ORIGINAL RESEARCH PAPER

ANAEROBIC POWER AND MUSCLE WORK CAPACITY OF LITHUANIAN BASKETBALL PLAYERS

Rūtenis Paulauskas

Lithuanian university of educational sciences,
Faculty of Sports and Health Education, Department of sport teaching, Studentų str. 39, LT–08106 Vilnius Tel. +370 698 39079
Email: rutenis.paulauskas@leu.lt

Abstract

Basketball players need to repeat performance of highly intensive work for a particular time combining them with rest intervals. However, the anaerobic power and repetitive work capacity of players has not been extensively analysed all over the world. The aim of our study is to investigate anaerobic power and specific capacity of elite and young basketball players. Methods. During competition period the indicators of anaerobic power of basketball players were measured: vertical jump power, anaerobic alactic muscular power, anaerobic capacity of intermittent work. Laboratory 5x6 second repeat-effort test with rest intervals of 24 sec were employed. Results. A statistically significant difference was observed for absolute muscle power of elite and young basketball players in the first sprint ($p<0.004$). The research on relative indicators for one kilogramme of the body mass showed that the power of elite (13.06W/kg) and young players (11.74W/kg) did not differ statistically ($p<0.09$). The fatigue index investigated in both groups did not differ ($p<0.77$). Conclusions. Vertical jump anaerobic power test showed that Lithuanian elite basketball players have higher jump but a longer contact time during the jump than young athletes. The research revealed that relative anaerobic alactic muscle power of elite basketball players did not differ from those of young (14y.o) and junior (17y.o.) athletes. The same anaerobic repetitive muscle work capacity was observed in both groups. It was established that the concentration of lactate in the blood increased after physical load and did not differ in all groups.

Keywords: *anaerobic, power, fatigue, lactate, recovery, muscles.*

Introduction

During the basketball game the duration of work may vary from a momentary throw or a pass to repetitive work that lasts for several hours. A player is referred to as possessing high endurance if he is able to demonstrate technical-tactical abilities and skills as well as physical possibilities during the match (Bompa, Haff, 2009). Muscular endurance is the capacity to sustain a static contraction or repeated muscle contractions (Wilmore et al., 2008)

Taking into account the content of basketball players', that is, duration and intensity of play actions (Trninic et al., 2000), proportions of breaks with work, emotional effect on the organism (Karipidis et al., 2001), the dominant role is assumed by repetitive work power and specific capacity (Hargreaves et al., 1992). This embraces an ability to cope with fatigue striving for achievement of best results under specific conditions of play (Mendes, Janeira, 2001).

Players need to repeat performance of highly intensive work for a particular time combining them with rest intervals. This is predetermined by the rules of the game: size of basketball court, duration of attack, duration of match, timeouts and other breaks during play (Krause et al., 2008). The biggest role is here played by the ability of the player's organism to recover fast (Buceta, 2000; Wissel, 2004). The situations, when players are given different time to play is characteristic of basketball (Carter et al., 2005). Such indicators as speed of recovery of energetic substances in muscles, functional power of circulatory and respiratory systems are among the most important indicators of basketball players' capacity (Foster et al., 1996; Kraemer, 2000). We have established that while playing basketball energy is generated resynthesizing ATP from PCr and from mixed energy source PCr - glycogen, without oxygen, i.e., working very intensively for a short period of time (Paulauskas et al., 2010). However, the anaerobic power and repetitive work capacity of players has not been extensively analysed all over the world. Being aware of repetitive work power and endurance, we could evaluate and more efficiently develop and train players.

The aim of our study is to investigate anaerobic power and specific capacity of elite and young basketball players and to carry out comparative analysis of indicators in these groups.

