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Original Article

Anthropometric and anaerobic characteristics of young basketball players

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Abstract:
Basketball is a sport in which the development of anaerobic power is of great importance as short intense workouts are part of the game. The purpose of this study is to determine the anaerobic capacity of adolescent basketball players. The study involved 15 basketball players aged 15.5 ± 1.2 years. The anaerobic test used is the Wingate test. The test results indicate that athletes have high peak power (522.9 ± 113.3 W) and high relative peak power (7.1 ± 0.5 W / kg). Blood lactate concentrations after Wingate anaerobic test significantly differ from those before the test (11.35 ± 1.62 mmol/l on the 1st min as compared with 2.57 ±0.30 mmol/l before the test). These results make it possible to conclude that training with adolescents is conducted properly in the direction of anaerobic capacity development. The study is the beginning of a longitudinal tracking on the development of these basketball players and will be used for tracking the changes every six months, which will allow the coaches to make appropriate changes in the training sessions.
KeyWords: adolescent basketball players, somatotype, Wingate test, blood lactate concentration

Introduction

Basketball is defined as a high-intensity sport in which anaerobic metabolism plays a key role (Castagna et al., 2009; Hoffman et al.,1999). Anaerobic contribution to basketball is known to be important for tactical movements (i.e. defensive / offensive transitions) and technical actions such as shooting, jumping, blocking, passing, staging and other technical movements (Castagna, et al., 2010; Delextrat & Cohen, 2008; Hoffman, et al., 1999).In basketball, successful performance depends on several fitness components (i.e. speed, agility and vertical jump height) that are anaerobic in nature (Hoffman, et al., 2000). These components must be repeated, with minimal performance decrease during the game. There is currently no special test that is accepted as a standard measure of anaerobic power of basketball players.

Currently, Wingate anaerobic laboratory test with a bicycle ergometer is accepted as the gold standard for determining anaerobic capacity. During the test, the subjects rotated the pedals at constant resistance for 30 seconds. The test requires a combination of phosphoryl, glycolytic and aerobic power. Peak power (PP) corresponds to the ability of a muscle to produce short-term mechanical power (peak phosphoryl power), while mean power (MP) best represents the glycolytic power of the legs. Wingate anaerobic test has been proven to be reliable and valid in children and adolescents with a variety of chronic conditions. Some authors propose shortening the Wingate test in children and conducting it instead of 30 seconds, to 20 seconds (Chia, et al., 1997), the reason being that children work mainly in aerobic mode, even at high intensity loads.

Coaches and sports professionals are aware that fitness and performance tests for athletes are an important component in the design of training programs and in the analysis of the athlete's progress in such programs. Therefore, the purpose of this study is to initiate a long-term trackingof the anaerobic capacity of adolescent basketball players, which will allow coaches to monitor the development of athletes as a result of training sessions.

Material & methods

Participants

The study was conducted at the end of October 2019. It was approved by University Research Ethics Committee of South-West University, Blagoevgrad. Before being included in the study basketball players and their parents learn about the methods that will be used, as well as the objectives of this study. Parents sign a declaration of informed consent. In the study participated 15young basketball players from Eurobasket team - Blagoevgrad (age – 15.5±1.2 years, height – 175.9±7.9 cm, weight – 63.9±11.1). The subjects attend the Center for Functional Studies in Sports and Kinesitherapy - SWU "NeofitRilski", Blagoevgrad, where all the researches were carried out. The anthropometric measurements were performed on the first venue in the center, and on the second venue they performed the test of anaerobic capacity.

Anthropometric measurements and determination of somatotype Prior to the study, participants were asked to refrain from physical exercise, food, and fluid intake. Height and weight were measured as well as a body

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composition with a bioelectric impedance analyzerIoi 353. From the obtained results Body Mass Index (BMI), Body Fat Mass (MBF) and Soft Lean Mass (SLM) were used. MBF was calculated by subtracting lean body mass from weight. SLM consists of total body water and proteins. These are the skeletal muscles that generate muscle strength and the visceral muscles of the organs such as the heart, stomach, and so on.

Determination of the somatotype was performed by the Heath-Carter method, with three skin folds (triceps, subscapular, supraspinale), two diameters (humerus, femur) and two girts (arm and calf).

