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Test 8 x 32.8 m as a Diagnostic and Fitness Level Control Indicator in Basketball (Diagnostic Test in Basketball)

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Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

Key words: *basketball, fitness diagnostics, lactic acid, glucose*

Abstract

Background: *Physiological studies conducted for over 20 years on basketball players have shown an increasing share of anaerobic efforts during the game. The players' throw effectiveness and their ability to move quickly on the playing field often determine the result of the match. The current control of kinematics and biochemical variables is crucial in the modern training process.*

Material/Methods: *The study was conducted on an 11-person group of male athletes from a Polish first-league basketball team. The subjects had to perform a fitness test proposed by the authors: 8x32.8m with bouncing, throwing a ball to the basket and running back without the ball. The course of the test was video-recorded. A blood sample was taken in the 1st, 3rd, 13th and 23rd minute after the test. The level of lactic acid as well as glucose concentration were assessed by Lactate Scout and FreeStyle Lite apparatus.*

Results: *The study revealed individual differences in the level of special fitness among the players. The throw effectiveness varied from 37 to 75% (mean 59%), while the maximal lactic acid concentration varied from 6.3 to 8.5 mmol/l (mean 7.2 mmol/l). The average maximal glucose concentration was 124.6 mg/dl. The range of lactic acid restitution time differentiated the players from 21 to 55 minutes (mean 30min).*

Conclusions: *Application of the test in practice allows determining the basic values of kinematic techniques of basketball players in terms of biochemical changes. It should be an effective tool to control and optimize the basketball training process.*

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Introduction

Aiming for continuous improvement in athletes' fitness level, coaches try to improve the resolution of the training control process through the use of numerous fitness tests. An increase in the volume and intensity of work only, without rational control, is limited by the level of the body's adaptability and the time that can be devoted to training. With the current state of knowledge, including various measurements with modern devices, we strive to optimize the practical ways to raise the efficiency of training [1, 2]. Mathematical methods that allow obtaining optimal solutions with a use of quantitative data in the training process are still searched for.

Modern training is based on two kinds of constraints: first of all, internal conditions - development of the biological and functional system, and, secondly, external constraints, such as the availability of training facilities, training process organization, knowledge and competencies of its participants, accepted principles of management [3, 4]. Control of internal conditions is necessary to assess biological and technical changes affected by training. Among the many diagnostic indicators of sports exercise, concentration of lactic acid is used most often. It is used in the assessment of aerobic capacity and anaerobic threshold by identifying the aerobic and anaerobic levels as well as the dynamics of restoration of the body after exercise [5]. Moreover, in studies of carbohydrate metabolism, determination of blood glucose is also used to control the mobilization of carbohydrate substrates strongly correlated with the metabolism of lactic acid [6, 7].

An analysis of physiological studies from over the past 20 years has shown an increasing share of anaerobic effort while playing basketball [8]. It is connected with a shorter time of action lasting 24 seconds and dividing the game time into 4 quarters, owing to which the game is more action-related with jumping, sprints, etc. [9]. In the study by Castagna et al. [10] junior basketball players observed during a match were running with the highest intensity at distances less than 10 m. Results of some other research suggest performing repeated sprints at the highest speed in basketball training in order to develop anaerobic capacity and lactate tolerance [11, 12]. It is known that the effectiveness of throws and the ability to play in defense directly impact the match result. Speed evaluation of the movement with the ball to the throw zone and return to the defense zone may play an important role in that matter. This is related to the high efficiency of throws often on extreme fatigue. In order to control dominant elements in the game of basketball, i.e. fast attack, counter, returning to defense and speeding up the game, it is necessary to understand the mechanisms responsible for their effectiveness. An assessment of such indicators as glucose and lactic acid may provide important information about individual capabilities of each player's biomechanisms.

The aim of the study is to propose a test used to assess changes in the efficiency of technique and the fitness level based on selected biochemical and kinematic indicators of basketball players.

The following research questions were asked:

1. Were there individual differences in the investigated kinematic values?
2. Were there individual differences in the tested biochemical values?
3. Is there a constant relationship between the maximum concentration of lactic acid and the dynamics of restitution after the completion of the test?
4. Was there a relationship between the requested kinematic and biochemical values?