Material and methods

The sample included 3 groups of participants (Tab. 1). 14y.o. young basketball players (I gr.), who regularly train 4 times a week and play in school learners' competitions, 17 y.o. junior players (II gr.) who regularly

Table 1

The participants of the research

Group	*Participants*	*n=*	*Age (year)*	*Height*	*Body mass*
I	*Young players*	*12*	*14.1±0.2*	*183.7 ±3,4*	*69.5±2.2*
II	*Junior players*	*15*	*16,5±0,7*	*193,7±8,5*	*82,1±13,1*
III	*Elite players*	*13*	*25,6 ± 0,6*	*195,9 ± 1,7*	*94,7 ±4,3*

trained 6 times a week and play in Lithuanian junior basketball league and 25.6y.o elite basketball players (III gr.), who regularly train 8 times per week and play in competitions of Lithuanian Basketball League (LBL) and Baltic Basketball League (BBL) were researched.

The participants and their guardians where necessary were informed to the aims and procedures of the study before providing their written informed consent. The study was approved by Lithuanian Bioethics Committee, according to Resolution #30/2008.

During competition period the indicators of anaerobic power of basketball players were measured:

- Jump height with both legs and swinging with both hands, length of contact time and vertical jump power (Bosco et. al., 1983)
- Anaerobic alactic muscular power (AAMP) (Margaria et. al., 1966)
- Anaerobic capacity of intermittent work (AC). Laboratory 5x6 second repeat-effort test with rest intervals of 24 sec were employed (Ward, 1991; Fitszimon et al., 1993). The veloergometer "*Monark Ergomedic 894 Ea"* was employed for this test. The average muscle power during each work interval was provided in watts (W) and fatigue index (FI) was calculated applying the formula: FI (%) = 100 - (P5 / P1×100)
- Three minutes after the physical load, the concentrate of lactate in the blood was measured applying the blood lactate test meter "Lactate Pro".
- Psychomotor response time (PRT) to light stimulus was measured and 10-s Taping-test was used (Skernevičius ir kt., 2004).

All data were analysed using SPSS for Windows v. 14.0. The results were processed applying methods of descriptive statistics: *MEAN* value were calculated, dispersion was evaluated calculating standard deviation of sample (s) and according to coefficient of variation (*CV*), providing parameters (Min and Max) of dispersion area. Dispersion analysis (ANOVA) were used to compare the three groups. Statistical significance was set at $P<0,05$.

Results

The study showed that young players and adult players in a single muscle contraction power were significantly different (Tab. 2).

Table 2

Anaerobic power and psychomotor functions of elite (III) , junior (II) and young (I) basketball players

Sample		Jump height (cm)	Contact time (mls)	Vertical jump power (W)	Vertical jump power (W/kg)	AAMP (W)	AAMP (W/kg)	PRT (mls)	MF (t/10s)
I group	Mean	46,3	195,9	1700,0	23,8	1051,9	14,8	176,5	87,8
	S	5,5	40,1	440,6	5,2	139,1	1,3	8,7	12,1
	CV%	11,9	20,5	25,8	21,8	13,2	8,8	4,9	13,7
II group	Mean	49,9	195,6	2076,1	25,6	1243,3	16,3	181,0	84,1
	S	7,0	29,0	425,0	5,4	394,9	1,4	18,6	11,1
	CV%	14,0	14,8	20,5	21,1	31,7	8,5	10,2	13,3
III group	Mean	56,7	213,6	2454,7	26,2	1610,0	17,2	165,8	85,8
	S	8,6	29,7	363,7	3,8	158,1	1,1	9,1	8,7
	CV%	15,2	13,6	14,8	14,5	9,8	6,4	5,5	10,1
P-value	*I-II*	<0,18	<0,5	*<0,001*	<0,43	<0,1	*<0,01*	<0,2	<0,16
	II-III	*<0,025*	<0,1	*<0,025*	<0,5	*<0,025*	<0,51	*<0,001*	<0,48
	I-III	*<0,04*	<0,32	*<0,001*	<0,26	*<0,001*	*<0,001*	*<0,035*	<0,5

It can be seen to have influenced by jump height and length of contact time. However, we see that all three groups of players differ only in the absolute vertical jump power. While the difference of relative vertical jump power is not statistically significant. This leads to the elite players is not large enough jump height (56.7cm) and a long contact time (213mls).

The first and second group of players AAMC differ insignificantly while in group II the absolute indicator of AAMC was statistically higher ($p < 0.01$). There are indications that the elite players absolute AAMC is higher than that of young players.

