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Anthropometric indicators and aerobic exercise capacity in young basketball players

Indicatorii antropometrici şi capacitatea aerobă de efort la jucătorii de baschet tineri

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Abstract

Background. The current tendencies of modern basketball involve multilateral and specific high level physical training, adapted to the peculiarities of age and level of training.

Aims. The anthropometric indicators and exercise capacity in the pre-competition period were studied in junior basketball players with specific training and pupils with general sports training.

Methods. Our research was performed in 6 groups (n=10 subjects/group), group I (15 years), group II (16 years), group III (17 years), controls, and group IV (15 years), group V (16 years), group VI (17 years), athletes. The monitored anthropometric parameters were: weight, height and indirectly, the body mass index. The exercise capacity indicators were: maximal O_2 consumption and maximal aerobic power.

Results. Insignificant increases in the weight, height and body mass index were found in the athlete groups compared to the non-athlete groups, except for the 17-year group for height. Significant increases in VO_2 max and maximal aerobic power were found in athletes compared to non-athletes of the same age.

Conclusions. Specific sports training determines an increase in aerobic exercise capacity and maximal aerobic power in young basketball players.

Key words: basketball players, VO_2 max, anthropometric indicators, physical exercise.

Rezumat

Premize. Tendinţele actuale ale baschetului modern presupun o pregătire fizică multilaterală şi specifică la un nivel ridicat, adaptată particularităţilor vârstei şi nivelului de pregătire.

Obiective. S-au studiat indicatorii antropometrici şi capacitatea de efort în perioada precompetiţională la jucătorii de baschet juniori cu pregătire specifică şi la elevii cu pregătire sportivă generală.

Metode. Cercetările au fost efectuate pe 6 loturi (n=10 subiecţi/lot), lotul I (15 ani), lotul II (16 ani), lotul III (17 ani), martori şi lotul IV (15 ani), lotul V (16 ani), lotul VI (17 ani), sportivi. Indicatorii antropometrici determinaţi au fost: greutatea înălţimea şi indirect indicele de masă corporală. Indicatorii pentru capacitatea de efort au fost: consumul maxim de O_2 şi puterea maximă aerobă.

Rezultate. Se observă creşteri nesemnificative ale masei corporale, înălţimii şi indicelui de masă corporală la loturile de sportivi faţă de loturile de nesportivi, cu excepţia loturilor de 17 ani pentru înălţime. Se observă creşteri semnificative ale VO_2max şi a puterii maxime aerobe la sportivi, faţă de nesportivii de aceeaşi vârstă.

Concluzii. Pregătirea sportivă specifică determină creşterea capacităţii aerobe de efort şi a puterii maxime aerobe de efort la jucătorii de baschet tineri.

Cuvinte cheie: baschetbalişti, VO_2max, indicatori antropometrici, efort fizic.

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Introduction

The extremely high requirements in modern basketball, characterized by the tendency towards exercise intensification, increase in the speed of movement and execution, lead to the fatigue of the central nervous system, manifesting by the decrease of concentration capacity, and to the overstrain of the myoarthrokinetic, acoustic and vestibular analyzers, which ensure the balance function during jumping.

Primary selection in basketball takes place at the age of 7-9 years based on the following indicators: very good health; good physical development (tall or very tall children, with a good weight balance).

Secondary selection is performed at the age of 12-14 years. A secondary post-selection study for the age of 14-15 years presents the following data: guards have a height of 185-188 cm, forwards 190-196 cm, and centers 200 cm, with an arm span of 195-205 cm and a longitudinal and transverse palmar diameter of 20-21 cm, 24-25 cm, respectively (Dragnea, 1996).

Final selection is intended for athletes that have undergone the previous selection stages and refers to evaluation under playing conditions, which is the real selection criterion that evidences talent.

According to Colibaba & Sufariu (2005), the motor structure of play determines three types of functional strain: aerobic, with an alternative or predominantly mixed manifestation; anaerobic alactacid; anaerobic lactacid. The alternation or the combination of strains occurs within the limits of the following relative values: 10-30 sec – anaerobic alactacid + anaerobic lactacid; 30-90 sec – anaerobic lactacid + anaerobic alactacid; 90-120 sec – anaerobic lactacid + aerobic.