Material and Methods

The study was conducted in an 11-person group of male athletes from a Polish first league basketball team. The subjects' average age was 25.3 ±5.4 years, mean body height 194.6 ±8.4cm, weight 93.3 ±7.7kg and BMI 24.6 ±1.7 kg/m².

The concentration of lactic acid was measured using the Lactate Scout analyzer, while that of glucose with the FreeStyle Lite apparatus. The blood sample was taken from the ear lobe in 1st, 3rd, 13th and 23rd minute after the test. In order to determine the kinematic changes, SONY 25 Hz video camera was used. The recorded video movie was converted by PC and Adobe Professional software. For archiving of the data and mathematical calculations, Microsoft Excel 2007 spreadsheet was used. The obtained in each repetition measurement following data was calculated individually for each tested athlete: speed of bouncing (v_b), running speed without the ball (v_{wb}), average speed of the performed test (v_T), the throw's time (t_{Th}) and the effectiveness of the throws (E_{Th}).

Test 8 x 32.8 m was carried out on a basketball court. A video camera recorded each player's performance in order to register the efficiency in the various phases of the test run (Fig. 1).

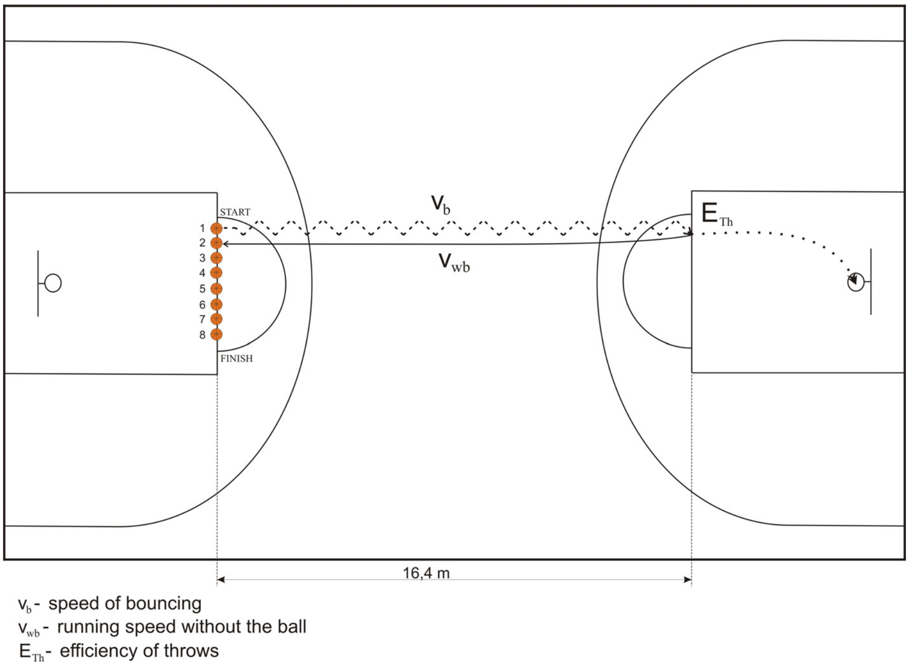

Fig. 1. Diagram of the 8 x 32.8 m test

The effectiveness of throws was evaluated (the number of matched points), as well as the time of test phases, namely: bouncing run time and return time for picking up the next ball. Throws were executed without stopping – a jump shot. Their time was measured from the moment of loss of contact with the ground again until feet tap.

The maximum value of lactic acid (LA_{max}) concentration and glucose (Gl_{max}), as well as their recovery time were also analyzed. The data were calculated using mathematical statistics, setting the mean values ($\bar{x}$), standard deviation (SD), the expected value (reglinx) and the Pearson linear correlation coefficient (r_{XY}). The coefficient strength assessment was made according to Stanisz [13]. The test presented by authors in this study is a proposal for specific basketball conditions that should be helpful in a diagnosis and control of athletes' level of physical fitness. The protocol of the study was approved by the local ethics committee, in accordance with the Helsinki Declaration.

