COMPARISON OF ANTHROPOMETRIC AND PERFORMANCE CHARACTERISTICS IN AMATEUR AND PROFESSIONAL LEVEL HANDBALL PLAYERS

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Abstract

The aim of our investigation is to compare anthropometric and performance characteristics of Latvian male young amateur level handball players with these characteristics in amateur and professional players from European countries. Eleven 19 - 21 year old male players trained in handball from ten to 14 years five times per week and playing regularly in weekends from the team of Latvian Academy of Sports Education (LASE) voluntary participated in the investigation. A vertical jump height is measured on a special platform. The throwing speed of the ball was measured by a reflected light method. The aerobic capacity of handball players is measured by load test on a treadmill, the speed of running increased step by step. The oxygen uptake and heart rate are measured during the test. The lactic acid level in the plasma is detected in periphery blood samples by special strips. The height and weight of LASE amateur handball players correspond with these characteristics in European amateur players. Our athletes are 2 – 4 cm shorter and have approximately 10 kg less weight in comparison with the professional level handball players. This can be explained by greater skeletal muscles mass in International level athletes. The vertical jump height and maximal ball throwing speed in LASE athletes are close with the data of Spanish amateur and professional players. Aerobic capacity of our handball players is approximately for 20 % lower in comparison with the amateur and professional athletes from France. Its value coincides with the norm for young untrained males. This means that our handball players need to improve their aerobic endurance.

Key words: anthropometric characteristics, vertical jump, throwing speed, aerobic capacity, handball
Introduction

Mean height and weight increase is observed in international level handball players during the last 20 - 30 years (Gorostiaga et al., 2005). A large height and lean body mass due to hypertrophied skeletal muscles are beneficial for performance in adult professional handball players (Gorostiaga et al., 2005). A taller stature is an advantage for throwing, stealing and handling of the ball in a direct duel with an opponent during the game.

Handball is a very strenuous team sport. Therefore handball players need high levels of anaerobic capacities determining the muscle power to achieve a fast running speed, powerful jumping and ball throwing (Rannou et al., 2001; Ziv & Lidor, 2009). This is proved by the fact that the maximal power, produced by arm muscles in a heavy weight horizontal bar press from supine position does not differ significantly between the handball players and weight lifters, but the strength for the weight lifters is significantly higher (Izquierdo et al., 2002). The higher absolute maximal strength and muscle power in the professional handball players in comparison with amateur players indicate that these parameters are important for successful performance in high-level handball (Gorostiaga et al., 2005). The effect of great skeletal muscles mass may be beneficial for throwing power improvement, but may decrease jumping abilities of the players.

An aerobic capacity also should be important to maintain high performance level of the athletes throughout all the game (Gorostiaga et al., 2005; Rannou et al., 2001). Buchheit M. et al. (2009) determined that approximately 90% of the energy released during a handball game is supplied by aerobic mechanisms. This means that an improved aerobic capacity must be important for a faster recovery between high-intensity efforts during match-play (Rannou et al., 2001), and a greater resistance to fatigue during training and competition (Zapartidis et al., 2009). The fatigue causes a reduction in throwing accuracy towards the end of each half in a simulated handball game (Zapartidis et al., 2007).

Significantly greater power characteristics (counter-movement jump height, handgrip strength, sprint running speed) and aerobic capacity are observed in elite adolescent (14 – 18 year olds) handball players in comparison with the non-elite adolescent athletes (Stijn et al., 2011).

The aim of our investigation is to compare anthropometric and performance characteristics of Latvian male young amateur level handball players with these characteristics in amateur and professional players from European countries.
Material and Methods

Eleven 19 - 21 year old male players trained in handball from ten to 14 years five times per week and playing regularly in weekends from the first league handball team of Latvian Academy of Sports Education (LASE) voluntary participated in the investigation. The study was performed in conformity with the standards of the Ethics Committee of the Latvian Council of Sciences. The anaerobic and aerobic performance tests are performed in the end of the first part of competition period.

Vertical jumps heights are measured on special platform (PD. 3A, Moscow, Russia). Before the jumping test the players performed general warming up for 15 minutes. Two kinds of jumps are performed: from standing position on the apparatus platform: 1) squat jump (SJ): from the standing position and before to jumping squat was performed until the knee was flexed approximately to 90° and hands on hips (SJ) and 2) countermovement jump (CMJ): from the standing position and before to jumping squat was performed until the knee was flexed approximately to 90° and free movements of the arms (CMJ). Every kind of jumps repeated five times, and the best results (highest SJ and CMJ) are taken into account.

The ball throwing speed (m/s) was measured by a special system “Superschus” (EDV-Beratung Arbeiter, Bremen, Germany). Before the throwing test the athletes performed general warming up for 15 minutes. The handball player threw a 0.4 kg ball at a maximal speed six times holding feet (including a front foot) on a floor. A distance between the athlete and the ball speed measuring device was 2.5 m. The speed was recorded by reflected light rays. The best result (highest speed of the ball) was taken into account.