Wingate test

The test was carried out with the Monarch 828 E mechanically-brakedcycleergometer. The Wingate typically involves 30 seconds of maximal exercise on either an arm-crank or leg-cycle ergometer. The testing device is a mechanically-braked cycle ergometer. Following a five-minute warm-up, which includes three sprints at varying resistances, the athlete may get off the bike during a three-minute recovery or stay on the bike and spin lightly. The athlete then begins to pedal as fast as possible without any or minimal resistance. Within three seconds, a fixed resistance is applied to the flywheel and the athlete continues to pedal "all out" for the duration of the test (e.g. 30 seconds). The resistance is applied to the flywheel by adding a predetermined amount of weight to the bicycle's weight tray. The resistance is a percentage of the athlete's body weight. At the end of the test, the maximum power (Peak Power) is set for 5 seconds. This is the maximum power the person can develop during the first 5 seconds. The relative maximum power is determined by dividing the maximum weight of the subject's weight. The system also allows determining the average power for 30 seconds.

Determination of blood glucose and lactate

Measurement is performed with BIOSEN C Line biochemical analyzer of the German company EKF Diagnostic. The determination of glucose and lactate in the blood is based on electrochemical measurement with a chip sensor. The sample is aspirated and entered into the system automatically. The sample contains β-D-glucose and L-lactate, which are converted by enzymes (immobilized on the chip sensors) into glucuronic acid and pyruvate, respectively, to form hydrogen peroxide. It releases free electrons that generate electrical current that is recorded by the electrode of the device. The resulting electrical signal is proportional to the concentration of glucose and lactate in the sample.

Blood was collected four times: before warm-up procedure and three times after the Wingate test – on the first, third and fifth minute.

Data collection and analysis

GraphPad Prism (Ver 3.0) was used to process and analyze the data. The mean values and standard deviations of all variables are calculated by descriptive statistics. Experimental data are presented in two ways: - as mean ± SD; and - as individual values for each person under study. For statistical analysis of the results t-test, Wilcoxon Signed Rank Test, One Way ANOVA, Kruskal-Wallis test and Dunn's Multiple Comparison Test as a post-test were used, the Graph Pad Prism statistical software was used to determine the Pearson's correlation coefficient and to generate graphs.

Results

The anthropometric data and somatotype components were presented in table 1and the somatogram is presented on figure 1.

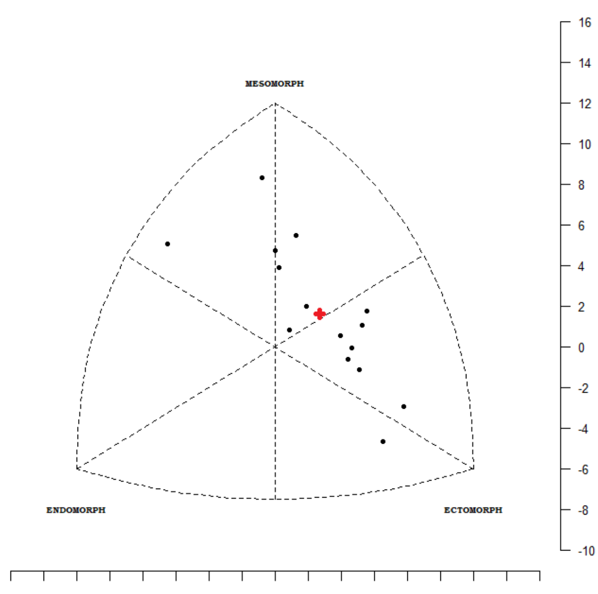

Fig. 1. Somatogram of the subjects (red – mean somatotype).