Results

The study revealed individual differences in kinematical and biochemical values as well as in throwing effectiveness.

An analysis of the kinematics shows that the highest throw efficiency was obtained by A.T. (87.5%) at the lowest test speed. In this case, the lowest speed achieved in the whole test (v_T) may have been influenced by the running speed without the ball (v_{wb}). In contrast to A.T.'s results, two athletes, B.P. and K.K., received the lowest effectiveness of throws, i.e. 37%. In both cases it was observed that v_T was similar to the average velocity in the group. Particularly noteworthy is player Ś.P.. He achieved the highest speed of bouncing ($v_{b)}$, running speed without the ball (v_{wb}) and, obviously in total speed (v_T). His throw effectiveness was above the whole group mean value and amounted to 62.7%.

Another indicator of athletes' fitness, clearly individualized, is the difference between v_b and v_{wb}. Its highest value (0.69m/s) was recorded by M.M, who achieved a greater speed while bouncing than when running without the ball. A similar trend was observed in most subjects (Tab. 1).

Only two players, G.D. and W.T., had a higher speed without the ball, but the value of difference (v_b-v_{wb}) did not exceed 0.04 m/s.

The next analyzed kinematic variable is the time of the throw (t_{Th}). Its value reflects the altitude of the take-off. The higher the value of the throw time, the higher the altitude the player achieved while performing the throw. The longest t_{Th} was observed in Ś.P. (4.7 s), while the shortest one in K.K. and A.T. (3.2 s). The analyzed data are presented in Table 1.

Tab. 1. Summary of the kinematic values obtained by the players during the test

No	Subjects	E_{Th} [%]	t_{Th} [s]	v_T [m/s]	v_b [m/s]	v_{wb} [m/s]	Difference [v_{bk}-v_b]
1.	M.G.	75.0	3.6	3.83	4.24	3.88	0.36
2.	Ś.P.	62.5	4.7	4.25	4.74	4.47	0.27
3.	B.P.	37.5	4.0	4.02	4.35	4.21	0.14
4.	K.K.	37.5	3.2	3.82	4.22	3.82	0.39
5.	G.D.	62.5	3.6	3.97	4.19	4.20	-0.01
6.	J.J.	50.0	3.7	4.11	4.41	4.31	0.10
7.	M.M.	62.5	4.3	4.05	4.71	4.02	0.69
8.	W.T.	50.0	3.5	4.05	4.25	4.30	-0.04
9.	KR.A.	75.0	3.7	3.89	4.13	4.09	0.04
10.	A.T.	87.5	3.2	3.77	4.17	3.75	0.42
11.	K.P.	50.0	3.3	3.97	4.49	3.92	0.57
$\bar{x}$		59.1	3.7	3.97	4.35	4.09	0.27
SD		15.901	0.461	0.142	0.211	0.230	0.242

An analysis of biochemical data revealed that M.M. obtained the lowest value of the maximal lactid acid concentration (LA_{max}). His result was 6.3 mmol/l. Only 3 players, Ś.P., J.J. and K.P. exceeded the average value of LA_{max} in the test. The highest value of LA_{max} was obtained by J.J. (8.7 mmol /l). Significant individual differences were found in the analysis of restitution time (LA_R). Its lowest value was noticed in B.P. (21.0 min). In the majority of the tested players LA_R fluctuated near the average value of the group. M.G.'s case diverged significantly from the most achieved results, because his restitution time, calculated by the reglinx function, was 55 min.

The distribution of the individual maximal concentration of glucose (Gl_{max}) in most cases was similar to the mean value, too. A clearly higher value was observed only in W.T. (Table 2).

In all subjects the maximal burst of lactic acid occurred in the third minute after finishing the test. There was a very high correlation (r_{XY} > 0.76) between lactic acid concentration obtained as early as in the first minute of restitution and the value of LA_{max}. Distinct correlations between LA_{max} and lactic acid concentration in the thirteenth and the twenty-third minute of restitution were also observed (see Table 3, Figure 2).

