ASSESSMENT OF ANAEROBIC ABILITIES OF VOLLEYBALL PLAYERS BY MEANS OF THE REPEATED-EFFORT TEST

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- Volleyball, repeated-effort test,
- Reach jump,
- Diagnostics in sport.

Abstract:

The aim of the research was to assess the anaerobic abilities of volleyball players representing a high sports level by means of the repeated-effort test, with regard to the practical aspects of its application.

Materials and methods: The study comprised 12 players from a 1st league volleyball team - TSV Sanok in the preparatory phase of the season. For the assessment of the motor fitness, a specialised repeated-effort test was used. The following factors were measured: body height, body mass and its components, maximum heart rate, the concentration of lactic acid in blood after 3 minutes of the completion of the effort, spike reach and the time of lateral movement by the net combined with block jumps. For the calculations, the basic measures of descriptive statistics were used. Normalisation of the features in the research groups was performed into the mean and the standard deviation of the control group. The significance of the differences was established by means of the student's t-test.

Results: The results showed differentiation between the two tested groups. The players from TSV Sanok obtained lower values of the tested indices in comparison to the control group.

Conclusions: The test worked out by Sheppard et al. is a valuable diagnostic tool in the functionality assessment of volleyball players.

INTRODUCTION

The results obtained by the player or by the team during a competition depend, to a large extent, on his/their functional, conditional, coordinational, technical and tactical as well as mental preparation [Ljach 2011]. Modern volleyball challenges the players with high expectations in the scope of a comprehensive, integral preparation covering all the above-mentioned components [Grządziel 1989; Klocek, Szczepanik 1995; Superlak 1995; Papageorgiou et al. 1998; Uzarowicz, Zdebska 1998; Naglak 2001]. In order to control the training process of a player in a rational way, one needs to have at his disposal an objective diagnosis of the current state of preparations, including the motor ones, with reference to the requirements of the training and the competitions [Ljach 2011]. The purpose of that is to assess the level of, first of all, those motor abilities which play the most important role in a

given discipline, conditioning a high efficiency of the sports competition. Periodically conducted diagnostics allow the assessment of the efficiency of the methods and training resources applied and, on the basis of that, they allow the introduction of potential adjustments, related to the choice of load, capacity and intensity of the training. What is more, the periodically performed control allows the comparison and positioning of the players within a team, which offers indirect information about their sports form and current usefulness in the game. A comprehensive assessment of the level of physical preparation of the team makes it possible to determine its weak and strong sides, thanks to which it can lead to the optimisation of the training process. The assessment of the motor preparation in volleyball is usually of analytical character and is related to the assessment of the vertical jump height, strength, speed, power, or selected coordinational abilities [Sheppard et al. 2013]. For that purpose, the measurement of: the reach jump (from a standing position and after a run-up), the long jump from a standing position, a medicine ball throw and a short-distance run is conducted. The above-mentioned diagnostic methods usually serve the purpose of estimating selected, individual motor abilities or they are performed in laboratory conditions and they do not reflect the specificity of volleyball motor activities. In the available topic literature there are few suggestions of specialised tests which allow a comprehensive and global assessment of the level of motor preparation of volleyball players, making use at the same time of the specific motor activities occurring during the game. One of such research tools is a repeated-effort test by Sheppard [Sheppard et al. 2007]. The structure of that test reflects motor activities characteristic of the volleyball players and the parameters measured, the duration of the trial, the number of repetitions and the aptness of their choice have induced the authors of this work to use it as a reliable diagnostic tool in the assessment of the level of motor fitness of 1st league volleyball players.

Aim of the work

The aim of the research was to assess the anaerobic abilities of volleyball players representing a high sports level by means of the repeated-effort test, with regard to the practical aspects of its application.

Material and Method

The study covered 12 players of a1st league men's volleyball team - TSV Sanok (Poland) in the preparatory period. The mean age of the players was 24.6 years, the average body height was 192.08cm, the average body mass was 88.1 kg. The control group (CG) consisted of 16 volleyball players from the national teams A and B of Australia.

