Changes in serum lipid profile of elite volleyball players in the competition period

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Summary

Study aim: To assess the changes in serum lipid profile of volleyball players in various phases of competition period characterised by creatine kinase activity.

Material and methods: A group of 14 Polish elite volleyball players aged 23 - 34 years were examined 3 times during the competition period lasting 10 weeks. Total cholesterol (TC), LDL, HDL, triacylglycerols (TG) and creatine kinase (CK) activity were determined in serum. Body fat content was determined from 4 skinfolds by Durnin’s method.

Results: Creatine kinase activity was very high throughout the study period although significantly decreased in relation to the first examination; TC, LDL, TC/HDL and LDL/HDL gradually increased while HDL decreased. Nevertheless, the values of TC, HDL, LDL and LDL/HDL were within normal limits in all subjects throughout the study.

Conclusions: The changes in lipid profile may be regarded as transitory and of no significant impact on the risk of cardiovascular diseases as in all cases they were within physiological ranges.

Key words: Lipid profile – Competitive training – Volleyball

Introduction

The hydrophobic lipid compounds are transported in the body as lipoproteins [22], which differ in size, density and the contents of lipids and proteins [1]. Three main categories of lipoproteins were discerned: of very low density (VLDL), of low density (LDL) and of high density (HDL). Intestinal lipid absorption is associated with the generation of chylomicrons, i.e. very large lipoproteins of very low density, which are rapidly eliminated from the blood stream [3]. Lipoproteins are generated predominantly in the liver, the VLDL ones being converted in blood into LDL which supply cholesterol to the cells. High-density lipoproteins (HDL) are generated in the liver and the intestine; they transport cholesterol from peripheral tissues back to the liver, the site of cholesterol degradation [5].

A close association is known between cardiovascular diseases (atherosclerosis, CHD, etc.) and lipid profiles [7,26], the concentrations of LDL and of total cholesterol being of particular importance [25]. On the other hand, high levels of HDL in serum are antiatherogenic and protect from CHD [14]. Regular physical exercises induce decreased levels of total cholesterol and LDL and increased HDL [2,10].

Competitive training, often of high volume or intensity, may consist of several sessions a day. When the loads are not sufficiently compensated by adequate rest and recovery, overload or overtraining may appear [15] due to metabolic disorders and the resulting impaired energy generation [20]. As reported by Petibois et al. [21], overtraining may induce changes in lipid metabolism in endurance athletes. The aim of this study was thus to detect possible changes in the lipid profile of elite volleyball players in various phases the competition period characterised by creatine kinase activity.

Material and Methods

Polish elite volleyball players (n = 14) aged 23 - 34 years volunteered to participate in the study and to blood withdrawals. The study was conducted from June to September 2006 on 3 occasions: two months after the training camp started (June; Examination 1), 3 weeks later (Examination 2; during that period the team participated in an international volleyball tournament lasting...
5 days) and another 7 weeks later, after the World League competitions had terminated (Examination 3). The players had two training sessions daily, except on match days when only one training session was run. During the last 7 weeks the team played two matches a week. All players were on a balanced diet supervised by a dietician throughout the study. The study protocol was approved by the local Ethics Committee.

Blood was withdrawn from the antecubital vein in the morning in the pre-prandial state. The subjects performed no strenuous exercise 24 h prior to blood withdrawal and consumed no fat-rich meals 12 h before. Blood was collected in tubes containing clotting enhancer and centrifuged. Total cholesterol (TC) and triacylglycerols (TG) were determined by colorimetry; the same method was applied to HDL after having removed other lipid fractions by phosphotungstic acid/magnesium chloride precipitation; LDL was computed from Friedewald’s formula [6]. Creatine kinase (CK) activity was determined spectrophotometrically at 340 nm and 37ºC. All assays were performed with the use of commercial kits (Biofarm, Poland) and automatic Arco analyser (Biotechnica, Italia). Body fat content was determined from 4 skinfolds according to Durnin et al. [4]. The data were subjected to one-way ANOVA for repeated measures using the STATISTICA 8.0 software. The level of p≤0.05 was considered significant.

Results

As follows from Table 1, the values of somatic features of volleyball players were fairly stable throughout the study period. The data in Table 2 show that during the 10-week study period some elements of the lipid profile underwent significant changes. Namely, mean values of TC, LDL, TC/HDL and LDL/HDL gradually increased while HDL gradually decreased as reflected by the significance of differences between consecutive examinations.

