EFFECT OF TRAINING ON THE SERUM LIPID PROFILE IN ABLE-BODIED AND SPINAL CORD INJURED RUGBY PLAYERS

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ABSTRACT: The aim of the present study was to examine the effect of rugby training on the serum lipid profile in able-bodied and wheelchair players. The following groups took part in the study: sedentary able-bodied men (Group M, n=10), inactive disabled men using wheelchairs (Group MW, n=10), semiprofessional rugby players (Group R, n=10), and wheelchair rugby players (Group RW, n=10). The serum triacylglycerols (TG), the total cholesterol (TC), the LDL cholesterol (LDL_{total}) and the HDL cholesterol (HDL_{total}) concentrations were assayed. The total cholesterol and the LDL cholesterol concentrations were higher in able-bodied sedentary men compared to non-disabled rugby players. There was also a tendency to higher HDL cholesterol concentration in rugby players compared to sedentary men (Group R vs. M). Rugby training resulted in a significant decrease of the LDL cholesterol and an increase in the HDL cholesterol concentration, as well as a tendency for lower total cholesterol levels in wheelchair players compared to sedentary tetraplegic men. The ratio of the total cholesterol to the HDL cholesterol was significantly lower in both groups of rugby players in comparison to the respective groups of sedentary men. The serum triacylglycerols (TG) concentration was similar in all studied groups. There was no difference in the serum lipid profile and the TC/HDL_{total} ratio between sedentary able-bodied and disabled men (Group M vs. MW), just as between non-disabled and wheelchair rugby players (R vs. RW). It seems that rugby training had a beneficial effect on the serum lipid profile in able-bodied as well as wheelchair players. These results confirm that active persons are at lower risk of cardiovascular diseases.

KEY WORDS: lipid profile, sedentary men, rugby players, wheelchair rugby players

INTRODUCTION

It is well known that regular physical exercise has a beneficial effect on the blood lipid profile resulting in an increase of the HDL cholesterol fraction and a decrease of triacylglycerols, the total cholesterol and the LDL cholesterol concentrations [14]. Epidemiological studies revealed a relationship between dislipidemia and the prevalence of atherosclerosis and coronary heart disease. Increased physical activity is associated with a reduction in the risk of cardiovascular disease, but there is conflicting information about the optimal intensity and the amount of exercise necessary for this reduction [20]. Marrugat et al. [23] demonstrated that physical activity with intensity greater than 7 kcal/min was significantly associated with a higher level of the HDL cholesterol and the lower total cholesterol/HDL cholesterol index. However Durstine et al. [7] noted that differences between sedentary and exercise groups become significant in individuals running 11 to 23 km/wk (700 to 1500 kcal/wk). It was demonstrated that endurance exercise at moderate intensity resulted in a significant increase in the HDL cholesterol level [8]. Lippi et al. [22] showed that in professional cross-country skiers and road cyclists the HDL cholesterol concentration was higher, whereas the total cholesterol, the triacylglycerols and the LDL cholesterol levels were lower compared to sedentary control groups. These results were confirmed by Hübner-Woźniak et al. [16] in wrestlers and volleyball players. In contradiction with these findings Giada et al. [13] did not observe any differences in the total cholesterol, the LDL and the HDL cholesterol levels in experienced soccer players and body builders compared to inactive men. Also Imamoglu et al. [17] did not determine any differences in the lipid profile between wrestlers and the sedentary control group.

Spinal cord injury impairs the ability of individuals with tetraplegia to perform large muscle mass aerobic exercise. It is caused by the impairment of the function of arms, legs and pelvic organs. The degree of impairment is determined by the neurological level of spinal cord injury, and the effect of skeletal muscle paralysis is the absence of venous muscle pump in the legs and the decrease in circulating blood volume [10]. In spinal cord injured persons the exercise response is considerably different to that in able-bodied people as a consequence of changes in motor, sensory and autonomic nervous systems [15]. It has been determined that in spinal cord
injured persons the serum lipid profile is less favorable than in able-bodied individuals [21]. Schmid et al. [27] have shown that tetraplegia in men was associated with a lower HDL cholesterol level compared to non-disabled male controls. However Kokkinen et al. [19] demonstrated that 20 weeks of strength training (3 times/wk) did not improve the serum lipid profile in non-disabled men, and it has been suggested that the adequate training volume is the main factor determining the effect of regular activity on serum lipids and lipoproteins. It would appear that a reduction in the number of risk factors for chronic disease in active subjects is also relevant for persons with spinal cord injury.

The physiological demands of rugby are complex, requiring players to have developed speed, muscular strength and power as well as high aerobic power [12]. Wheelchair rugby is becoming increasingly popular amongst individuals with spinal cord injuries, and can be recommended as a viable approach to improving cardio-respiratory fitness [1]. Therefore disability sport is being used as a way to prevent cardiovascular disease. Persons with spinal cord injuries, as well as able-bodied subjects, can have their cardiovascular risk evaluated by the blood lipids profile. The aim of the present study was to examine the effect of rugby training on the serum lipid profile in able-bodied and wheelchair players.