For the assessment of the motor fitness of the players a specialised test (Repeated-Effort Test) [Sheppard et al. 2007] was used. Prior to the beginning of the test, the measurements of the body height were made, with the use of the Martin anthropometer. The body mass and its components were established by means of the electrical bioimpedance, with the use of the Tanita TBF 300 body composition analyser. The maximum heart rate (HR max) was determined by means of the Polar pulsometer. The lactic acid concentration in blood was assessed after 3 minutes of completing the effort by means of the Biosen C analyser. The height of the vertical jump was measured by means of a vane measuring tool and the movement speed trials were recorded by means of a Mikrogate photocell.
For the calculations, the basic measures of descriptive statistics were used and the percentage decrease of the values between the first trial (Ideal) and the mean of all the trials (Actual) was

calculated. The significance of the differences between the results obtained by the volleyball players from TSV Sanok and the CG was calculated by means of the student's t-test.

Description of the test

The test contains motor activities which are characteristic for a volleyball player from the frontcourt: spike jumps, blocking and moving along the net. The test consists in performing the trial four times, at the maximum speed, every 20 seconds. The duration of the effort corresponds to the average duration of a rally during a volleyball match, which is approximately 12 seconds, and the restingtime between particular trials depends on the remaining time until the next starting signal, which is approximately 8 seconds. The tool employed for the measurement of the reach jump was placed between the net and the attack line (3m), at a distance of 1.5m from the net, and 1 m from the left sideline.One pair of photocellsfor recording the time of the trial was located 1.5m away from the left sideline, with one stand being on the centre line of the court, and the other 1.5m away from it. The other pair of photocells was located 3m away from the net (on the attack line), with one stand being 1.5m away from the sideline and the other one 3m further, towards the centre of the court. On the other side of the net, in the middle of the court, 2m apart from each other, two volleyballs were mounted. The bottom part of the ball, located 15cm away from the net (on the opposite side to the player), was located 258cm away from the floor (15cm above the net) (Fig. 1).

The course of the test

The player starts the test 4m back from the net, on the signal of the researcher, who starts the timer. After the run-up, the player makes a maximum spike jump in the designated zone. The height of that jump is recorded and read from the vane tool. After the landing, the playermoves as quickly as possible to the right, along the net – after crossing the photocell line the time count turns on. Next, the player performs two block jumps, covering with his hands the balls mounted on the stand, and then moves as quickly as possible to the right until he gets his foot onto or past a taped line 1m in from the right sideline. During the performance of the block the player is not allowed to touch the net. Then, while moving left, the player repeats all the previous actions, starting with two block jumps. After touching the second ball mounted on the stand, the player moves backwards and diagonally, toward the 3m line. After crossing the photocell line, the time stops and the player, after going backwards and making a run-up, performs the second spike jump just like at the beginning of the trial. The next trial starts 20 second after the timer is started during the first performance of the test (the resting time depends on the speed at which the test has been performed). Each player repeats the test four times.

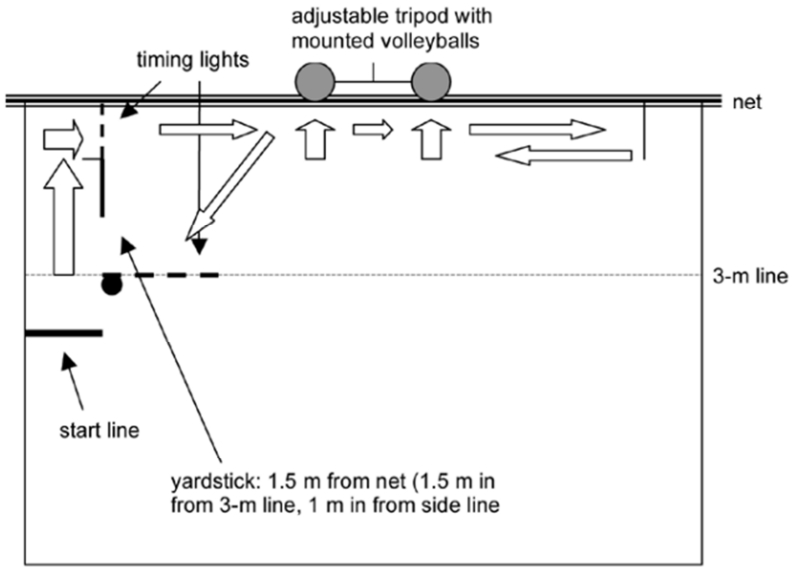


Figure 1. Test outline.

