SELECTED PARAMETERS OF ANAEROBIC FITNESS AND SOMATIC COMPONENTS AMONG SUPER-LEAGUE TEAM HANDBALLERS PLAYING VARIOUS POSITIONS

Krzysztof Krawczyk

1 The Physical Culture Centre, Maria Curie - Skłodowska - University in Lublin, Poland

Keywords: anaerobic fitness, somatic components of body composition, interval training, handball.

Abstract:

Study aim: The aim of the study was to evaluate the relative mechanical work (J/kg), maximal power (W/kg) and the time to attain (s) and of maintaining (s) power in the Wingate test among super-league handballers playing different positions. Additionally, the somatic components of the body were assessed, based on measuring body composition.

Material and methods: Participants: 20 players of the super-league handball team. Mean age of the subjects - 25.84 ± 3.36 years, mean body height - 191.89 ± 12.82 cm, mean body mass - 97.99 ± 7.18 kg, mean BMI - 25.85 ± 1.91. Anaerobic fitness was assessed in accordance via the Wingate-30 s test procedure, on a Monark 824E cycle ergometer, using the MCEv5.0 software program, while body composition was assessed with the Tanita SC 330, Japan body composition analyser.

Results: The mean value of the maximum power among the participants was - 11.45 ± 0.86 W/kg., mean value of the work - 256.78 ± 15.93 J/kg., the mean value of the time to attain power - 4.63 ± 0.80 s., mean value of time maintaining power - 2.91 ± 1.05 s., power decrease index - 26.17 ± 3.52%. The mean value of the FAT% index - 12.92 ± 3.27% and the mean percentage of water in the body composition - TBW% - 60.94 ± 1.99.

Conclusions: The selected parameters of anaerobic fitness obtained by the participants in the Wingate test were at a good and average level, which certainly did not guarantee the achievement of high sports results in the men’s handball super-league competition. Higher values of the parameters regarding anaerobic fitness were obtained by the players playing in the positions: centre and winger, relative to pivots and goalkeepers. The values of body composition tissue components were within the limits of the results for referencing.

Introduction

While assessing the nature of handball at a competitive level, it should be considered extremely diverse, in the constantly changing conditions of energetic work of the muscles, which requires a variety of actions from a player during a sports competition [1]. Given the duration of a handball match - 60 minutes, it can be stated that physical effort is based on aerobic potential, which is the foundation and basis for shaping speed endurance [2]. Handball belongs to the group of endurance and speed sports [3]. The development of aerobic and anaerobic physical fitness is of particular importance in the training process. Both these mechanisms of work energy secure serve the systematic regeneration of adenosine-triphosphate (ATP), and their activity depends on the duration and intensity of exercise [4].

One of the main ways to obtain this is based on anaerobic sources is reconstruction of ATP in a reaction involving phosphocreatine. However, the resources of
that the players with higher levels of VO2max are able to resynthesis [10]. The rate of phosphocreatine resynthesis depends on oxygen metabolism, which suggests that players with higher levels of VO2max are able to resynthesize this compound more efficiently [11]. The ability of the muscles to perform another intense effort depends, at least in part, on the rate of phosphocreatine resynthesis and the rate of elimination of hydrogen ions.

In modern handball, anaerobic fitness is an important component of the match load structure [12]. Research on the structure of the “match” load by Czerwiński [13] and Norkowski [14] allowed to prove that in the case of handball, 30-35% of the game time is spent in the zone of anaerobic efforts. Reliable planning, registration, control and analysis of training loads is one of the basic requirements of modern training as a process enabling the achievement of the highest sports levels [15]. Obtaining the highest level of adaptation to exercise, of specific metabolic nature, which is expressed in increased fitness indices and progression of the sports result, is the basic task of sports training [12, 15].

In handball, assuming the metabolic nature of exercise as the criterion, the training measures and methods used mainly include: loads performed in the area of anaerobic transformations of lactic acids, during which the highest activity in the area of anaerobic metabolism is observed, and loads carried out in the area of non-lactic anaerobic transformations, the intensity of which corresponds to the level of maximal anaerobic power. The moments of achieving maximal non-lactic acid efficiency, lactic acid and oxygen sources of energy correspond to the following values of work in time intervals - 10, 60, 180 seconds [16].