Tab. 2. Summary of biochemical values obtained by the players during the test

No	Subjects	LA_{max} [mmol/l]	LA_R [min]	Gl_{max} [mg/dl]
1.	M.G.	6.8	55.0	123
2.	Ś.P.	8.2	32.4	121
3.	B.P.	6.4	21.0	125
4.	K.K.	6.4	26.3	120
5.	G.D.	6.9	21.7	127
6.	J.J.	8.7	39.4	128
7.	M.M.	6.3	31.4	122
8.	W.T.	7.1	34.2	146
9.	KR.A.	6.6	21.5	116
10.	A.T.	7.1	25.9	120
11.	K.P.	8.5	27.7	123
$\bar{x}$		7,2	30.6	124.6
SD		0.875	9.970	7.852

Tab. 3. Correlations of LA_{max} with LA obtained in the 1st, 13th and 23rd minute of restitution

	LA_{max}	LA_R [mmol/l]		
		1st min	13th min	23rd min
$\bar{x}$	7.2	5.4	5.3	3.2
SD	0.875	1.110	1.274	1.206
r_{XY}	0.763*			
	0.616*			
	0.514			

* $p < 0.05$

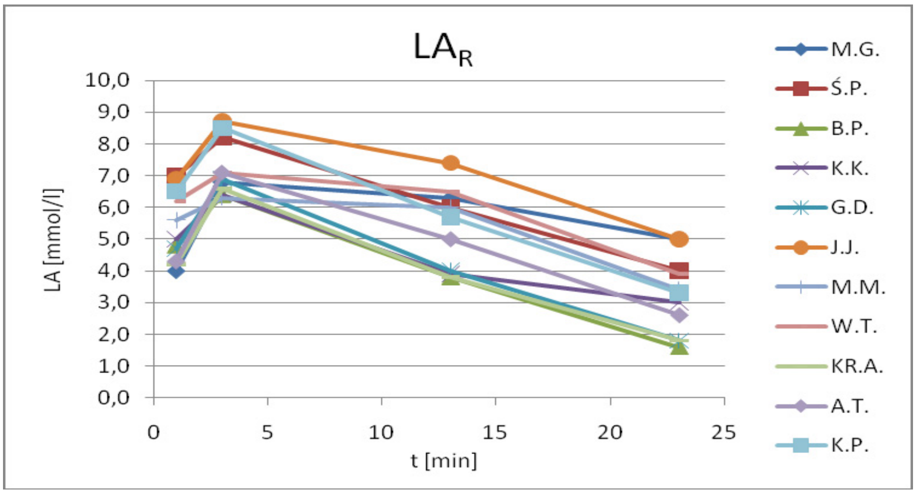

Fig. 2. Dynamics of lactic acid restitution (LAR) in the tested players

The dynamics of lactic acid restitution, however, reveals individual differences. For example, in the case of J.J. we can observe a much larger increase in lactic acid concentration between the first and the third minute of restitution, as well as a more rapid decline in lactic acid concentration between the third and the thirteenth minute, than in M.M. In both subjects, the dynamics of lactic acid restitution between the thirteenth and the twenty-third minute was at a similar level (Fig. 3).

