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SELECTED PARAMETERS OF ANAEROBIC CAPACITY AND BODY TISSUE COMPONENTS IN HANDBALL PLAYERS FROM THE PREMIER LEAGUE TEAM

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Abstract

Study aim. Review of literature related to handball reveals that modern handball performed at the highest level of competition is dominated by short-term, 5–20 second sequences of anaerobic efforts. Given the above data and lack of scientific reports describing the level of anaerobic capacity in handball players representing a high sports level, it was considered appropriate to investigate the efficiency of this field of capacity in the men's premier league team. The aim of the study was to assess the relative mechanical work (J/kg) and maximal power (W/kg) obtained in the Wingate test, and to measure tissue components (BMI, FAT%, TBW%).

Study design. Subjects: 16 handball players from the premier league team. The average age of subjects = 25.33 ± 7.05 years, mean body height = 192.40 ± 7.18 cm, mean body mass = 98.31 ± 12.82 kg. Anaerobic capacity assessment was carried out in accordance with the Wingate – 30 s testing procedure, using the Monark 824E bicycle ergometer, and the MCE v. 5.0 computer program. Measurement of body tissue components were made using the Tanita SC330 body composition analyzer.

Results. The average maximum power was – 11.15 ± 0.80 W/kg, average work – 253.88 ± 16.93 J/kg, average time of attaining power – 4.83 ± 081s, time of maintaining power – 3.06 ± 1,08 s. The average BMI was 26.45 ± 1.91; FAT% – 12.92 ± 3.27; TBW% –59.02 ± 2.43.

Conclusions. In the process of training handball at a high competitive level, more attention should be paid to the development of anaerobic endurance by increasing the share of interval-type loads.

Introduction

Handball is a sports discipline in which the ability to perform repetitive, short-term sprints of maximal intensity is of decisive significance [1, 2]. In the course of the game, the exercise load is characterized by the repetition of short-term high intensity efforts, such as runs, jumps, throws, which are separated by efforts of low intensity [3]. Success in hand ball is largely dependent on an increase in exercise capacity that can be obtained through special preparation and adequate development of motor skill levels [4].

During intense exercise, skeletal muscle work is based on anaerobic processes, which are the dominant source of energy [5, 6]. Scientific studies have shown that the ability to perform high intensity repetitive efforts depends on the phosphorcreatine resources in the muscles and the speed of their re-synthesis [7]. The rate of phosphocreatine re-synthesis is dependent on aerobic metabolism, suggesting that players characterized by a higher level of VO_{2max} index values are more prone to effective re-synthesis of the compound [8]. The ability of muscles to perform another intense effort depends at least in part on the rate of re-synthesis of phosphor-

creatine and the rate of elimination of hydrogen ions. PCR resources are quickly restored (30–60 seconds), while the elimination of H + takes much longer (5–10 min) [9].

In modern handball, an important component of the match load structure is an aerobic exercise capacity [10]. Studies on the "match" load structure by Czerwinski [11, 12] and Norkowski [13, 14] have proven that in the case of handball, 30–35% of the game time occurs in the area of anaerobic efforts. Therefore, the share of efforts characterizing anaerobic metabolism, their structure and proportions incline to carry out the content of training in accordance with the physiological characteristics of handball. In the available domestic and foreign literature, there is little data on anaerobic capacity of handball players representing a high level of competitive sports. Measurements of body composition are important in the assessment of nutritional status, as well as assessing the risk of developing illnesses related to irregular body fat contents [15]. Increased content of FAT is the main factor causing an increase in the level of TC, LDL-C and TG concentration, while FFM value significantly affects HDL-C concentration and TG in the serum [16,17]. Physically active individuals, e.g. athletes, gain benefits important for their health, such as normalization of body mass and maintenance of appropriate balance between lean body mass and body fat [18,19].Water in the body is the single most important component of body mass. All cells in the body can function properly only when the it has an appropriate amount of water. Knowledge on fat and water contents in the body can provide some kind of guidance when adjusting a diet, fitness program or fluid intake, and thus can contribute to improving health status [20].

The aim of this study was to assess the level of selected anaerobic capacity indicators and body tissue components in handball players at a high level of competitive sports. Based on analysis, observation of championship competitions and the results obtained in them, the following hypothesis was put forward: "The handball team is not properly prepared for competition in terms of anaerobic capacity".