The test was preceded by a demonstration and before the beginning of the trial the players had been thoroughly informed about its course. Then, each of them performed the test twice, with a low intensity. Before the results were recorded, the players had undergone a volleyball-typical warm-up, after which each of the players performed one cycle of the test with the maximum intensity, without the results being recorded. After 5 minutes of rest the players got down to the test proper, the results of which were recorded. In each repetition what was recorded was the height of the two spike jumps and the time of movement combined with the block jumps. The results of the first spike jump were defined as 'idealjump' and the time of movement during the first repetition as 'idealtime'. The mean results of the height of the 8 spike jumps were defined as 'actualjump', and the mean of the four times needed to move along the net together with the block jumps were defined as 'actualtime'.

Results of the study

The comparison of the body height in both groups shows that the players from TSV Sanok are shorter than the players from the control group, and the differences observed are statistically significant ($p<0.05$). No significant difference, though, was found within the scope of body mass. Thus, it can be stated that the volleyball players from the control group (CG) are characterised by a slenderer bodybuild, characteristic of highly qualified volleyball players. The maximum heart rate recorded during the test was lower in the group of the players from TSV Sanok. The measurement of the LA concentration performed 3 minutes after the completion of the effort revealed a considerably higher level of acidification among the tested players in comparison with the results in the control group (Tab. 1). The occurring differences are statistically significant (Fig. 2).

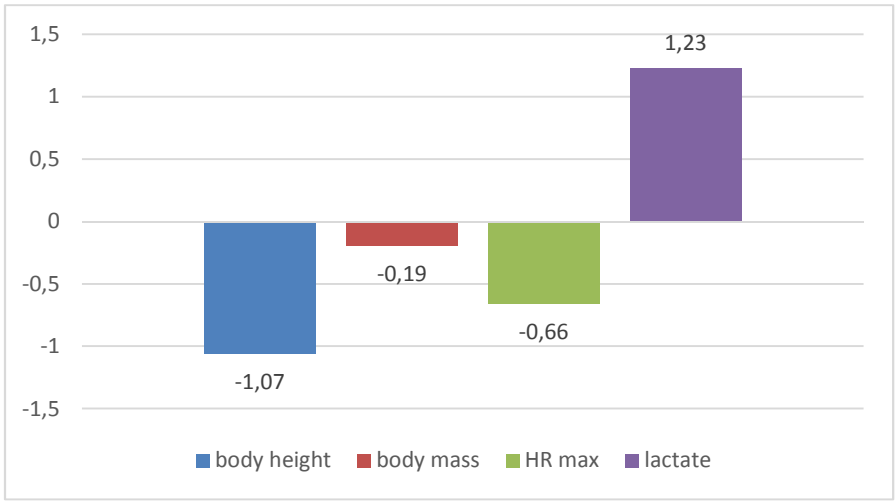
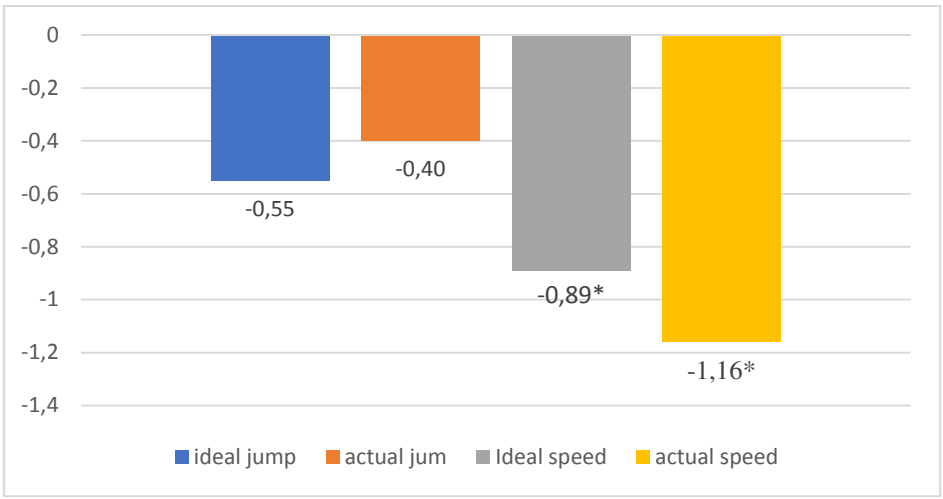


