The Relationship between Serum Lipids and Obesity among Elementary School in Birjand: A Case Control Study

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**ABSTRACT**

**Background:** Childhood obesity could induce some risk factors for cardiovascular disease (CVD) including serum lipid abnormalities, hypertension, and atherosclerosis. The present study aimed to comparison the lipid profile in normal children with cases having overweight, obesity and central obesity.

**Methods:** In this case control study, which was conducted 2013, serum lipids for three groups of children including cases with overweight (Body mass index (BMI): 85-95th percentiles to age and sex and waist circumference (WC) <90th percentile to age and sex = Case group1), central obesity without general obesity (BMI <85th percentiles and WC ≥ percentile 90 = Case group 2) and central obesity with general obesity (BMI ≥95th percentile and WC ≥ percentile 90 = Case group 3) were compared with control group (BMI < 85th percentiles WC <90th percentile). Data were analyzed using software SPSS-16 by chi-square and ANOVA tests at significance level α=0.05.

**Results:** Each group consisted of 100 individuals. The highest mean of serum lipids and the highest extent of dyslipidemia existed in the children having central obesity along with general obesity. So that 49%, 28%, and 38% students of this group show hypertriglyceridemia, hypercholesterolemia, and low high-density lipoprotein cholesterol (HDL-C). Odd ratio of hypertriglyceridemia, hypercholesterolemia and low HDL-c, in children with at least one abnormal index (BMI and/or WC) compared with control group were 3.73 (95% CI: 1.98, 6.99), 1.37 (95% CI: 0.71, 2.65) and 2.98 (95% CI: 1.51, 5.87), respectively.

**Conclusions:** With regard to the relationship between central obesity and adverse changes in lipid profiles, the screening children for central obesity to prevention of cardiovascular disease are recommended.

**Introduction**

Obesity is the most common chronic metabolic diseases which influences the children and adolescents\textsuperscript{1}. Childhood obesity resulted in epidemic levels in developing and developed countries. Overweight and obesity of childhood are known to have significant impact on physical and psychological health\textsuperscript{2}. Childhood obesity engages the risk factors for cardiovascular disease (CVD) including blood lipid abnormalities, hypertension, and atherosclerosis\textsuperscript{3}.

Pathological examinations indicate that atherosclerosis has begun from childhood and the extent of atherosclerosis changing in children has correlated with risk factors in adults\textsuperscript{4}.

Cardiovascular disease results in high number of worldwide per year, so that these diseases have been accounted as the most important factor of death in developed countries. They are mentioned as multi-factor diseases having several risk factors. Obesity is one of the preventive factors in cardiovascular disease\textsuperscript{5}.

Indexes could be used to measure obesity are body mass index (BMI), waist circumference (WC), and waist to hip ratio (WHR). Waist circumference is stronger index to determine health risk than BMI\textsuperscript{6}. Obesity and overweight raises adverse changes in lipid profiles as complications of obesity\textsuperscript{4,6}. While, decreasing or increasing the related obesity indices such as BMI and waist circumference might affect the parameters of lipid\textsuperscript{7}. In 2012, among each 5 children at age group 8-17 years old, a child had an adverse lipid concentration of total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), or non-high-density lipoprotein cholesterol (non-HDL-C)\textsuperscript{8}. Anthropometric
Methods

In this case-control study, which was conducted in 2013, four groups of children according to anthropometric indexes were selected among elementary school children in Birjand, south Khorasan Province, East of Iran. These students were identified in the previous study on determining the prevalence of obesity in the primary school children. There, clustering sampling method was applied to select the sample group. Overweight and obesity were considered based on percentages of Center for Diseases Control and prevention (CDC) Transmitted after prevention for BMI. Thus, 85-95th percentiles were considered as overweight with respect to age and sex; and ≥ 95th percentile as obese. In order to determine central obesity, waist circumference equal or more than percentile 90 to age and sex referred. The sample size based on the study by Fesharakinia et al. on the relationship between BMI and serum lipids in elementary school chidren of Birjand was calculated. According to HDL-C in children with normal BMI (44.2±9.2 mg/dl) and obese students (47.6 ±7.5 mg/dl) and at confidence level (95%) and power (80%), 100 students per each group were studied.