A commonly used test for assessing anaerobic fitness is the Wingate by Bar-Or [17]. According to many authors, the Wingate test can be a useful tool among coaches for diagnostic, prognostic and selective purposes [5, 12, 18]. In the available domestic and foreign literature, there is little data on the anaerobic fitness of handball players representing a high sports level [14, 19, 20]. The aim of the study was to assess the parameters of anaerobic fitness and body tissue components among handballers playing various positions, at the superleague level. The characteristics of the game resulting from the observations and the results obtained during the championship competitions indicated deficits in the level of anaerobic fitness among the studied players.

Materials and methods

The study comprised the following participants: 20 players of the Polish Super League handball team. Mean age of the subjects - 25.84 ± 3.36 years, mean body height - 191.89 ± 12.82 cm, mean body mass - 97.99 ± 7.18 kg. The mean value of the BMI (body mass index) - 25.85 ± 1.91 kg/m², mean FAT% (percentage of fat content) - 19.92 ± 3.27% and mean TBW% (total body water) - 60.94 ± 1.99%. The research was carried out in October 2018 at the laboratory of the Centre for Physical Culture at Maria Curie-Skłodowska University in Lublin.

The following test methods were used: 1. Wingate test - consisted of performing a 30-second maximal effort on a cycle ergometer with an individually selected load, amounting to 7.5% of body mass [17]. The test was performed after a 5-minute warm-up on the cycleergometer followed by the 5-minute rest. The Monark 824 E cycloergometer (Sweden) was used, which was connected to an IBM PC Pentium class computer, with the MCE_v_5.1 computer program [21]. Rotation sensors were mounted on the flywheel. During 1 pedal revolution, the flywheel made 3.70 turns, which corresponds to a distance of 6 m. After determining the appropriate height of the saddle and handlebars, the exercisers performed the test in a seated position, starting the test work from a standing position. The feet were fastened to the pedals with straps. During the effort, the subjects were motivated to reach the maximal speed of pedal rotation as quickly as possible and to maintain it until the end of the test. Using the MCE_v_5.1 program, the following measurements and calculations were performed: number of rotations of the flywheel (N), the value of the work performed (W) in (J/kg), mean power (Pm) in (W/kg), maximal power (Pmax) in (W/kg), the time to attain maximal power (Ta Pmax) in (s), time to attain upper limit of power (Ta Pul) in (s), time of maintaining upper power limit (Tm Pul) in (s) and the rate of decrease in power (PDR) in (%) [22]. Body composition was assessed in the morning via the bioelectric impedance...
method (using the "Tanita" SC 330 body composition analyser, Japan). Lean body mass (FFM%), fat tissue content (FAT%), water percentage (TBM%) were determined and BMI was calculated. The obtained results were statistically processed by calculating the arithmetic means (x), standard deviations (SD), minimum (Min) and maximum (Max) values and the Pearson correlation coefficient (r). All calculations were performed with the SPSS v. 21. [23].

Results

As it results from the data presented in Table 1, in the stress test, the relative mechanical work performed by the athletes and the value of the maximal power reached the average level according to the classification proposed by Norkowski and Noszczak [24]. The mean value of the time to attain maximal power in the Wingate test was classified as an average result, while the average value of maintaining maximal power as a good result. Furthermore, the mean value of the power decrease rate index, calculated as the percentage difference between maximal and minimal power registered after obtaining maximal power, reached an average level.

The results of mean anaerobic fitness parameters among handballers playing various positions are presented in Table 2. Analysing the contents of the table, it should be stated that the highest values of maximal power were achieved by: wingers, centres, pivots and goalkeepers. As for the time to attain maximal power, the order was pivot, winger, goalkeeper, centre, respectively. The highest values of the time of maintaining the upper power limit were achieved by: wingers, centres, pivots and goalkeepers.

### Tab. 1. Mean values of anaerobic fitness parameters among the subjects

<table>
<thead>
<tr>
<th></th>
<th>W [J/kg]</th>
<th>Pmax [W/kg]</th>
<th>Ta Pmax [s]</th>
<th>Tm Pul [s]</th>
<th>PDR [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>256.78**</td>
<td>11.45 **</td>
<td>4.63 **</td>
<td>2.91 ***</td>
<td>26.17 **</td>
</tr>
<tr>
<td>SD</td>
<td>± 15.93</td>
<td>±0.86</td>
<td>±0.80</td>
<td>±1.05</td>
<td>±3.52</td>
</tr>
<tr>
<td>Min</td>
<td>229.42</td>
<td>9.71</td>
<td>3.71</td>
<td>1.47</td>
<td>18.98</td>
</tr>
<tr>
<td>Max</td>
<td>277.61</td>
<td>12.68</td>
<td>5.56</td>
<td>5.67</td>
<td>31.14</td>
</tr>
</tbody>
</table>