PRT is the best elite basketball players – 165.8mls, while the worst are young players – 181mls. Taping test showed no differences between the groups.

Average muscle power was highest during the first sprint and then gradually decreased in all groups. A statistically significant difference was observed for absolute muscle power of elite and young basketball players in the first sprint ($p<0.004$) (Tab. 3). Significant dispersion of indicators was characteristic of three groups: coefficient of variation (CV) exceeded 20%.

Table 3

Anaerobic muscle power of elite (III), junior (II) and young (I) basketball players performing 5×6 sec repeat-effort test

Sample		*1 sprint*		*2 sprint*		*3 sprint*		*4 sprint*		*5 sprint*	
		W	*W/kg*	*W*	*W/kg*	*W*	*W/kg*	*W*	*W/kg*	*W*	*W/kg*
I group	Mean	816.00	11.74	770.83	11.09	752.75	10.81	763.75	10.94	739.08	10.59
	S	210.61	1.24	203.98	0.99	211.04	1.13	215.50	0.88	216.29	1.13
	CV%	25.81	10.52	26.46	8.91	28.04	10.43	28.22	8.07	29.26	10.66
II group	Mean	1060,07	12,78	1030,47	12,47	980,73	11,86	938,13	11,35	918,33	11,05
	S	280,77	1,66	235,80	1,20	233,64	1,19	220,94	1,08	237,42	1,16
	CV%	26,41	12,98	22,81	9.62	23,77	10,03	23,45	9,51	25,81	10.49
III group	Mean	1235.8	13.06	1207.08	12.78	1160	12.28	1144.2	12.11	1101.2	11.65
	S	289.08	2.37	264.24	2.22	272.77	2.33	265.58	2.21	249.15	2.04
	CV%	23.39	18.17	21.89	17.39	23.51	18.97	23.21	18.28	22.62	17.52
P-value	*I-II*	*<0.025*	0.10	*<0.005*	*<0.001*	*<0.005*	*<0,005*	*<0.025*	0.35	*<0.025*	0.36
	II-III	0,1	0,32	*<0,05*	0,4	*<0,05*	0,32	*<0,025*	0,15	*<0,05*	0,15
	I-III	*<0.002*	*0.09*	*<0.0001*	*<0.015*	*<0.003*	*<0.05*	*<0.0006*	*0.07*	*<0.006*	*0.25*

Note: CV – coeficient of variation

The research on relative indicators for one kg of the body mass showed that the power of elite (13.06W/kg) and young players (11.74W/kg) did not differ statistically ($p<0.09$). The dispersion of indicators of young basketball players totaled 10.5%, junior players – 12.98%, whereas it amounted 18,2% in the group of elite basketball players.

The most significant difference in muscle power was recorded in I and II groups during the second work interval. The absolute indicators of higher performance basketball players were higher by 436.2W ($p<0.0001$), the same tendency was observed in values of relative indicators, which were 1.7W/kg bigger in the group of elite players ($p<0.02$).

Power indicators decreased at similar rate in all groups during the third, fourth and fifth work intervals. The absolute muscle power of elite basketball players remained statistically higher during these work intervals, whereas relative power did not differ. Dispersion of power indicators around the mean changed insignificantly in all the intervals of work.

Table 4 present values of muscle capacity. Evaluating repetitive work capacity, the difference between the first and fifth work interval was calculated. The absolute muscle power of elite basketball players totalled 128.2W and that of junior players was higher by – 13.51W while that of young athletes was lower by 76.9W. The difference between the I-III and I-

II groups was statistically significant. The fatigue index investigated in both groups did not differ.

After the physical load, the lactate concentration in the blood was measured, which was 9.1mmol/l in the group of young basketball players, whereas the lactate concentration in the blood of professional basketball players equalled 9.5mmol/l. No statistically significant difference was recorded in all three groups. As it can be seen from the results, very large dispersion about the mean CV = 41.4% was observed in the group of young players. Dispersion of these indicators in the group of professionals is smaller compared to the other group but it is still remains large (CV = 25.5%).