Four groups were selected as follows:

- Case 1: Body mass index: 85-95th percentiles to age and sex and waist circumference <90th percentile to age and sex (overweight).
- Case 2: Body mass index <85th percentiles to age and sex and waist circumference equal or more than percentile 90 to age and sex (central obesity without general obesity).
- Case 3: Body mass index ≥95th percentile to age and sex and waist circumference equal or more than percentile 90 to age and sex (central obesity with general obesity).
- Case 4: Body mass index <85th percentiles to age and sex and waist circumference < 90th percentile to age and sex.

Control group were matched of age, gender and residence with cases groups by using group-matching method.

The students who according definition was in one of the cases group and their parents to participate in the study were satisfied by convenience sampling method were selected.

Results

Each group consisted of 100 students. Average age of cases and control groups students was 9.5±1.7 and 9.7±1.3 year, respectively. There was no significant difference between both groups. There were 50% girls and 50% boys in the groups.

Mean of cholesterol, triglycerides, and LDL were higher in the children with BMI ≥ 95th percentile than group with age and sex and WC equal or more than percentile 90, which age, and sex (central obesity with general obesity) and mean of HDL was lower in this group rather than other groups. Mean of serum lipids in the groups under study have been represented in Table 1. With regard to ANOVA, there was a significant difference on mean cholesterol, triglycerides, HDL and LDL in the studied groups (P<0.001).

Results from Tukey test indicated that there was a significant difference as for mean cholesterol, LDL, and non-HDL in the students with BMI: 85-95th percentiles (overweight) and BMI < 85th percentiles to age and sex and WC≥90th percentiles (central obesity without general obesity) and the students with BMI ≥ 95th percentiles to age and sex and WC ≥ 90th percentiles (central obesity and general obesity). Moreover, there was a significant difference on students with BMI < 85th percentiles to age and sex and WC ≥ 90th percentiles (central obesity and general obesity) and normal students as well as two other groups. There was no significant difference about mean TG and HDL in students with overweight and students of control group.

The highest extent of hypertriglyceridemia, hypercholesterolemia and high LDL was existed in the students with central obesity and general obesity (case3), so that 49%, 28% and 24% of students in this group had Hypertriglyceridemia, hypercholesterolemia and high LDL, respectively. The highest amount of low HDL was existed in the group of students with central obesity with general obesity (case 3) (Table 2).
Table 1: Comparison means of lipids in the study groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Case 1&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Case 2&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Case 3&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Control&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triglyceride (TG)</td>
<td>88.9</td>
<td>36.1</td>
<td>105.5</td>
<td>54.6</td>
<td>121.6</td>
<td>60.8</td>
<td>74.6</td>
<td>29.3</td>
<td>0.001</td>
<td></td>
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<tr>
<td>Total cholesterol (TC)</td>
<td>170.4</td>
<td>22.2</td>
<td>169.1</td>
<td>31.2</td>
<td>187.4</td>
<td>37.7</td>
<td>168.9</td>
<td>28.7</td>
<td>0.001</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Low-density lipoprotein cholesterol (LDL-C)</td>
<td>96.5</td>
<td>21.1</td>
<td>97.2</td>
<td>24.4</td>
<td>109.5</td>
<td>23.9</td>
<td>95.1</td>
<td>20.9</td>
<td>0.001</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Non-high-density lipoprotein cholesterol (non-HDL-C)</td>
<td>119.7</td>
<td>22.7</td>
<td>121.4</td>
<td>31.8</td>
<td>141.1</td>
<td>39.4</td>
<td>113.9</td>
<td>24.3</td>
<td>0.001</td>
<td></td>
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</tr>
<tr>
<td>High-density lipoprotein cholesterol (HDL-C)</td>
<td>51.3</td>
<td>10.2</td>
<td>48.1</td>
<td>11.5</td>
<td>45.7</td>
<td>11.7</td>
<td>54.1</td>
<td>11.3</td>
<td>0.001</td>
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</tbody>
</table>

