr>
<tr>
<td>HDL (mg/dl) Normal</td>
<td>28 (70)</td>
<td>34 (90)</td>
<td></td>
</tr>
<tr>
<td>Abnormal</td>
<td>12 (30)</td>
<td>4 (10)</td>
<td></td>
</tr>
</tbody>
</table>

HDL, high-density lipoprotein; TG, triglyceride.

There was a statistically significant increase in both right and left CIMT in the patients’ group than controls as in Table 2.

Regarding BP in the studied groups, there was a statistically significant increase in mean values of the BP in the patient group compared with the control group; however, all values were within the normal range (Table 2).

### Table 2. Comparison between the two studied groups as regards anthropometric measurements, laboratory parameters, carotid intima-media thickness, and blood pressure Z score.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Patients group (N = 40)</th>
<th>Control group (N = 40)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropometric measurements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height Z-score</td>
<td>0.70 ± 1.09</td>
<td>−0.98 ± 1.01</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Weight Z-score</td>
<td>4.73 ± 2.21</td>
<td>−0.49 ± 0.93</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BMI Z-score</td>
<td>5.88 ± 1.52</td>
<td>0.95 ± 0.76</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Laboratory parameters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>161.3 ± 29.0</td>
<td>158.3 ± 17.6</td>
<td>NS</td>
</tr>
<tr>
<td>TG (mg/dl)</td>
<td>92.4 ± 35.7</td>
<td>75.5 ± 16.2</td>
<td>0.009</td>
</tr>
<tr>
<td>LDL (mg/dl)</td>
<td>104.5 ± 23.0</td>
<td>100.6 ± 18.2</td>
<td>NS</td>
</tr>
<tr>
<td>HDL (mg/dl)</td>
<td>40.3 ± 11.3</td>
<td>43.8 ± 5.2</td>
<td>NS</td>
</tr>
<tr>
<td>FBS (mg/dl)</td>
<td>83.5 ± 8.4</td>
<td>78.4 ± 10.4</td>
<td>NS</td>
</tr>
<tr>
<td>CIMT Right CIMT (mm)</td>
<td>0.46 ± 0.11</td>
<td>0.41 ± 0.39</td>
<td>0.003</td>
</tr>
<tr>
<td>Left CIMT (mm)</td>
<td>0.48 ± 0.11</td>
<td>0.41 ± 0.04</td>
<td>0.001</td>
</tr>
<tr>
<td>Blood pressure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP Z-score</td>
<td>2.81 ± 0.96</td>
<td>0.43 ± 0.51</td>
<td>0.04</td>
</tr>
<tr>
<td>DBP Z-score</td>
<td>2.67 ± 1.04</td>
<td>0.37 ± 0.43</td>
<td>0.03</td>
</tr>
</tbody>
</table>

CIMT, carotid intima-media thickness; DBP, diastolic blood pressure; FBS, fasting blood sugar; HDL, high-density lipoprotein; SBP, systolic blood pressure TG, triglyceride.
There was a statistically significant positive correlation between right CIMT and each age and weight Z score and between left CIMT and weight Z score in the patients’ group as in Table 5.

The cutoff value of right CIMT to predict cardiovascular risk factor in the patient group was more than 0.51 mm with a sensitivity of 86.7%, specificity of 100%, PPV of 100%, NPV of 97.1%, and with a diagnostic accuracy of 97.5% (Fig. 1).

There was a statistically significant positive correlation between right CIMT and each of age, and weight Z score and between left CIMT and age in the control group as in Table 6.

4. Discussion

The prevalence of obesity in children and adolescents is increasing rapidly in most developing countries and in some industrialized nations [24].

This study aimed to assess CIMT in a group of Egyptian obese children and to investigate its relationship with cardiovascular risk factors.