Table 1. The anthropometric data of the subjectsand somatotype components of the subjects
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ID	Age, years	Height, cm	Weight, kg	LBM, kg	MBF, kg	SLM, kg	BMI, kg/m^2	Endomorphy	Mesomorphy	Ectomorphy
NH1	15	170	59.5	50.7	8.8	47.2	20.6	2.6	5.6	3.2
NH2	17	178	85.1	64.5	20.6	59.6	26.9	4.4	5.3	1.1
NH3	17	156	50.7	44.4	6.3	41.5	20.8	2.7	6.6	2.3
NH4	14	174	55.9	50.3	5.6	47	18.5	2.2	2.9	4.7
NH5	14	180	57.4	54.7	3.3	50.7	17.7	1.7	2.2	5.6
NH6	17	184	76.1	64	12.1	59.6	22.5	2.8	3.4	3.2
NH7	15	175	57.7	54.5	3.2	51	18.8	1.9	3.8	4.6
NH8	16	187	85.9	70	15.9	65	24.6	2.3	4.3	2.4
NH10	16	185	62.8	57.4	5.4	53.7	18.3	2.0	3.1	4.3
NH11	15	182	66.5	59.5	7	55.5	20.1	1.6	3.9	4.4
NH12	16	170	53.6	49.6	4	46.4	18.5	2.1	3.4	4.1
NH13	15	177	62.3	55.5	6.8	51.9	19.9	2.4	3.9	3.4
NH14	14	179	69	61.7	7.3	57.6	21.5	2.4	3.9	3.4
NH15	17	171	64.4	53.9	10.5	50.1	22	2.7	5.0	2.6
NH16	14	170	51.8	46.9	4.9	43.9	17.9	2.6	3.4	4.8
Mean	15.5	175.9	63.9	55.8	8.1	52.0	20.6	2.4	4.0	3.6
±SD	1.2	7.9	11.1	7.1	4.9	6.5	2.6	0.7	1.1	1.2

LBM – leanbodymass**, MBF** – massofbodyfat**, SLM** – softleanmass**, BMI** – bodymassindex**, Mean** – mean value, **SD –** standard deviation.

Anaerobic capacity was determined by Wingate test and the peak power, minimal power, relative peak power and anaerobic fatigue, as well as blood lactate and glucose concentrations before and on the 1st, 3rd and 5th minutes after the test were presented in table 2. It was expected to obtain correlations between anthropometric date and somatotype and they were as follows: endo component and MBF (r=0.81, p=0.0003), ecto component and MBF (r=-0.84, p=0.0001), BMI and endo component (r=0.78, p=0.0007), BMI and meso component (r=0.54, p=0.04), BMI and ecto component (r=-0.91, p<0.0001), and age and ecto component (r=-0.66, p=0.008). All possible correlations between anthropometric data, Wingate test results and blood lactate concentrations before and after Wingate test were checked and presented in table 3
There are no correlations between somatotype and Wingate test results and blood lactate concentrations.

Dicussion

The study involved 15 young basketball players from the EuroBasketball Club at the age 15.5±1.2 years. The anthropometric data are presented in Table 1. The subjects participate in competitions in two age groups. At this age the range the differences in the growth and development of adolescents are wide and this could be seen from Table 1. Height varies greatly between 156 - 187 cm, respectively weight - 50.7 - 85.9 kg, as well as other indicators of body composition. All differences were statistically significant (t test, p <0.0001). The height and weight of young basketball players are comparable to the literature data (Kostopoulos, 2015; Turna & Kılınç, 2018) for individuals of the same age. The study participants were divided into four age groups (14 years old - four, 15 years old – five, 16 years old – three and 17 years old – four) and we found thatthere was no statistically significant difference in height, weight, body weight, and body mass index between ages.

To be successful, a basketball player must be tall. All the subjects are tall, some comparable to elite adult basketball players. Other young people have the potential to achieve this height, which will be tracked over time. Not only height is important in the basketball game. Large bodies also give players an advantage, as this is a guarantee for greater power and successful fighting on the field and under the basket. Muscle mass is strongly influenced by training and is an indicator of its effectiveness. In addition to measuring body composition, muscle mass can also be determined by somatotype determination. The somatotype of the subjects was determined by the Heath-Carter method and the results are presented in Figure 1. Even with elite adult basketball players, there are large differences in height, weight and body type. The mean somatotype in the study group was 2.4-4.0-3.6, with the endomorphic component varying from 1.6 to 4.4, the mesomorphic from 1.6 to 6.6, and the ectomorphic from 1.1 to 5.6.

Table 2. Results from Wingate test and blood lactate and glucose concentrations were measured before and after Wingate test.