Discussion

The study shows that elite players vertical jump power is higher due to the higher jump height. Other studies have shown that the NCAA DI (U.S.) players this rate can reach up to 69.9 cm, while NBA 68,5 cm (Hoffman, 2006). However, the negative is that an older Lithuanian player during the jump the length off contact time is the same as young players or even lower.

It is interesting to note that all three groups of players absolute single vertical jump power and anaerobic alactic muscle power are statistically different. While the relative, where to move only your body weight did not differ statistically between the groups (Villa, Vaquera, Rodríguez, 2009).

Hoffman (2006) argues that elite basketball player is an excellent result which aims to 21.97 W/kg, while our elite players, it was 17.2W/kg.

The study shows that during the 5x6 sec. test absolute indicators of muscle power are higher in the group of elite athletes compared to the same indicators of younger players (Fig. 1).

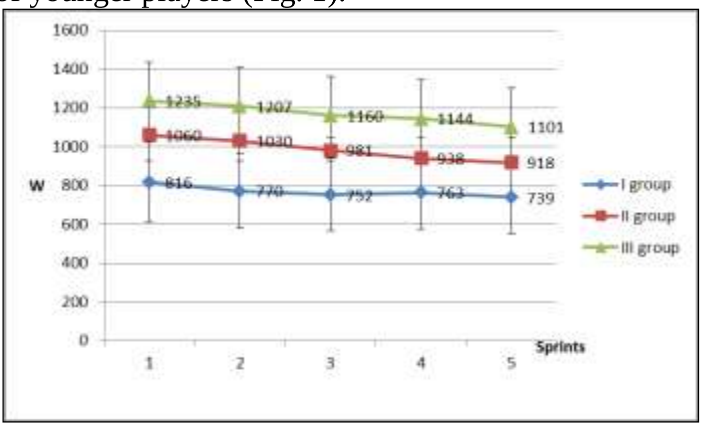

Figure 1. Change in absolute muscle power (W) of elite, junior and young basketball players performing 5×6 second repeat-effort test

However, differences in relative muscle power were observed only in the second work interval. This means that 14 year old players equal elite athletes in relative power of short muscle work. It can be stated that the average relative anaerobic alactic muscle power of professionally trained athletes is not sufficient. However, both relative and absolute anaerobic alactic muscles powers are significant because in play situations an athlete has to overcome not only power of own body gravity but also to cope with a personal contact with an opponent.

Ellis et al., (2000) point out that in game situations high average indicator is of utmost importance during all the five work intervals. Average relative muscle power of the researched elite basketball players equalled 12.4W/kg, and the average relative muscle power in the group of junior basketball players totalled 11.9W/kg, young players – 11W/kg (Fig. 2).

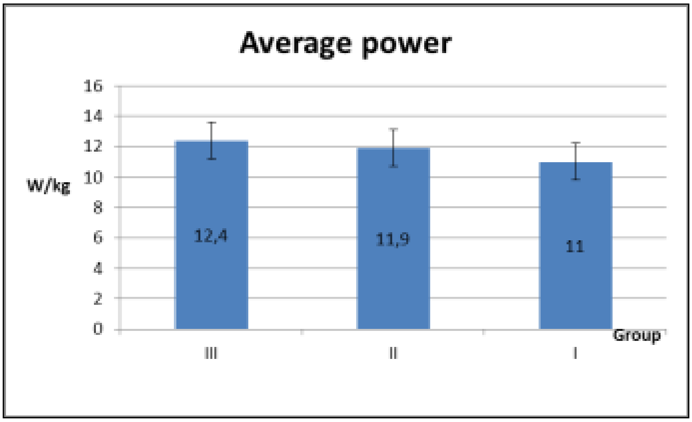

Figure 2. Average working power during 5×6 sec repeat-effort test of elite basketball players (III gr.), junior basketball players (II gr.) and young basketball players

Applying this test it was necessary to evaluate change in power of short muscle work under conditions of short recovery time. A decrease in work power is expressed through fatigue index (FI), whose lower value refers to better endurance of muscle power. Table 4 contains the fatigue index of anaerobic alactic muscle powers, which is particularly important for basketball and other sportive games. It can be seen that young players fall behind adult ones. Astrand and Rodahl (1986), Wilmore, Costill and Kenney (2008) point out that the prevailing duration of anaerobic alactic energy production reactions ranges from 6 to 10sec. Working at maximum intensity for such a period, phosphocreatine (PCr) is enough resynthesising ATP.