Obesity has been associated with hypertension and an increased risk of cardiovascular diseases.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Right CIMT</th>
<th>Left CIMT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Correlation coefficient (r)</td>
<td>P value</td>
</tr>
<tr>
<td>Age (year)</td>
<td>0.314</td>
<td>0.049</td>
</tr>
<tr>
<td>Weight Z-score</td>
<td>0.226</td>
<td>0.000</td>
</tr>
<tr>
<td>Height Z-score</td>
<td>0.121</td>
<td>0.455</td>
</tr>
<tr>
<td>BMI Z-score</td>
<td>0.208</td>
<td>0.318</td>
</tr>
<tr>
<td>WC Z-score</td>
<td>0.147</td>
<td>0.119</td>
</tr>
<tr>
<td>HC Z-score</td>
<td>0.150</td>
<td>0.357</td>
</tr>
<tr>
<td>Duration (year)</td>
<td>0.234</td>
<td>0.145</td>
</tr>
<tr>
<td>SPB Z-score</td>
<td>0.188</td>
<td>0.327</td>
</tr>
<tr>
<td>DPB Z-score</td>
<td>0.022</td>
<td>0.894</td>
</tr>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>0.153</td>
<td>0.346</td>
</tr>
<tr>
<td>TG (mg/dl)</td>
<td>0.152</td>
<td>0.349</td>
</tr>
<tr>
<td>LDL (mg/dl)</td>
<td>−0.035</td>
<td>0.828</td>
</tr>
<tr>
<td>HDL (mg/dl)</td>
<td>0.24</td>
<td>0.883</td>
</tr>
</tbody>
</table>

CIMT, carotid intima-media thickness; DBP, diastolic blood pressure; FBS, fasting blood sugar; HC, hip circumference; HDL, high-density lipoprotein; LDL, low-density lipoprotein; SBP, systolic blood pressure; TG, triglyceride; WC, waist circumference.

Based on previous population studies, risk estimation indicated that at least two-thirds of the prevalence of hypertension could be directly associated with obesity [25].

In the present study, we evaluated the influence of obesity on children’s growth by comparing anthropometric measurements of the studied groups. There was a statistically significant increase in the mean values of height, weight, and BMI Z-scores in the patient group when compared with controls (Table 2).

Calculation of Z-score of anthropometric measures is more sensitive than percentile changes as it denotes the units of SD from the median. It allows the clinician to easily detect the movement toward or away from the median [26].

A Z-score of 0 means that the anthropometric measure is the same as the median. A Z-score can also be positive or negative, indicating whether it is above or below the median and by how many SDs; if data are normally distributed, a Z-score between −2 and +2 is considered normal [27].

BMI is adopted by WHO as the best single tool to detect overweight and obesity from age 2–20 years. BMI between 85 and 95 percentiles is considered overweight and that more than or equal to 95th percentile is considered obesity [28].

High lipid levels were relatively common among obese children, suggesting that obesity should be considered a risk factor for hypercholesterolemia,

Fig. 1. ROC curve right CIMT. CIMT, carotid intima-media thickness; ROC, receiver-operating characteristic.
and screening obese children for hypercholesterolemia should be mandatory [29].

Szczygiełska et al. [30] showed that mean total cholesterol and TG concentrations were higher in obese persons than normal-weight participants, and HDL-cholesterol concentration was lower in obese patients compared with normal and overweight individuals. Differences in mean concentrations of LDL-cholesterol were not significant.

The present study revealed that the mean values of both right and left CIMT were significantly increased in children with simple obesity compared with controls (Table 2).

Receiver-operating characteristic (ROC) curve was used to determine the best cutoff value of CIMT to predict the cardiovascular risk factor in the patient group (Figs. 1 and 2).

Based on this result, we compared the distribution of the two studied groups as regards the cutoff value of CIMT, and we found that 32.5% of patients versus none of the controls had thickness more than the cutoff value for both right and left CIMT, which may predict the cardiovascular risk in this percent of cases (Table 7).

Also, Kotsis et al. [31] reported that the mean IMT of internal carotid arteries was increased with increasing BMI. Mean IMT was significantly higher in obese patients compared with normal-weight (P < 0.01) and underweight (P < 0.001) patients. Mean IMT was significantly higher in overweight patients compared with normal-weight ones (P < 0.05).

The significantly increased CIMT in obese children in our results and other studies can suggest the high-risk patients for future cardiovascular events, and this is because CIMT has been proposed as a potential tool for cardiovascular risk stratification and is considered a direct measure of atherosclerosis [32].