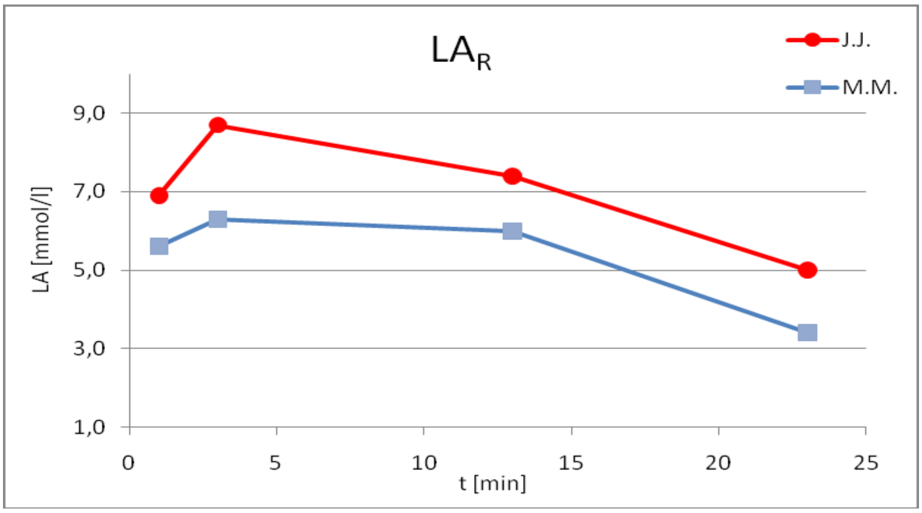

Fig. 3 Dynamics of lactic acid restitution (L_{AR}) of the players with the highest and lowest LA_{max}.

Based on the 8 x 32.8 m test results, the following have been observed:

- individual differences in kinematic and biochemical values in the tested players,
- a decreasing dependence between the maximum concentration of lactic acid and LA_R dynamics after finishing the test,
- inverse dependence between test values of v_b and v_{bk} and the effectiveness of throws to the average strength connection.

Discussion

The experiment showed differences in the level of fitness in both the kinematics and biochemical indicators in the examined basketball players. The obtained results allow comparing and identifying differences between individual players as well as checking the effects occurring in the training process. Identification of the kinematic changes increases the efficiency of the coaching process by an individual selection of training loads. It is also helpful in choosing the optimal variant of players' positions during the match. In this research it was found that the players performing a higher throw efficiency (E_{Th}) were slower in the total test (v_T) than their teammates of lower E_{Th}. Probably these athletes preferred the efficiency of throws to the total speed they could achieve in the whole test. In terms of a match it is essential for the final result to carry out a successful attack at a speed exceeding the speed of the opposing team's defenders. The ability to return quickly to the defense zone is of great importance, too. Speed achieved in sprints (both while bouncing and without the ball) reflects biochemical results, i.e. lactate and glucose concentration in blood. The higher the intensity of effort, the higher the lactate level. According to kinematics, the development of the throw effectiveness and the development of the athlete's speed with and without the ball should be a key to success. The results of biochemical tests (e.g. lactic acid and glucose concentration) are very reliable indicators of an athlete's physical engagement in training tasks. The impact of exercise intensity on carbohydrate metabolism is still under investigation of numerous authors.

Research on physiological effects of repeated sprints in basketball players has been conducted by Meckel et al. [14]. The athletes performed two types of repeated sprints (6 x 30 m) – with and without the ball, in random order. The authors noticed that the fastest sprint time and the total sprint time were significantly better in running without dribbling than with dribbling. These data seem to be contradictory to the results presented in our study. On the other hand, blood lactate values achieved by the tested athletes are similar to those recorded in male basketball players during competition [15].

During a basketball game a player takes about 105 different types of movements with high intensity lasting 2–6 seconds with a frequency of one every 21 seconds [16]. Therefore, the ability to repeat the efforts of a very high intensity may be an important factor in evaluating the level of special fitness in basketball players [17]. While such a short duration of a single effort is mainly attributable to the phosphocreatine energy system, its repetition during the match mobilizes anaerobic glycolysis and oxidative metabolism to ATP resynthesis [18].

In 2002–2003, twenty NBA coaches were surveyed about using special fitness tests. The coaches were asked what parameters were usually tested in the clubs. It was found that during this period the subjects used 7–8 selected tests of agility, flexibility, endurance, muscle strength, speed, aerobic endurance and anaerobic capacity. Anthropometric measurements and body fat assessments were also carried out [19]. The survey revealed that coaches used aerobic capacity tests more frequently than anaerobic tests, although basketball is mainly dominated by anaerobic exercise [20, 21, 22]. The ability to repeat the submaximal efforts is an important element of basketball players' fitness [17]. It is believed that athletes who can meet these requirements are probably better players than those which less adaptation [7, 23, 24].

Conclusions

1. Application of the test in practice allows determining basic values of basketball players' kinematic techniques in terms of biochemical changes.
2. The test results enable coaches to assign the athlete's position on the playing field.
3. The proposed test can be used as an effective tool to control and optimize the basketball training process.

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