Every handball player performed incremental load test to exhaustion – a running test on a treadmill. Cardiopulmonary diagnostic equipment „Oxygen Mobile Via Sys” (Via Sys Healthcare GMBH, Germany) was used to register an electrocardiogram and respiratory characteristics. A mean duration of the test was 28 ± 2 minutes. A lactic acid concentration in the capillary blood was detected by a special lactate analyzers „Biosen 5030” (EKG – diagnostic, Germany) every two minutes (in the end of every load intensity step). The speed of running on a treadmill increased step by step every two minutes for 0.15 m/s.

The aerobic capacity characteristics: absolute and relative oxygen uptake, running speed and power are determined at the aerobic and anaerobic threshold, as well as, the maximal oxygen uptake loads. The average aerobic performance characteristics were determined at aerobic threshold intensity load. It was the workload, when a lactic acid concentration started to increase above the rest level. A break point was
seen in the relationship between the workload on the ergometer and the lactic acid concentration in the capillary blood (Coyle, 1995). They were determined at the anaerobic threshold intensity workload (onset of the blood lactate accumulation), when the lactic acid concentration in the capillary blood rapidly increased (it was below or close to 4 mmol/l). The break point was seen in relationship between the running speed on treadmill and concentration of the lactic acid in the blood (Sjodin & Jacobs, 1981). The same aerobic performance characteristics were determined at the maximal oxygen uptake load.

The mean values and standard deviations are calculated for all determined characteristics in handball players. A correlation analysis was done to determine the relationships between the anthropometric parameters, and the anaerobic and aerobic performance characteristics (significance $p < 0.05$).

Results

The mean anthropometrical characteristics of the handball players are shown in the Table 1. The mean height of LASE players is above 180 cm, only two players are shorter. The mean body weight is close to 85 kg, the weight greater than 90 kg is observed in two athletes, as well as, more than 100 kg in two players. The mean value of the body mass index is close to the upper border of norm, but this value is increased and exceeds 26 kg/m² in thee players.

The mean height of squat jump is $47.5 \pm 7.0$ cm (Table 1), this value exceeds 50 cm in five athletes. The countermovement jump height is higher for approximately 9 cm, the mean value is $57 \pm 10$ cm, the height is more than 60 cm in four players and exceeds 70 cm in one athlete. The relationship between the body mass index in the handball players and the vertical jump height is not significant for both kinds of jumps: squat jump (coefficient of correlation $r = -0.08; p > 0.05$) and countermovement jump ($r = -0.11; p > 0.05$).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Age, years</th>
<th>Height, cm</th>
<th>Body weight, kg</th>
<th>Body mass index, kg/m²</th>
<th>Squat jump height, cm</th>
<th>Counter-movement jump height, cm</th>
<th>Ball throwing speed, m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± S.D.</td>
<td>20 ± 1</td>
<td>186.7 ± 8.1</td>
<td>84.7 ± 11.1</td>
<td>24.2 ± 1.7</td>
<td>47.5 ± 7.0</td>
<td>57,1±10,1</td>
<td>26.4 ± 1.5</td>
</tr>
</tbody>
</table>
The mean ball throwing speed is 26.4 ± 1.5 m/s. This value varies from 24 to 29 m/s in different players. The relationship between the body mass index and handball throwing speed is not significant (r = -0.33; p > 0.05).

The aerobic capacity characteristics of our handball players are shown in the Table 2. The mean heart rate at the aerobic threshold load in handball players reaches 78 ± 2 % of the maximal heart rate (HR_{max}). This means that the aerobic threshold load intensity in LASE handball players is between medium and high intensity (McArdle et al., 2000).

The mean heart rate at the anaerobic threshold load intensity in our players is fast: 169 ± 6 beats per minute. It coincides with 91 ± 2 % from the maximal heart rate. This means that the aerobic capacity of the athletes is rather low. From the data of other authors (Gorostiaga, 2005) the mean heart rate of handball players during the match-play is over 80 % from the maximal heart rate. This value for our players relates to 149 beats per minute and more. This means that the mean load intensity during the game is between the aerobic and anaerobic thresholds and some time periods the heart rate exceeds the anaerobic threshold. The mean relative maximal oxygen uptake in LASE handball players is 46.4 ± 4.4 ml/kg min.