In the study of Daniela et al. [33]: two groups of children were included, 50 obese and 50 nonobese, with a mean age of 12.6 ± 3.1 years. The obese children demonstrated significantly increased mean CIMT values compared with nonobese children matched for age and sex, which predict an enhanced future cardiovascular disease in obese children compared with nonobese.

In our study, there was a significant positive correlation between right CIMT and each of age and weight, while the left CIMT was positively correlated with weight only (Table 5).

Stabouli et al. [34] reported that CIMT was positively correlated with age, BP values, and BMI percentile and Z-score, while age was an independent prognostic factor for CIMT. The Kandil et al. [35] study included 41 obese children and 41 healthy children as a control group (5–14.5 years old) and reported that CIMT was significantly associated with weight, BMI, W/H ratio, skinfold thickness, and BP, and demonstrated significant positive correlations of the CIMT with anthropometric parameters.

In our study, there was a positive correlation between either right or left CIMT and each of cholesterol, TG, LDL, FBS, and a negative correlation between right or left CIMT and HDL, all with a nonsignificant value (Table 5).

This might be due to the fact that most of our studied cases were in early adolescence and their lipid profiles were within the normal values.

In agreement with our results, Fang et al. [36] studied 86 obese children with a mean age of 10.5 ± 1.6 years compared with 22 healthy nonobese

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**Table 6. Correlations between right and left carotid intima-media thickness, and clinical data in the control group.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Right CIMT</th>
<th></th>
<th>Left CIMT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Correlation coefficient (r)</td>
<td>P value</td>
<td>Correlation coefficient (r)</td>
<td>P value</td>
</tr>
<tr>
<td>Age (years)</td>
<td>0.414</td>
<td>0.008</td>
<td>0.535</td>
<td>0.00</td>
</tr>
<tr>
<td>Weight Z-score</td>
<td>0.430</td>
<td>0.011</td>
<td>0.011</td>
<td>0.947</td>
</tr>
<tr>
<td>Height Z-score</td>
<td>0.107</td>
<td>0.546</td>
<td>0.053</td>
<td>0.746</td>
</tr>
<tr>
<td>BMI Z-score</td>
<td>0.227</td>
<td>0.415</td>
<td>0.236</td>
<td>0.256</td>
</tr>
<tr>
<td>SBP Z-score</td>
<td>0.055</td>
<td>0.721</td>
<td>0.170</td>
<td>0.815</td>
</tr>
<tr>
<td>DBP Z-score</td>
<td>0.063</td>
<td>0.677</td>
<td>0.092</td>
<td>0.557</td>
</tr>
</tbody>
</table>

CIMT, carotid intima-media thickness; DBP, diastolic blood pressure; SBP, systolic blood pressure.

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**Table 7. Distribution of the two studied groups according to the cutoff value of carotid intima-media thickness.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Patient group [n (%)]</th>
<th>Control group [n (%)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right CIMT (mm) &gt;0.51</td>
<td>0</td>
<td>13 (32.5)</td>
</tr>
<tr>
<td>Left CIMT (mm) &gt;0.51</td>
<td>0</td>
<td>13 (32.5)</td>
</tr>
</tbody>
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CIMT, carotid intima-media thickness.

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![Fig. 2. ROC curve left CIMT. CIMT, carotid intima-media thickness; ROC, receiver-operating characteristic.](image-url)
children and reported that CIMT was significantly related to TG in obese children and adolescents.

In the study of Danlela et al. [33], CIMT was positively correlated with LDL and total cholesterol, while no correlation was observed between CIMT and each of HDL-cholesterol—TGs levels.

Kandil et al. [35] demonstrated no correlation between CIMT and total cholesterol, TGs, and LDL-cholesterol; however, there was a significant negative correlation to HDL-cholesterol. Thomas et al. [37] studied 96 obese children with a median age of 11 years and compared them with 25 non-obese children of the same age, sex, and pubertal stage and found no significant correlation between CIMT and lipids except for HDL-cholesterol.

Conflicts of Interest
None declared.

References