MATERIALS AND METHODS

The subjects of the present study were sedentary able-bodied men (Group M, n=10), inactive disabled wheelchair users (Group MW, n=10), semiprofessional rugby players (Group R, n=10) and wheelchair rugby players (Group RW, n=10). The level of lesion of sedentary wheelchair users and wheelchair rugby players varied from C7 to C8. Physical characteristics of the studied groups are given in Table 1. All participants were familiar with the aim and protocol of the study and gave their written consent to participate, which was approved by the local Ethics Commission according to the Declaration of Helsinki. The body mass and body height of each subject were measured and the body mass index was calculated. Fat content was evaluated from four skinfolds (biceps, triceps, subscapular, iliac) according to Durnin et al. [6]. Measurements of skinfolds were made twice on the left body side, in standing position.

Blood was withdrawn from antecubital vein in the morning, in preprandial state, into non-heparinized tubes. The collected blood was centrifuged at 3000 rev/min for 15 min. The serum triacylglycerols (TG) and the total cholesterol (TC) concentrations were determined by enzymatic-colorimetric methods at 37°C using respective commercial kits (Alpha Diagnostics, Poland). Prior to the HDL cholesterol (HDLcholesterol) measurement the remaining serum lipoproteins were precipitated with polyethylene glicol and centrifuged. In the supernatant cholesterol was assayed with commercial kit (Alpha Diagnostics, Poland) also used for total cholesterol (TC) and the total cholesterol (TC/HDLcholesterol) determination. The LDL cholesterol (LDLcholesterol) was calculated according to Friedewald’s formula [11].

Data were reported as mean values ± SD. Shapiro-Wilk’s test was used to check the normality of distribution in the data analysis. The Student’s t-test for independent data and the Mann-Whitney’s U-test were used in cases of normal and non-normal distributions, respectively. The level of significance was set at p<0.05.

RESULTS

Able-bodied rugby players were significantly younger compared to control, sedentary men and to wheelchair rugby players (Table 1). The reason for this difference was that the non-disabled rugby players were selected to ensure similar rugby training experience. Wheelchair rugby players were also lighter, and their BMI and the percent of body fat were lower compared to able-bodies athletes.

The total cholesterol and the LDL cholesterol concentrations were higher in sedentary able-bodied men compared to non-disabled rugby players (Group R) (Table 2). However between able-bodied rugby players and the respective group of sedentary men only a tendency to higher HDL cholesterol concentration was seen in Group R. Rugby training resulted in a significant decrease of LDL cholesterol and an increase of the HDL cholesterol concentration, as well as a tendency to a lower total cholesterol level in wheelchair players compared to sedentary disabled men. The ratio of the total cholesterol to the HDL cholesterol (TC/HDLcholesterol) was significantly lower in both groups of rugby players in comparison to respective groups of sedentary men. The triacylglycerols (TG) concentration was similar in all studied groups. There was no difference in the serum lipid profile and

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Able-bodied</th>
<th>Tetraplegic</th>
</tr>
</thead>
<tbody>
<tr>
<td>M (n=10)</td>
<td>R (n=10)</td>
<td>MW (n=10)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>29.2 ± 4.1</td>
<td>21.3 ± 2.9*</td>
</tr>
<tr>
<td>Body height (cm)</td>
<td>179.3 ± 4.8</td>
<td>183.6 ± 7.8</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>82.6 ± 8.8</td>
<td>91.4 ± 14.3</td>
</tr>
<tr>
<td>BMI</td>
<td>25.7 ± 2.4</td>
<td>27.5 ± 4.8</td>
</tr>
<tr>
<td>Fat content (%)</td>
<td>18.4 ± 3.9</td>
<td>22.1 ± 6.5</td>
</tr>
<tr>
<td>Training experience (years)</td>
<td>-</td>
<td>7.7 ± 3.9</td>
</tr>
<tr>
<td>Duration of disability (years)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Legend: * Groups M and MW – sedentary men; groups R and RW – rugby players; ** Significantly lower compared to Group M and Group RW (p<0.001), Significantly lower compared to Group R at: *p<0.05, **p<0.01, ** Significantly higher compared to Group MW (p<0.001),
the TC/HDL<sub>chol</sub> ratio between sedentary able-bodied and disabled men (Group M vs. MW) just as between non-disabled and wheelchair rugby players (Group R vs. RW).