ID	PP (W)	LP (W)	RPP (W/kg)	AF (%)	lactate, mmol/l				glucose, mmol/l			
					before	1 min	3 min	5 min	before	1 min	3 min	5 min
NH1	518	358	7.63	30.89	2.49	14.22	15.64	18.16	4.81	4.05	4.64	4.80
NH2	688	427	7.14	37.94	2.37	9.70	11.71	11.39	3.80	4.12	4.30	4.22
NH3	362	275	6.21	24.03	2.24	9.84	12.10	12.41	5.59	5.18	5.40	5.67
NH4	352	293	6.13	16.76	2.91	9.51	10.56	11.33	3.82	3.88	4.43	4.74
NH5	453	334	6.83	26.27	2.71	10.30	11.50	11.19	4.29	4.14	3.97	4.28
NH6	625	454	7.4	27.36	2.43	11.57	10.72	10.76	4.06	4.95	5.18	4.97
NH7	496	354	7.61	28.63	2.61	9.01	11.33	11.57	3.77	3.79	3.86	3.87
NH8	737	521	7.51	29.31	2.79	10.34	12.24	11.44	3.82	4.09	4.46	4.71
NH10	550	361	7.23	34.36	3.10	11.50	11.67	13.15	5.43	6.40	6.56	6.37
NH11	578	422	7.68	26.99	2.59	12.18	15.54	14.70	5.09	4.71	5.04	4.50
NH12	401	299	6.97	25.44	2.49	12.40	14.19	13.59	4.89	6.24	5.79	5.22
NH13	581	359	7.56	38.21	2.14	11.93	14.64	15.05	5.72	5.96	6.02	5.94
NH14	551	430	6.82	21.96	2.19	12.13	15.11	14.81	6.50	5.69	5.61	5.05
NH15	540	378	6.84	30.00	2.37	11.14	13.33	11.67	6.76	5.65	5.72	5.74
NH16	412	242	6.87	41.26	3.09	14.48	16.00	16.40	5.58	5.17	5.64	4.65
Mean	522.9	367.1	7.1	29.29	2.57	11.35	13.09	13.17	4.93	4.93	5.11	4.98
±SD	113.3	74.5	0.5	6.54	0.30	1.62	1.93	2.22	0.99	0.90	0.80	0.70

PP – peakpower**, LP –** lowerpower**, RPP –** relative peak power, **AF** – anaerobic fatigue, **Mean –** mean value, **SD –** standard deviation.

The distribution of somatotypes in the group covers the area close to ectomorphism, except for two cases that are more pronounced endomorphic mesomorphs. The ectomorphic mesomorphic type is the type characteristic in most team sports and in elite athletes this component is highly expressed (Gryko, et al., 2018; Martínez, et al., 2014; Gutnik, et al., 2015). The young basketball players fall into the ectomorphic mesomorph category, which is further evidence of the correct selection of athletes by the coach and the right approach of training.

The first study of the anaerobic potential of the study group was conducted. Currently, Wingate anaerobic laboratory test with a bicycle ergometer is accepted as the gold standard for determining anaerobic capacity. During the test, subjects pedal at constant resistance for 30 seconds. The test requires a combination of phosphoryl, glycolytic and aerobic power. Peak power (PP) corresponds to the ability of a muscle to produce short-term mechanical power (peak phosphoryl power), while mean power (MP) best represents the glycolytic power of the legs. Wingate anaerobic test has been proven to be reliable and valid in children and adolescents with a variety of chronic conditions.

The Wingate test determines anaerobic capacity, which is extremely important in basketball. Many of the exercises performed require both technique and high explosive power. Children work mainly in aerobic mode, but under the influence of training, their body gradually adapts to the anaerobic regime. Some important features between children and adults and their responses to physical activity indicate that children have not matured enough. In many sports, lack of maturity works to the detriment of children and they cannot meet the standards of older and young adults. The biggest differences are related to anaerobic energy generation, with children having serious functional disabilities compared to adults when performing heavy (supramaximal) loads lasting from 10 to 60 s. At an early age, both boys and girls have significant similarities, but during adolescence boys develop functionally better, leading to better athletic performance. The adolescents have already developed their anaerobic capacityto some extent, as the subjects have been involved in sports and in particular basketball for 5-6 years. This time is enough to lead to some adaptations. Adapted muscle, in addition to working in anaerobic mode, begins to accumulate larger amounts of glycogen to use at high intensity loads and also tolerates higher lactate concentrations. The results of the Wingate test are presented in Table 2. The results show that the subjects have high power in the test and are close to the results of elite European basketball players (Delextrat & Cohen, 2008).

Average power and fatigue index (the difference between the maximum and minimum power of the Wingate test as a percentage of maximum power) indicate the capacity of the glycolytic system, especially in combination with measurement of post-loading blood lactate concentration (Lee, 1993).