### Table 2

Aerobic capacity characteristics of LASE handball players at the aerobic and anaerobic threshold load intensity

<table>
<thead>
<tr>
<th>Load intensity</th>
<th>Running speed, m/s</th>
<th>Heart rate, beats per minute</th>
<th>Heart rate, % from the HR_{max}</th>
<th>Oxygen uptake, ml/kg min.</th>
<th>Oxygen uptake, % from VO_{2} max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic threshold</td>
<td>2.70 ± 0.22</td>
<td>145 ± 6</td>
<td>78 ± 2</td>
<td>33.5 ± 4.0</td>
<td>72.1 ± 6.0</td>
</tr>
<tr>
<td>Anaerobic threshold</td>
<td>3.63 ± 0.24</td>
<td>169 ± 7</td>
<td>91 ± 2</td>
<td>41.1 ± 4.9</td>
<td>88.7 ± 4.4</td>
</tr>
</tbody>
</table>

Discussion

The mean height of the professional handball players in Spain: 188.7 ± 8.0 cm (Gorostiaga et al., 2005) and in France: 190.0 ± 1.2 cm (Rannou et al., 2001) exceeds the mean stature of LASE amateur players (186.7 ± 8.1 cm). The height of our players is close to this characteristic in Spain amateur handball players: 183.8 ± 7.0 cm (Gorostiaga et al., 2005), but amateur players in France are shorter (their mean height is 177.0 ± 1.4 cm (Rannou et al., 2001).

The mean body weight in LASE handball players 84.7 ± 11.1 kg is slightly greater in comparison with amateur athletes from Spain (82 ± 10 kg), but the professional players from Spain (body weight 95 ± 13 kg) are
heaver for approximately 10 kg than our players (Gorostiaga et al., 2005). This can be explained by greater skeletal muscles mass in the professional level Spanish athletes (their fat free body mass is 81.7 ± 9 kg and body fat is in norm: 13.8 ± 2 % (Gorostiaga et al., 2005) in comparison with Latvian amateur players. Our handball players are heaver in comparison with the amateur (mean body weight 74 ± 2 kg) and professional (mean body weight 79 ± 1 kg) players from France (Rannou et al., 2001).

The mean squat jump height (47.5 ± 7.0 cm) in LASE athletes coincides with the data of Spanish amateur (46.9 ± 7.0 cm) and professional players (46.8 ± 7.0 cm) (Gorostiaga et al., 2005). The significantly higher body mass of the professional European handball players can be a reason of the maximal squat jump height decrease.

The mean height of the countermovement jump in our players is 57.1 ± 10.1 cm. This characteristic is not measured in the Spanish and France handball players but the data from the former Soviet Union professional handball players at 70-ties of the 20 century are available: their mean countermovement jump height was 93 cm (Wallace & Cardinale, 1997). The body weight of players was lower before some decades (Gorostiaga et al., 2005). Therefore it was safer to use plyometric training to improve the vertical jump height. The plyometric exercises must be used with caution in athletes with the body weight above 90 kg because the risk of sport injuries is increased (Wallace & Cardinale, 1997). The weight greater than 90 kg is observed in two athletes and more than 100 kg in two players in the LASE team.

The mean maximal ball throwing speed in LASE athletes (26.4 ± 1.5 m/s) also is close to Spanish amateur (21.8 ± 1.6 m/s) and professional players (23.8 ± 1.9 m/s) (Gorostiaga et al., 2005). The maximal ball throwing speed in Latvian amateur male handball players is measured as the maximal forceful ball throw velocity from the standing position. In Spanish athletes the maximal ball throwing speed from the standing position to the goal is measured. It must be more difficult task and needs additionally good coordination of movements to throw ball to the goal.

The relative maximal oxygen uptake of our handball players (46.4 ± 4.4 ml/kg·min.) is approximately for 20 % lower in comparison with the same characteristic in amateur (57.3 ± 3.1 ml/kg·min.) and professional (58.7 ± 0.9 ml/kg·min.) athletes from France (Rannou et al., 2001). The mean relative maximal oxygen uptake in LASE amateur players coincides with the norm for young (20 – 29 year olds) untrained males: from 42.5 to 46.5 ml/kg·min. (Cooper, 1982). This means that our handball players need to improve their aerobic endurance and performance of cardiovascular system.
Conclusions

1. The height and weight of LASE amateur handball players correspond with these characteristics in European amateur players. Our athletes are 2 – 4 cm shorter in comparison with the professional level handball players. LASE handball players have approximately 10 kg less weight in comparison with the Spanish professional level handball players, but our players are heavier in comparison with the amateur and professional players from France.

2. The vertical jump height and maximal ball throwing speed in LASE athletes are close with the data of Spanish amateur and professional players. The correlations between the body mass index in the LASE handball players and power characteristics (the vertical jumps height and the ball throwing speed) are not significant (p > 0.05). This means that skeletal muscles hypertrophy in professional handball players does not give them advantages in jumping and throwing abilities. The plyometric exercises must be used with caution in professional athletes with great body mass due to muscles hypertrophy. Therefore the height of vertical jumps in professional players is not higher in comparison with amateur athletes.

3. Aerobic capacity of our handball players is approximately for 20 % lower in comparison with the amateur and professional athletes from France. Its value coincides with the norm for young untrained males. This means that our handball players need to improve their aerobic performance.

References


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