<sup>a</sup> Overweight: body mass index 85-95 percentile for the age and sex
<sup>b</sup> Central obesity without general obesity: body mass index <85 percentile and waist circumference ≥90 percentile for the age and sex
<sup>c</sup> Central obesity with general obesity: body mass index ≥95 percentile and waist circumference ≥90 percentile for age and sex
<sup>d</sup> Control: body mass index <85th percentile and waist circumference <90 percentile

Table 2: Comparison the frequency of dyslipidemia in the study groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Control&lt;sup&gt;e&lt;/sup&gt;</th>
<th>Case 1&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Case 2&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Case 3&lt;sup&gt;c&lt;/sup&gt;</th>
<th>n (%)</th>
<th>n (%)</th>
<th>P value</th>
<th>n (%)</th>
<th>n (%)</th>
<th>P value</th>
<th>n (%)</th>
<th>n (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triglyceride (TG)</td>
<td>13 (13.0)</td>
<td>20 (20.0)</td>
<td>0.182</td>
<td>38 (38.0)</td>
<td>0.001</td>
<td>49 (49.0)</td>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Total cholesterol (TC)</td>
<td>13 (13.0)</td>
<td>8 (8.0)</td>
<td>0.249</td>
<td>15 (15.0)</td>
<td>0.663</td>
<td>28 (28.0)</td>
<td>0.009</td>
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<tr>
<td>Low-density lipoprotein cholesterol (LDL-C)</td>
<td>5 (5.0)</td>
<td>8 (8.0)</td>
<td>0.390</td>
<td>11 (11.0)</td>
<td>0.108</td>
<td>24 (24.0)</td>
<td>0.001</td>
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</tr>
<tr>
<td>Non-high-density lipoprotein cholesterol (non-HDL-C)</td>
<td>11 (11.0)</td>
<td>12 (12.0)</td>
<td>0.845</td>
<td>22 (22.0)</td>
<td>0.033</td>
<td>40 (40.0)</td>
<td>0.001</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>High-density lipoprotein cholesterol (HDL-C)</td>
<td>11 (11.0)</td>
<td>13 (13.0)</td>
<td>0.382</td>
<td>30 (30.0)</td>
<td>0.001</td>
<td>38 (38.0)</td>
<td>0.001</td>
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</tbody>
</table>

<sup>a</sup> Control: body mass index <85th percentile and waist circumference <90 percentile
<sup>b</sup> Overweight: body mass index 85-95 percentile for the age and sex
<sup>c</sup> Central obesity without general obesity: body mass index <85 percentile and waist circumference ≥90 percentile for the age and sex
<sup>d</sup> Central obesity with general obesity: body mass index ≥95 percentile and waist circumference ≥90 percentile for age and sex

Existence of a variety of dyslipidemia in each of the cases groups compared to control group has been represented in Table 3. In case 3 group (central obesity and general obesity) odds of all types of dyslipidemia significantly higher than the control group. The highest value of odds ratio was related to high triglyceride (OR=6.43; 3.18, 12.97). In student with central obesity without general obesity (case 2) odd ratio of high triglyceride, high non-HDL cholesterol (non-HDL-C) and Low high-density lipoprotein cholesterol (HDL-C) significantly higher than the control group. In case 1 group (overweight) significant association was not found in types of dyslipidemia between case and control groups.