The lactate concentration at 1, 3 and 5 minutes after the test differs statistically from the pre-test concentration. Evidence of higher anaerobic capacity is the ability of a muscle to tolerate higher lactate concentrations.

The blood glucose concentration does not change before and after the Wingate test.

The relationships between all the data obtained are analyzed. As expected, significant correlations were found between anthropometric data and somatotype components: the endomorphic component and MBF ($r = 0.81$, $p = 0.0003$), the ectomorphic component and MBF ($r = -0.84$, $p = 0.0001$), the BMI and the endomorphic component ($r = 0.78$, $p = 0.0007$), BMI and mesomorphic component ($r = 0.54$, $p = 0.04$), BMI and ectomorphic component ($r = -0.91$, $p < 0.0001$), and age and ectomorphic component ($r = -0.66$, $p = 0.008$). These correlations are expected because the amount of adipose tissue determines the size of the endomorphic component as well as the body mass index. With age, the ectomorphic component normally decreases as the mass increases and with it the amount of muscle and fat tissue.

Table 3. Relationships between obtained parameters

	Age, years	Height, cm	Weight, kg	LBM, kg	MBF, kg	SLM, kg	BMI, kg/m^2	PP (W)	LP (W)	RPP (W/kg)	AF (%)	lactate, mmol/l			
												before	1 min	3 min	5 min
Age, years		ns	ns	ns	0.57 p=0.059	ns	0.6 p=0.018	ns	ns	ns	ns	ns	ns	ns	ns
	Height, cm		0.67 p=0.006	0.84 p<0.0001	ns	0.85 p<0.0001	ns	0.71 p=0.0031	0.73 p=0.002	0.55 p=0.035	ns	ns	ns	ns	ns
		Weight, kg		0.94 p<0.0001	0.88 p<0.0001	0.94 p<0.0001	0.87 p<0.0001	0.93 p<0.0001	0.92 p<0.0001	ns	ns	ns	ns	ns	ns
			LBM, kg		0.68 p=0.0051	0.99 p<0.0001	0.68 p=0.0055	0.95 p<0.0001	0.95 p<0.0001	ns	ns	ns	ns	ns	ns
				MBF, kg		0.67 p=0.0064	0.97 p<0.0001	0.77 p=0.0007	0.69 p=0.0048	ns	ns	ns	ns	ns	ns
					SLM, kg		0.67 p=0.067	0.91 p<0.0001	0.95 p<0.0001	0.52 p=0.049	ns	ns	ns	ns	ns
						BMI, kg/m2		0.76 p=0.0011	0.72 p=0.0026	ns	ns	ns	ns	ns	ns
							PP (W)		0.92 p<0.0001	0.68 p=0.0056	ns	ns	ns	ns	ns
								LP (W)		0.56 p=0.03	ns	ns	ns	ns	ns
									RPP (W/kg)		ns	ns	ns	ns	ns
										AF (%)		ns	ns	ns	ns

LBM – leanbodymass**, MBF –** massofbodyfat**, SLM –** softleanmass**, BMI –** bodymassindex**, PP –** peakpower**, LP –** lowerpower**, RPP –** relative peak power, **AF** – anaerobic fatigue.

No correlation was found between the somatotype components and the results of the Wingate test, as well as blood lactate concentrations.

The relationships between anthropometric parameters, Wingate test results, and blood lactate concentrations were analyzed. All possible relationships are presented in Table 3, which also lists the Pearson coefficients where there is a dependency.

A normal tendency with age is to increase body fat and, accordingly, body mass index. Height affects weight and is directly related to muscle mass, maximum, minimum and relative maximum power. Weight is expected to correlate well with body fat, muscle mass, body mass index, maximum and minimum power. Body fat is related to body mass index as well as maximum and minimum power. There are significant correlations between muscle mass and maximum and minimum power, as well as a moderate correlation with relative maximum power. Body mass index affects maximum and minimum power in the Wingate test.

Conclusions

As a conclusion of this study we could say that the adolescent athletes showed significant anaerobic capacity values, with results close to that of elite basketball players. The work presented here is the beginning of a long-term study of adolescent basketball players. The results obtained provide valuable information to the trainer on the development of the athletes, as well as ideas for changes in training to improve certain qualities (in this case anaerobic capacity).

Conflicts of interest. The authors declare that there is no conflict of interest.

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