Study design

Study participants: 16playersfrom the KS Azoty Puławy team. The average age of subjects = 26.53 ± 3.36 years, mean body height = 192.40 ± 12,82 cm, mean body mass = 98.31 ± 7.18 kg. The research was conducted during the starting period, on 6 Oct. 2014 in the laboratory of the Physical Culture Centre at Maria Curie-Sklodowska University in Lublin. The Wingate Test consisted of performing a 30-second, maximal effort on a bicycle ergo meter with an individually selected load of 7.5% of body mass [21, 22, 23]. The test was performed after a 5-minute warm-upon the ergo meter and after a 5-minute rest following the effort.

The study used the Monark 824E Cyklo Ergometr (Sweden), connected to an IBM PC Pentium computer, and the MCE_v_5.1 computer program [23]. Rotation sensors were fixed to a flywheel. During one revolution of the pedals, the fly wheel performed 3.70 of a revolution, which corresponded to a distance of 6m. After establishing proper seat and handle bar height, the participant performed the effort seated, starting the effort from an immobile position. Their feet were fastened to the pedals. During the exercise, the participants were motivated to perform maximal speed of pedal rotation as quickly as possible, and to maintain it until the end of the effort. Using MCE_v_5.1., the following measurements and calculations were taken:

- number of flywheel revolutions,
- the value of the performed effort (J/kg),
- average power (W/kg),
- maximal power (W/kg),
- time of attaining P max (s) ,
- time of attaining P border (s),
- time of maintaining P border (s).

The Wingate test was chosen because it is a generally useful laboratory test used to assess muscular strength, muscular endurance, and its fatigue. Wingate has also found application as a test, which helps to analyze the physiological response of the organism to super maximal efforts [24]. The Wingate is a reliable test and when performed on the same day, the correlation coefficient is 0.95–0.98, and within 1–2 weeks, 0.90–0.93 [24]. Also, high correlation coefficient scan be observed between the Wan T. results and the results of other tests: anaerobic performance – sprint 40 m – 0.86; anaerobic endurance-swimming 25 m – 0.87–0.90; anaerobic power – the *Margaria*-Kalamen power *test* – 0.79 [25].

Body composition was assessed by bioelectrical impedance (using the body composition analyzer – Tanita SC330, Japan), fat-free mass (FFM%) was determined, as well as body fat (FAT%) and total body water (TBW%) [26]. The obtained results were statistic ally elaborated, calculating arithmetic means (x), standard deviations (SD), as well as minimal (min.) and maximal (max.) values All calculations were performedusing SPSS v. 20 [27].

Results

As it may be assumed from the data provided during Tab. 1 the stress test, relative mechanical work performed by the athletes reached the average level according to the classification by Norkowski and Noszczak

Table 1. Average values of anaerobic capacity indicators in KS "Azoty" Puławy handball players

N 16	Effort	Pmax.	TA	TM	PDV
X	253.88****	11.15 ****	4.83 ****	3.06 ***	24.84 ****
SD	± 16.93	±0.80	±0.81	±1.08	±3.62
Min.	228.42	9.73	3.73	1.45	17.88
Max.	278.61	12.65	6.36	5.97	31.50

Legend:

TA – time of attainment
TM – time of maintenance
PDV – power decrease value
**** average result
*** good result

Table 2. Average values of anthropometric and body composition indicators in KS "Azoty" Puławy handball players

N = 16	Age	Body mass	Height	BMI	FAT %	TBW%
X	26.53	98.31	192.40	26.45	12.92	59.02
SD	±3.36	±12.82	±7.18	±1.91	±3.27	±2.43
Min.	20	83.50	178	24	7.50	55.60
Max.	34	120.50	202	30.10	17.30	62.90

Legend:

BMI – body mass index
FAT% – body fat
TBW% – total body water

[28]. In contrast, the average value of maximal power attained by the subjects was at a good level. The average value of time of at training maximal capacity in the Wingate test was classified as an average result, while the average value of maintaining borderline power was considered as a good result. Also, the average index of power decrease, calculated as the percentage difference between maximal power and minimal output recorded after attaining the maximal power, reached an average level.

According to the data in Tab. 2, the average value of the BMI of the subjects was super-standard. The average value of percentage of fat issue content sand water in body mass of the athletes, fell within the range of values considered as normal.