**DISCUSSION**

The main goal of the present study was to examine the serum lipid profile in wheelchair rugby players. To our knowledge this is the first time such a study has been conducted. Our results show a beneficial effect of rugby training on serum lipids and lipoproteins, suggesting that active spinal cord injured individuals are at a lower risk of cardiovascular disease. Dallmeijer et al. [4] has noted that the HDL cholesterol concentration was significantly higher and the TC/HDL<sub>chol</sub> ratio was lower in tetraplegic men engaged in regular sport activities than in sedentary spinal cord injured individuals. Also Brenes et al. [3] reported an increased HDL and antiatherogenic subfraction HDL<sub>2</sub> cholesterol levels in wheelchair athletes compared to sedentary wheelchair users. High density lipoprotein (HDL) cholesterol levels are strongly and inversely associated with cardiovascular diseases [18]. According to Thompson et al. [29] the HDL<sub>2</sub> subfraction is responsible for the elevated serum HDL cholesterol concentration in active persons. It is well known that the decreased level of HDL and HDL<sub>2</sub> cholesterol and the increased ratio of TC/HDL<sub>chol</sub> suggest a higher risk of coronary heart disease related to the inactive life style of spinal cord injured persons [28]. Schmid et al. [27] revealed that the unfavorable serum lipid profile in tetraplegic persons is dependent on the lesion level, and the high-lesion individuals are characterized by an extreme reduction in VO<sub>2</sub>max. It was shown that in spinal cord injured men participation in the 8-week interval arm training improved the peak oxygen uptake and had a favorable effect on the serum lipid profile [5]. Bostom et al. [2] proved a significant relationship between the peak oxygen uptake during arm cranking and the beneficial changes in lipid profile.

In the present study it was stated that sedentary able-bodied and spinal cord injured men had a similar serum lipid profile. Ozgutas et al. [26] showed that the LDL cholesterol concentration was higher while the HDL cholesterol level was lower in persons with spinal cord injury than in control, able-bodied subjects. Also El Sayed et al. [9] reported that the resting level of serum TG in disabled individuals was significantly higher and the HDL cholesterol was lower compared to able-bodied persons, and stated that the mechanism responsible for the increase in the HDL with training is likely to be related to the increased activity of cholesterol transport enzymes. Musa et al. [25] showed that 8 weeks of interval training resulted in an increase of the HDL cholesterol level and a decrease in the TC/HDL<sub>chol</sub> ratio in disabled men. The results obtained by Maso et al. [24] contradict this, and imply that in able-bodied experienced rugby players the HDL concentration was lower compared to sedentary men.

**CONCLUSIONS**

Results of this study demonstrate that in the group of able-bodied rugby players the total cholesterol and the LDL cholesterol levels were significantly lower than in the sedentary control group, while in the group of wheelchair athletes the LDL cholesterol concentration was lower and the HDL cholesterol level was higher compared to inactive tetraplegic men. It seems that rugby training had a beneficial effect on the serum lipid profile in able-bodied as well as wheelchair players. These results confirm that active persons are at lower risk of cardiovascular diseases.

**Acknowledgements**

The study was supported by grant DS-119 from University of Physical Education, Warsaw, Poland. The authors wish to thank Elzbieta Baczkowska-Posnik for her excellent technical assistance in the data collection. The authors extend special thanks to the all able-bodied and tetraplegic participants of this study.

**REFERENCES**


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**TABLE 2. THE SERUM LIPID PROFILE IN THE STUDIED GROUPS (MEAN ± SD)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Able-bodied&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Tetraplegic&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (n=10)</td>
<td>MW (n=10)</td>
</tr>
<tr>
<td></td>
<td>R (n=10)</td>
<td>RW (n=10)</td>
</tr>
<tr>
<td>TG (mmol/l)</td>
<td>0.88 ± 0.29</td>
<td>1.02 ± 0.46</td>
</tr>
<tr>
<td></td>
<td>1.06 ± 0.39</td>
<td>0.76 ± 0.35</td>
</tr>
<tr>
<td>TC (mmol/l)</td>
<td>4.68 ± 0.58</td>
<td>4.33 ± 0.50</td>
</tr>
<tr>
<td></td>
<td>4.10 ± 0.48</td>
<td>3.93 ± 0.45</td>
</tr>
<tr>
<td>LDL&lt;sub&gt;chol&lt;/sub&gt; (mmol/l)</td>
<td>3.16 ± 0.55&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.69 ± 1.24&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>2.25 ± 0.48</td>
<td>2.20 ± 0.40</td>
</tr>
<tr>
<td>HDL&lt;sub&gt;chol&lt;/sub&gt; (mmol/l)</td>
<td>1.13 ± 0.30</td>
<td>1.12 ± 0.20&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>1.31 ± 0.19</td>
<td>1.38 ± 0.40</td>
</tr>
<tr>
<td>TC/HDL&lt;sub&gt;chol&lt;/sub&gt;</td>
<td>4.44 ± 1.41&lt;sup&gt;**&lt;/sup&gt;</td>
<td>3.98 ± 0.86&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>3.17 ± 0.50</td>
<td>2.87 ± 0.38</td>
</tr>
</tbody>
</table>

Legend: *p<0.05, **p<0.01,  A Significantly different compared to Group MW (p<0.05)