Table 3: Odds ratio estimates of dyslipidemia in the cases groups in comparison with control group<sup>e</sup>

<table>
<thead>
<tr>
<th>Groups</th>
<th>Case 1&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Case 2&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Case 3&lt;sup&gt;c&lt;/sup&gt;</th>
<th>All cases&lt;sup&gt;d&lt;/sup&gt;</th>
<th>OR (95% CI)</th>
<th>OR (95% CI)</th>
<th>OR (95% CI)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triglyceride (TG)</td>
<td>1.67 (0.78, 3.58)</td>
<td>4.16 (2.05, 8.47)</td>
<td>6.43 (3.18,12.97)</td>
<td>3.73 (1.98, 6.99)</td>
<td></td>
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<tr>
<td>Total cholesterol (TC)</td>
<td>0.58 (0.23, 1.47)</td>
<td>1.19 (0.56, 2.66)</td>
<td>2.61 (1.23,5.35)</td>
<td>1.37 (0.71, 2.65)</td>
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</tr>
<tr>
<td>Low-density lipoprotein cholesterol (LDL-C)</td>
<td>1.65 (0.52, 5.23)</td>
<td>2.40 (0.80, 7.19)</td>
<td>6.08 (2.21,16.69)</td>
<td>3.21 (1.20, 8.29)</td>
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<td></td>
</tr>
<tr>
<td>Non-high-density lipoprotein cholesterol (non-HDL-C)</td>
<td>1.09 (0.45, 2.61)</td>
<td>2.31 (1.05, 5.08)</td>
<td>5.30 (2.51,11.22)</td>
<td>2.61 (1.32, 5.20)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>High-density lipoprotein cholesterol (HDL-C)</td>
<td>1.19 (0.50, 2.81)</td>
<td>3.52 (1.65, 7.54)</td>
<td>4.91 (2.30,10.32)</td>
<td>2.98 (1.51, 5.87)</td>
<td></td>
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</tbody>
</table>

<sup>a</sup> Control: body mass index <85th percentile and waist circumference <90 percentile
<sup>b</sup> Overweight: body mass index 85-95 percentile for the age and sex
<sup>c</sup> Central obesity without general obesity: body mass index <85 percentile and waist circumference ≥90 percentile for the age and sex
<sup>d</sup> Central obesity with general obesity: body mass index ≥95 percentile and waist circumference ≥90 percentile for age and sex

The highest correlation coefficient was observed between triglycerides and body mass index (BMI) (r=0.474) and triglycerides and weight (r=0.455). correlation coefficient between low high-density lipoprotein cholesterol (HDL-C) and weight ,body mass index and WC were negative (Table 4).

Table 4: correlation coefficient between body mass index (BMI) weight and waist circumference (WC) with lipid serum in study group

<table>
<thead>
<tr>
<th>Lipid</th>
<th>Weight</th>
<th>BMI</th>
<th>WC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triglyceride (TG)</td>
<td>0.455</td>
<td>0.474</td>
<td>0.342</td>
</tr>
<tr>
<td>Total cholesterol (TC)</td>
<td>0.253</td>
<td>0.277</td>
<td>0.203</td>
</tr>
<tr>
<td>Low-density lipoprotein cholesterol (LDL-C)</td>
<td>0.269</td>
<td>0.296</td>
<td>0.237</td>
</tr>
<tr>
<td>High-density lipoprotein cholesterol (HDL-C)</td>
<td>-0.209</td>
<td>-0.270</td>
<td>-0.201</td>
</tr>
<tr>
<td>Non-high-density lipoprotein cholesterol (non-HDL-C)</td>
<td>0.338</td>
<td>0.286</td>
<td>0.332</td>
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</tbody>
</table>

<sup>a</sup> Correlation is significant at the 0.01 level (2-tailed).

Discussion

In the study by Dr Nazem et al, the highest mean of cholesterol, triglycerides, and LDL; and the lowest mean of HDL; and the highest amount of dyslipidemia have been seen in the students with central obesity with general obesity (case 3). The students with central obesity without general obesity have been more likely exposed to risk compared to control group or the group with overweight especially in hypertriglyceridemia and low HDL.