Figure 2. Normalised results of selected indices of the TSV Sanok players in comparison with the control group.

Comparing the results of both groups obtained in the test it could be claimed that in the group of 1st league players from TSV Sanok the values are lower in the scope of all the measured indices than those obtained by the players from the CG. The two groups were differentiated the most by the speed of movement by the net combined with block jumps (Fig.3).



*significance p<0.05.

Figure 3. Normalised results of selected indices of the TSV Sanok volleyball players and the control group (CG).

The differences are statistically significant and the groups of TSV Sanok players differed from the control group mostly in the meantime (Actual speed) obtained during the four repetitions. Comparing the results of the reach jump (vertical jump), it can be stated that they are higher in the CG, with the differences being statistically insignificant though.

Table 1. Results of the measurements in the control group (Sheppard) and in the group of the TSV Sanok players.

Variables	**Control Group**	**TSV Sanok**
Body height	200.5 ±7.9 cm	192.08 ± 9.53 cm
Body mass	90.1 ± 9.8 kg	88.1 ± 6.57 kg
Age	23.7 ±2.0 years	24.6 ± 2.80 years
HR max	186 ± 12 beats/min	178 ±10.26 beats/min
Lactate 3’	8.1 mmol/l ± 2.2 mmol/l	10.80 mmol/l ± 3.5 mmol/l

Repeated effort test (Sheppard)				
Control Group		% decrement	**TSV Sanok**	% decrement
Ideal jump- attack reach	333.88 ± 8.71 cm	2.11%	329.1±13.23 cm	1.55%
Actual jump –attack reach	326.86 ± 7.22 cm		323.97 ±13.36 cm	
Ideal speed	7.12± 0.45 s	3.91%	7.52 ± 0.32 s	5.05%
Actual speed	7.41± 0.45 s		7.92 ± 0.28 s	

Ideal - first trial in the test; Actual - mean of all the trials

Summary

Diagnosing in sport is an inherent element of the training process. Researchers emphasise that a starting point in the choice of training resources and the methods of assessing the player’s preparation is a thorough knowledge of the characteristics of the game and the tasks assigned to the players in the sports competition [Raczek 1999; Scates, Linn 2003; Šimonek 2006]. In volleyball, motor activities are of unique character. The step-touch, the crossover step, the two-step, (digs, forward and sideways sprawls, forward and side knee drops), or jumps after a two-footed take off and two-handed bumps are not natural forms of activity. The actions of a player are short-termed and reactive with quick movement and a change of direction as well as with manifold repeated maximum jumps. The players are forced to constant changes of positions from block or attack jumps to defending the ball in the field [Grządziel, Ljach 2000]. That requires a wide range of abilities to perform complex movements, a quick start for the ball, a quick reaction or maintaining the ready-for-action position. From the motor perspective volleyball is included among the disciplines of the strength-and-power character [Jonath, Krempel 1991; Scatess, Linn 2003], requiring a high level of power [Trzaskoma, Trzaskoma 2000; Price 2005], which is revealed, among others, during jumps, quick starts for the ball, as well as while hitting the ball during the attack or the service [Simonek 2006]. Effort in volleyball is of a mixed nature: aerobic and anaerobic. Matches can last long, but the game is not continuous. The rally, though short, lasting from a