Legend: ** average result; *** good result

### Tab. 2. Mean values of anaerobic fitness parameters among handballers playing different positions

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Goalkeepers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N-4</td>
<td>X</td>
<td>10.21**</td>
<td>238.60**</td>
<td>4.89**</td>
<td>2.41**</td>
</tr>
<tr>
<td>SD</td>
<td>0.84</td>
<td>11.87</td>
<td>0.71</td>
<td>0.15</td>
<td>2.29</td>
</tr>
<tr>
<td>Min</td>
<td>9.69</td>
<td>228.39</td>
<td>4.12</td>
<td>2.25</td>
<td>22.19</td>
</tr>
<tr>
<td>Max</td>
<td>11.21</td>
<td>249.31</td>
<td>5.41</td>
<td>2.49</td>
<td>25.97</td>
</tr>
<tr>
<td><strong>Centres</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N-6</td>
<td>X</td>
<td>11.28**</td>
<td>259.48**</td>
<td>4.87**</td>
<td>2.98***</td>
</tr>
<tr>
<td>SD</td>
<td>0.79</td>
<td>15.36</td>
<td>0.87</td>
<td>1.78</td>
<td>3.46</td>
</tr>
<tr>
<td>Min</td>
<td>10.98</td>
<td>250.31</td>
<td>4.98</td>
<td>2.36</td>
<td>22.25</td>
</tr>
<tr>
<td>Max</td>
<td>11.02</td>
<td>258.46</td>
<td>5.42</td>
<td>2.54</td>
<td>23.74</td>
</tr>
<tr>
<td><strong>Wingers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N-6</td>
<td>X</td>
<td>11.51**</td>
<td>261.89**</td>
<td>4.68**</td>
<td>3.22***</td>
</tr>
<tr>
<td>SD</td>
<td>0.77</td>
<td>16.00</td>
<td>0.90</td>
<td>0.73</td>
<td>4.31</td>
</tr>
<tr>
<td>Min</td>
<td>10.87</td>
<td>243.74</td>
<td>3.73</td>
<td>2.83</td>
<td>17.18</td>
</tr>
<tr>
<td>Max</td>
<td>12.66</td>
<td>278.28</td>
<td>5.14</td>
<td>4.18</td>
<td>29.23</td>
</tr>
<tr>
<td><strong>Pivots</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N-4</td>
<td>X</td>
<td>10.89**</td>
<td>239.02*</td>
<td>4.22**</td>
<td>2.68**</td>
</tr>
<tr>
<td>SD</td>
<td>0.14</td>
<td>0.65</td>
<td>0.42</td>
<td>0.36</td>
<td>6.43</td>
</tr>
<tr>
<td>Min</td>
<td>10.50</td>
<td>234.56</td>
<td>4.13</td>
<td>2.35</td>
<td>26.11</td>
</tr>
<tr>
<td>Max</td>
<td>10.97</td>
<td>255.48</td>
<td>4.64</td>
<td>2.89</td>
<td>35.31</td>
</tr>
</tbody>
</table>

Legend: * weak result; ** average result; *** good result;
Analysing the values of Pearson’s correlation coefficient between the parameters of anaerobic fitness and anthropometric indices of the studied handballers playing different positions. The highest value can be observed in goalkeepers and centres. However, in the case of wingers, the correlation coefficient value is at a lower level. The highest values of the correlation occur between maximal power and body mass, maximal power and body height, and the time of maintaining the upper limit of power and body mass. There was also a weak correlation between maximal power and body fat content FAT% and lean body mass FFM%: 0.14568 and 0.05951, respectively.

<table>
<thead>
<tr>
<th></th>
<th>Pmax/Body mass</th>
<th>Pmax/Body height</th>
<th>Ta Pmax./Body mass</th>
<th>Tm Pul Body mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goalkeepers N-4</td>
<td>0.52</td>
<td>-0.81</td>
<td>0.41</td>
<td>-0.47</td>
</tr>
<tr>
<td>Centres N-6</td>
<td>0.46</td>
<td>-0.33</td>
<td>0.21</td>
<td>0.61</td>
</tr>
<tr>
<td>Wingers N-6</td>
<td>0.52</td>
<td>-0.87</td>
<td>-0.05</td>
<td>0.0014</td>
</tr>
<tr>
<td>Pivots N-4</td>
<td>-1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