Discussion

In handball, maintaining a high intensity of playing is only possible in the case of having high anaerobic and aerobic potential [29, 13]. High tolerance of the match effort is always better in athlete shaving a high VO_{2max} index value and anaerobic endurance. It is recommended that the level of aerobic and anaerobic capacity should be under constant control. Reduction below 54ml/kg/m in [30] in the case of aerobic capacity, and below 10.83 (W/kg) [28] in the case of anaerobic capacity, poses a significant limitation for specialized training of handball players. The ability to adjust the structure of training loads to starting loads is a key issue in the training process. Czerwinski [29] showed that the level of training intensity in handball is much lower than that observed in competitive conditions.

The most frequently mentioned cause is organizational failure in technical-tactical exercises, which are not sufficiently strong enough exercise stimulus from the point of view of adaptation to the actual conditions of the game. The results of the study by Norkowski [13, 14] suggest that the problem is related to the low effectiveness of methods for developing anaerobic capacity implemented in the exercises; their structure and organization do not correspond to physiological criteria of maximal anaerobic efforts. The cited authors present a consensus view that a direct consequence of inadequate training in anaerobic capacity is low tolerance of the body to repeated lactate-type efforts.

An indication of this state area cute manifestations of fatigue during the game, which in turn have significant impact on lowering the effectiveness of offensive and defensive actions. The subjects from the KS "Azoty"

Puławy team were subjected to diagnostic tests because of poor sports results obtained in the first 7roundsof the 2014/2015 season. The study results confirmed the hypothesis that the team is not properly prepared for the season in terms of anaerobic capacity. The obtained results of the Wingate test, in which the maximal power value was an average 11.15 (W/kg),and the minimal and maximal values, respectively 9.73–12.65 (W/kg), classify the result as average in accordance with the previously cited authors [28]. A similar situation exists in the case the results of time of attaining maximal power and then maintaining borderline power.

The average values of time of maintaining borderline power were within the range of assessment considered as good, probably as a result of achieving poor results of maximal power and time of its attainment. Also determined as average was theme an value of percentage decrease in the power index, calculated as the percentage difference between maximal and minimal power registered after attaining maximal power [23]. Referring to the analysis of the preparatory period, it should be emphasized that the team's preparation was on the basis of the stating method. This method was not favourable for the anticipated effects of training. Despite the high intensity of training obtained during the control competitions, not all the athletes, and especially the "doubles", participated in the practice for the same period of time.

It is probable that during the earlier period of preparation, inadequate time was also devoted to anaerobic capacity development training. The earlier cited results and examples of works on the development of anaerobic capacity, point to the importance of this sphere in the overall efficiency of an athlete's energy potential. According to Jansen et al. [31], Karp [32] and Ryguły et al. [33], the primary method of developing and maintaining a high level of anaerobic capacity is interval training with a maximal intensity load, and according to Linossier et al. [34], the most effective means of impact are repetitive efforts lasting up to 10s. Regular, high intensity physical exercise with elements of interval loads cause greater changes in anaerobic and aerobic capacity, and also more beneficial modification of anthropometric and biochemical indicators, compared to endurance exercises of low or moderate-intensity [35, 36, 37, 38].

Studying the content of fat tissue in the body is greatly significant in evaluating nutritional status or the risk of development of illnesses such as:coronary heart disease, type 2 diabetes, hyperlipidemia [39, 40]. The results of measuring water content in the body depend on fat and muscle contents in body mass. If the fat content is high or when the content of muscles is low, the level of residual water content in the body can be low [18, 19]. The participating handball players presented normal percentage values of fat tissue and water in the body mass. The average value of BMI, which was at 26.45, may be suggestive of high content of muscle mass in body composition, which is confirmed by the results. The results presented in this study may serve as complementary knowledge regarding diagnosis of the training process in handball for teams performing at high competitive level of sports.

Conclusions

Based on the analysis of the obtained results, the following conclusions were formulated:

1. Selected indicators of anaerobic capacity obtained by the studied athletes using the Wingate test were at good and average levels, which did not guarantee obtaining high sport performance results in the handball premier league competition.
2. The studied handball players presented normal percentage values off at tissue and water in the body mass.
3. In the process of practicing handball at a high competitive level, more attention should be paid to the development of anaerobic endurance by increasing the share of interval-type loads.

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