Table 4

Muscle power decrement and fatigue index of elite basketball players (III), junior (II) and young players (I) between 1 and 5 as well as concentration of lactate in the blood

Sample		*1-5 sprints*			*La*
		W	*W/kg*	*FI (%)*	*mmol/l*
I group	Mean	76.92	1.15	9.74	9.12
	S	38.08	0.57	4.65	3.77
	CV%	49.51	49.79	47.77	41.40
II group	Mean	141,74	1,73	13.37	8,82
	S	52.31	0,61	4.36	3,97
	CV%	36,09	35.01	49,15	35,23
III group	Mean	128.23	1.35	10.11	9.48
	S	71.80	0.70	4.42	2.42
	CV%	55.99	52.33	43.77	25.52
P-value	*I-II*	*<0,025*	0,25	0,45	0,63
	II-III	<0,5	0,15	0,89	0,67
	I-III	*<0.038*	*0.505*	*0.990*	*0.772*

According to the above mentioned authors, recovery depends on a big number of factors but the main processes occur within 1.5 – 3min. During the conducted research, the rest period between work intervals amounted 24 sec. Therefore, the main factor predetermining better capacity of anaerobic alactic muscle capacity could be a bigger reserve of PCr accumulated in muscles as well as higher activity of creatine-kinase (Kraemer, Ratamess, 2005).

The fatigue index has no significant differences in all three groups. Stapf (2000) states that good fatigue index of repetitive work capacity of elite Australian basketball player's equals 5%. The FI of elite basketball players in the research sample was 10.1%, similar to that of young players (9.7%) and junior (13.37%) (Fig. 3).

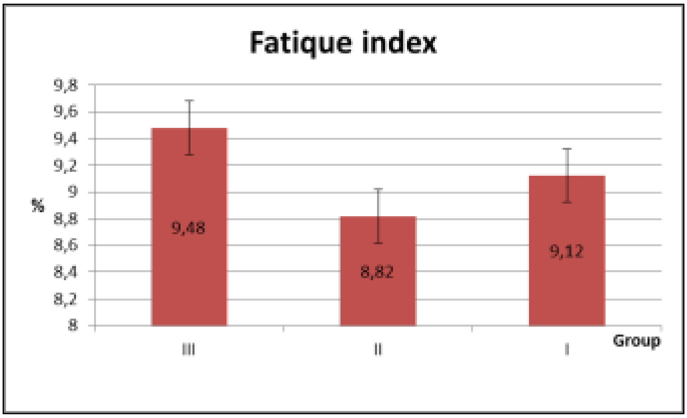

Figure 3. Fatique index during repeat-effort test of elite basketball players (III gr.), junior basketball players (II gr.) and young basketball players (I)

Fatigue index is not correlated with a large number of indicators of physical development and physical fitness (Fitszimons et al., 1993). Evaluating effect of repetitive work on activity of glycolytic reactions in muscles, the concentration of lactate in the blood was measured. The concentration in the blood of all the basketball players considerably exceeded lactate accumulation threshold (LAT) and was the same in all groups. This shows that the amount of PCr, which is necessary for ATP resynthesis, starts decreasing during repetitive work and the activity of anaerobic glycolytic reactions increases. However, the dispersion of indicators around the mean show that contribution of energy sources to capacity of repetitive work is very individual.

Conclusions

1. Vertical jump anaerobic power test showed that Lithuanian elite basketball players have higher jump but a longer contact time during the jump than young athletes. While jump height power of elite basketball players muscle is less than the world's elite players.
2. The research revealed that relative anaerobic alactic muscle power of elite basketball players did not differ from those of young (14y.o) and junior (17y.o.) athletes.
3. The same anaerobic repetitive muscle work capacity was observed in both groups.
4. It was established that the concentration of lactate in the blood increased after physical load and did not differ in the two groups.

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