The situation is similar in the case of results concerning the time to attain maximal power and the time of maintaining its upper limit. The mean values of power limit maintenance time were in the range of the good score, probably due to the poor maximal power results and the time to attain maximal power. Moreover, the average score can be used to determine the average value of the percentage in power decrease, calculated as the percentage difference between the maximal and minimal power values recorded after obtaining the maximal power level [21]. Additionally, handballers playing different positions: goalkeepers and pivots obtained maximal power values qualified as weak, while the centre and wingmen - average - according to Norkowski’s classification [24]. The obtained value regarding the time of maintaining the upper limit of power is similar, which proves better strength in the energy area of anaerobic glycolysis among players in centre and winger positions compared to goalkeepers and pivots.

The results of Pearson’s correlation coefficient analysis between selected features indicate the highest values to be between maximal power and body mass, as well as maximal power and body height of the tested competitors. Also, the relationship between the time of maintaining power and body mass of the subjects is characterised by higher values, with the exception of the handballers playing the wing positions.

While leading a team, a coach cannot allow a situation in which the usefulness of the player decreases significantly due to exhaustion of energy resources. In handball, which is characterised by variability of effort, training requires thoughtful action, taking into account, first of all, knowledge of the coach regarding the structure of sports competition [2]. The research results allowed to confirm the hypothesis that the analysed team is not properly prepared for the season in terms of anaerobic fitness. The obtained values for the Wingate test, in which the maximal power was an average level of 11.45 (W/kg), with the minimal and maximal values between 9.71-12.68 (W/kg), respectively, classify the result as average and in line with those obtained by the previously cited authors [24]. The results of Pearson’s correlation coefficient analysis between selected features indicate the highest values to be between maximal power and body mass, as well as maximal power and body height of the tested competitors. Also, the relationship between the time of maintaining power and body mass of the subjects is characterised by higher values, with the exception of the handballers playing the wing positions.

The strength of this relationship cannot be inferred from the size of the correlation coefficient alone, as it also depends on sample size (the degree of freedom), which was limited for obvious reasons [23]. The previ-
ously cited results and examples of research on shaping and controlling anaerobic fitness indicate the importance of this area of endurance in the overall energy potential of an athlete.

According to Jansen [25], Karp [26] and Rygula [27], the basic method of shaping and maintaining a high level of anaerobic fitness is interval training with a maximal load intensity; while according to Linossier [28], the most effective means of influence are repetitive efforts lasting up to 10s. Systematic, high-intensity physical exercises with elements of load intervals, induce greater changes in anaerobic and aerobic fitness, as well as more favourable modification of anthropometric and biochemical indices, compared to low level endurance exercise and that of moderate intensity [29, 30, 16].

Rannou, Prioux and Zouhal obtained similar proportions concerning the values of anaerobic parameters in athletes playing particular positions in the game [31]. The maximal power values were similar to those of the sprinters and higher than those in athletes training endurance disciplines. In other studies, higher power values have been in field players compared to goalkeepers [32, 33]. The values of body tissue components also differentiate athletes playing different positions, e.g. the percentage of body fat in body composition (FAT%). Both in this study an in the research by other authors [32], the highest values of this index were observed in pivots, and the lowest in centres. Testing players’ predispositions in terms of playing positions may be of great significance for recruitment and selection [19].

The results presented in this study can be used as a supplement to the already existing knowledge on the diagnosis of the training process in elite handball teams.

Conclusions

Based on the analysis of the obtained research results, the following conclusions can be drawn:

1. Selected parameters of anaerobic fitness, obtained by the participants in the Wingate test, were at a good and average level, which did not guarantee the achievement of high sports success in the men’s handball super-league competition.

2. Higher values of anaerobic fitness parameters were obtained by handballers playing centre and winger positions, compared to pivots and goalkeepers.

3. There is a correlation between the obtained values of maximal power and the anthropometric indices of the tested players.

4. In the process of high-level handball training, great attention should be paid to shaping anaerobic fitness by increasing the share of interval loads.

5. Constant control regarding the level of aerobic and anaerobic fitness training loads, as well as evaluation of functional changes in athletes, enable rational planning and implementation of the training process.

References:


Author for correspondence
Krzysztof Krawczyk,
ORCID: 0000-0002-0863-840X
The Physical Culture Centre,
Maria Curie - Skłodowska - Uniwersity in Lublin, Poland
E-mail: k.krawczyk@poczta.umcs.lublin.pl
tel. 607 666 686.