few to several seconds, is very intense and requires a high efficiency of the phosphagen energy system [Scates, Linn 2003]. According to Emmy [2003] the breaks, when the ball is off the court, lasting on average from 20 to 40 seconds cause that the contribution of the anaerobic glycolysis in the energy supply and, related to it, the production of the lactic acid is small. The match often lasts over 2 hours, and in its course the players make over 100 jumps [Frączek 2012]. That is why it is important to maintain a high level of power not just at the beginning, but throughout the match [Scates, Linn 2003]. This short characterisation of volleyball shows that the diagnosis of the motor fitness of the players is not a simple thing. It seems that for the aptness of the assessment, the key element lies in the choice of appropriate research tools which reflect the motor actions occurring in the game as closely as possible. Hence, Repeated-Effort Test by Shepperd et al. seems to be a valuable instrument allowing the assessment of selected indices of motor fitness of the players. In the study, the results obtained in the test by 1st league players of TSV Sanok and the players from the Australian national team were compared. The measurement of selected somatic indices showed that the Australian players were considerably taller than the tested players, which, given the statistically insignificant differences in the body mass, proves their slenderer figures. According to many authors [Fiedor et al. 1980; Saryczew 1983; Grządziel 1989], body height and arm reach are among the basic criteria for volleyball selection. It seems obvious that the players from the Australian national team have been selected from a wide group of players and they are characterised by over-average values when it comes to those criteria. The comparison of the level of lactates concentration in blood in both groups showed that it was lower in the control group. The structure of the test requires from the tested players the performance of intensive efforts repeated four times every 20 seconds. The contribution of the fast glycolytic system increases rapidly after the initial 10 seconds of exercise [McArdle et al. 2000]. Mercier [1991] showed, however, that the level of lactates in blood increases significantly already 6 seconds after the beginning of intensive effort. What is more, Balsom [1992] put forward a hypothesis that the glycolytic energy system is used from the first seconds of intensive effort. That is particularly significant in those disciplines in which there are short but maximally intensive efforts, such as spike jumps in volleyball [Chamari et al. 2001]. A higher level of lactates in the blood of the players from TSV Sanok in comparison to the players from the CG is a proof of a bigger workload they have completed. The comparison of the height of the reach jump did not show significant differences; it should be mentioned, though, that the players from the CG obtained better results. The differentiation results from the body height, which has a considerable influence on the spike reach. A conclusion could be also drawn that with a considerable advantage of the CG's body height, the lack of statistically significant differences in spike reach results from a higher level of jumping skills as presented by the players from TSV Sanok. A lower body height requires a higher jump of the player to the mounted ball, hence a higher amount of the work performed, like in the case of the players of TSV Sanok during the test, and a higher value of the LA concentration. The higher values of the LA concentration in the blood of the players from TSV Sanok may also imply their lower level of anaerobic endurance. The level of anaerobic endurance affects the efficiency of actions during the game. Manifold repeated jumps or starts for the ball cause tiredness, which lowers the efficiency of the player [Hespanhol et al. 2007]. A higher percentage decrease in the values between the first trial – Idealspeed and the mean of all the trials – Actualspeed in the case of the players from TSV Sanok (Tab. 1) indicates their earlier tiredness. During the match that will manifest itself in their lack of precision, errors in the technique of particular elements, the lowering of the spike and block jump as well as in the delayed reaction time of the player.

The limitation in the reliable comparison of the two tested groups seems to be lying in the statistically significant difference in the body height of the tested players in comparison

with the control group. In the above-presented test, the premise of which is based on multi-fold (performed sixteen times) jumps, the players with a lower body height are forced to make a higher jump so as to cover the ball with their hands. Consequently, the time of the jump is longer than in the case of the taller players from the CG. A shorter performance time of one repetition by the players from the CG may also result from their better individual technique of movement, related to the sports level that they represent.

Conclusions

1. In all the tested indices, the players from TSV Sanok obtained worse results than the control group. Statistically significant differences were noticed in the speed of lateral movements along the net.
2. Lack of significant differences in the spike reach, with a considerable advantage in the body height of the control group, indicates better jumping abilities of the players from TSV Sanok.
3. The test does not unambiguously assess whether the time of performing a single trial results from the speed of the player's movements, as one of its components is the jump to the high-mounted ball, which is related to the body height and the duration of a jump.

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