### Table 1. Basic somatic data (means ±SD) of Polish elite volleyball players (n = 14)

<table>
<thead>
<tr>
<th>Examination Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Normal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>26.8 ± 2.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body height (cm)</td>
<td>198.7 ± 7.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>94.4 ± 7.7</td>
<td>90.9 ± 9.3</td>
<td>92.8 ± 8.8</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>23.9 ± 1.4</td>
<td>22.9 ± 1.9</td>
<td>23.1 ± 1.1</td>
<td></td>
</tr>
<tr>
<td>Fat content (%)</td>
<td>10.7 ± 2.3</td>
<td>11.0 ± 2.5</td>
<td>11.2 ± 2.3</td>
<td></td>
</tr>
</tbody>
</table>

Legend: TC – Total cholesterol; TG – Triacylglycerols; CK – Creatine kinase; * Significantly (p<0.05) different from Examination 1; † – Significantly (p<0.05) different from Examination 2

### Table 2. Mean values (±SD) of lipid profile indices and of creatine kinase (CK) activity in Polish elite volleyball players (n = 14)

<table>
<thead>
<tr>
<th>Examination Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Normal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC (mg/dl)</td>
<td>161.5 ± 16.7</td>
<td>171.2 ± 13.9</td>
<td>174.4 ± 12.4*</td>
<td>120 - 200</td>
</tr>
<tr>
<td>HDL (mg/dl)</td>
<td>51.0 ± 8.0</td>
<td>46.5 ± 4.5</td>
<td>42.2 ± 5.7**</td>
<td>30 - 70</td>
</tr>
<tr>
<td>LDL (mg/dl)</td>
<td>87.7 ± 19.8</td>
<td>107.2 ± 14.9*</td>
<td>113.0 ± 14.2*</td>
<td>&lt;135</td>
</tr>
<tr>
<td>TG (mg/dl)</td>
<td>114.1 ± 31.7</td>
<td>87.8 ± 15.2*</td>
<td>96.1 ± 28.9</td>
<td>&lt;150</td>
</tr>
<tr>
<td>TC/HDL</td>
<td>3.24 ± 0.65</td>
<td>3.71 ± 0.46*</td>
<td>4.19 ± 0.56**</td>
<td>&lt;4.0</td>
</tr>
<tr>
<td>LDL/HDL</td>
<td>1.78 ± 0.58</td>
<td>2.33 ± 0.41*</td>
<td>2.73 ± 0.57**</td>
<td>&lt;4.5</td>
</tr>
<tr>
<td>TG/HDL</td>
<td>2.33 ± 0.85</td>
<td>1.92 ± 0.45</td>
<td>2.30 ± 0.68</td>
<td>&lt;1.8</td>
</tr>
<tr>
<td>CK (U/L)</td>
<td>507 ± 221</td>
<td>313 ± 121*</td>
<td>312 ± 107*</td>
<td>&lt;190</td>
</tr>
</tbody>
</table>

All individual values of TC, HDL and LDL were within normal limits. The same was true in case of TG, except two subjects in whom the values exceeded 150 mg/dl in Examination 1. In case of TC/HDL, the numbers of subjects whose values exceeded the 4.0 upper limit were 3, 5 and 8 in consecutive examinations. The LDL/HDL index was within normal limits in all cases while the values of TG/HDL exceeded the 1.8 upper limit in most subjects (10, 8 and 11 subjects in consecutive examinations). All individual values of CK activity exceeded 190 U/l except two subjects in whom the values were below that limit in Examinations 2 and 3.

Discussion

Physical exercise is known to positively affect the lipid profile, i.e. to decrease the concentrations of total and LDL-cholesterol and of triacylglycerols, and to
increase that of HDL [8,10]; Petitbois et al. [21] noted those effects in 20 rowers in a 47-week study. However, in overtrained athletes, HDL-cholesterol was decreased [17]. In this study, training-induced increases in total and LDL-cholesterol were noted but no similar reports were found in the available literature. Some explanation of that finding may follow from Magkos’ et al. report [16], who subjected healthy, untrained individuals to an isolated, prolonged exercise and found a rapid elimination of VLDL from blood and, in consequence, a drop in TG levels; this was associated with increased concentration of intermediate density lipoproteins (IDL), the precursor of LDL. Both IDL and LDL contain more cholesterol than VLDL.

The lipid profile contains not only the concentrations of lipid serum constituents but their ratios as well; among them are TC/HDL, whose increase is strongly associated with the incidence of CHD in diabetics [11] and the decrease with an arrest of CHD progress [27]. Yu et al. [28] found those two indices to amount to 4.1 ± 1.2 and 2.0 ± 0.8, respectively, in triathletes; his findings were similar to those reported in this study. However, those indices markedly decreased by about 30% following an Ironman competition.

Another index, TG/HDL, was shown to be strongly correlated with insulin resistance [18] which was reported in overtrained rowers [21]. Insulin is essential in glycogen resynthesis [29], its insufficient level being one of the factors responsible for the overload or overtraining [12]. Moreover, in a study on over 4000 healthy subjects, an increased value of TG/HDL (above 1.8) was shown to be correlated with disorders in the post-exercise heart rate recovery [23]. In this study, mean values of the TG/HDL index were fairly stable and exceeded the 1.8 level. This may suggest that the high training loads reflected by creatine kinase activities combined with some metabolic disturbances brought about mounting fatigue.

Creatine kinase activity may serve as an indirect indicator of training loads [24] and the resulting muscle damage [9] which may appear even several days post-exercise [19]. The results of this study were indicative of very high training loads the athletes were subjected to.

Summing up, the observed changes in lipid profile indices are suggestive of metabolic disturbances brought about by training- and competition-induced overload. Those changes may be regarded as transitory and of no significant impact on the risk of cardiovascular diseases as in all cases they were within physiological ranges.

References


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