Although the students with overweight had lower level of serum lipids than obese students, they had higher triglycerides and lower HDL than control group, while there was no difference between them and control group within cholesterol and LDL. It can be concluded that central obesity was an important risk factor in dyslipidemia nevertheless.
longing with central and general obesity its destructive effect was more on lipid profile.

In a study within relationship of serum lipids and anthropometric index among 6-18 years old students of Isfahan, a significant relationship between all lipids except HDL and obesity, overweight and central obesity was seen [11].

Mean of cholesterol, triglycerides, and LDL have been greater in the students with overweight and obesity than the students with normal weight [10]. Although, there, central obesity has not been mentioned the prevalence of central obesity along with general obesity is more and increasing serum lipids might have been associated to central obesity in obese students.

In the study by Fesharakinia et al prevalence of hypertriglyceridemia has been greater in obese students than students with normal weight [10]. However, no significant relationship was observed between prevalence of other dyslipidemia and obesity and overweight [10].

In Mashhad, average triglycerides, cholesterol, and LDL have been greater in the obese children than children with normal weight while, average HDL has been less, that shows good consistency with this study [12].

The relationship between serum lipids and anthropometric indexes has been supported in other studies, e.g. in U.S., 45.8% of children with overweight had abnormal lipid. Further, children with highest BMI had the lowest HDL [13]. In India, higher amount of cholesterol, LDL, and triglycerides were in obese children. There was a significant relationship between BMI and lipid profile [11].

In the present study, a significant association was found between amounts of BMI and WC and triglycerides, cholesterol, LDL, and HDL. In the study by Fesharakinia et al., a significant relationship existed between BMI and triglycerides, total cholesterol, and LDL [10].

In Tehran about lipid glucose study, there was a significant relationship between BMI and various types of dyslipidemia, however, WHR kept its significant association only with hypertriglyceridemia and low HDL-C [13].

In the present study, the highest correlation coefficient was existed between BMI and triglycerides, while a significant correlation was witnessed between BMI, waist circumference, and weight and all serum lipids.

In a study on 6-11 years old children in Qatar, the highest correlation coefficient existed between waist circumference and triglycerides. Moreover, a high correlation was witnessed between waist circumference and high LDL cholesterol, and an inverse correlation was between waist circumference and HDL [14].

In China, by increasing BMI, amount of TC and TG increases, that a negative relationship was witnessed between HDL and BMI [12]. In Arabia, a positive correlation was between BMI and cholesterol and LDL, and a negative correlation was between BMI and HDL. There was no correlation between BMI and triglycerides [15].

In other studies on other age groups including premenopausal women and the elderly, a high correlation existed between waist circumference and serum lipids [15-20]. Obesity was associated with lipid disturbances, especially with HDL-C reduction, in obese non-diabetic patients [21].

These results indicate that WC is the main parameter associated with serum lipid levels [15]. In this study, as the sample group has been selected in the previous study, frequency students with BMI ≥95th percentile to age and sex and WC less than percentile 90 to age and sex was low and we could not compared a group with BMI ≥95th percentile and WC <90th percentile (general obesity without central obesity) with others groups, and this can be regarded as restriction in this study.

The results of this study can be a guide for clinicians to screening of obese children for lipid profile.

As a limitation of this study, due to the non-random sampling and differences geographical and cultural, results may not be representative for the whole overweight or obese Iranian students.

**Conclusions**

The highest adverse changes in lipid were in the students with central obesity and general obesity. It seems that central obesity can be a stronger index to predict abnormal blood lipids than general obesity while in most of cases, central obesity is followed by general obesity, it is suggested all the obese children especially the children with central obesity are examined in sake of dyslipidemia. As measurement of anthropometric indices especially waist circumference, weight, and height is an easy and non-invasive measure, it can be used as a means for screening in detection of the students who are exposed to risk of dyslipidemia.

**Acknowledgments**

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**Conflict of interest statement**

The authors declare that they have no conflicts of interest.

**References**