Hypothesis

Height, weight, the body mass index and physiological data may significantly contribute to the improvement of selection methods in the case of young basketball players, but they cannot determine in a high proportion individual sports performance.

Material and methods

Research protocol

a) *Period of the research*

The research was approved by the Ethics Board of the ”Iuliu Haţieganu” University of Medicine and Pharmacy Cluj-Napoca and the informed consent of the subjects' parents was obtained. The determination period was May 2012 for groups I, II and III, and for groups IV, V and VI, three weeks in May 2013, after training.

Subjects and groups

The determinations were performed in 6 groups (n=10 subjects/group):

- 3 control groups; CI (15 years), CII (16 years), CIII (17 years)
- 3 groups of athletes; AIV (15 years), AV (16 years), AVI (17 years)

The groups of young professional athletes were members of the ”U Mobitelco” Club Cluj-Napoca and the control groups were pupils of the Informatics High School in Cluj-Napoca.

b) *Tests applied*

Anthropometric indicators

- direct - weight (G) in kg, by weighing with a digital scale, and height (H) measured in cm using a stadiometer, for the determination of the body mass index (BMI);
- indirect - BMI, calculated using the formula G/H^2 (kg/m^2).

Aerobic exercise capacity (AEC) was indirectly investigated using the Åstrand-Ryhming method (Drăgan 2002); 6 minute submaximal exercise, performed on the Ergoline 900 cycloergometer (commercialized by Tehnomed SRL, Cluj-Napoca), with a 40-80/min rotation and 2.5 W/Kg intensity, maintained constant throughout the duration of the test.

The aerobic exercise indicators were:

- maximal O_2 consumption in ml (VO_2max);
- maximal aerobic power in ml/kg ($MAP = VO_2max/G$);

c) *Statistical processing*

Statistical processing was performed using the Excel application (Microsoft Office 2007) and the StatsDirect v.2.7.2 software. The results were graphically represented using the Excel application (Microsoft Office 2007).

Results

a) *Comparative statistical analysis of anthropometric indicators in the studied groups*

Body mass (Table I)

The statistical analysis of body mass values, *considering all groups*, showed very statistically significant differences between at least two of the groups (p=0.001).

The statistical analysis of body mass values, *considering all control groups*, revealed statistically significant differences between at least two of the groups (p=0.0322).

The statistical analysis of the body mass values, *considering all athlete groups*, indicated highly statistically significant differences between at least two of the groups ($p=9.64x10^{-5}$).

The statistical analysis of body mass values *for unpaired samples* showed:

- highly statistically significant differences between groups A15-A16 and A15-A17 ($p<0.001$)
- statistically significant differences between groups C15-C16 and C15-C17 ($p<0.05$).

Table I

Comparative analysis of body mass values (measured in kg) in the studied groups and statistical significance.

Group	Mean	SE	Median	SD	Min.	Max.	Statistical significance (p)	
C15	59.3	3.7861	56	11.9727	45	80	C15-C16: 0.0218	C15-A15: 0.1004
A15	52.2	3.2755	50.5	10.3580	40	76	C15-C17: 0.0243	C16-A16: 0.9717
C16	72.5	4.3621	71.5	13.7941	55	95	C16-C17: 0.8541	C17-A17: 0.7598
A16	72.3	3.4417	72	10.8837	50	89	A15-A16: 0.0005	
C17	73.7	4.7259	72.5	14.9447	55	105	A15-A17: 0.0002	
A17	72	2.7203	72.5	8.6023	59	89	A16-A17: 0.9463	

Height (Table II)

The statistical analysis of height values, *considering all groups*, evidenced highly statistically significant differences between at least two of the groups ($p=3.42x10^{-8}$).

The statistical analysis of height values, *considering all control groups*, showed very statistically significant differences between at least two of the groups (p=0.00345).

The statistical analysis of height values, *considering all athlete groups*, revealed highly statistically significant differences between at least two of the groups ($p=3.31x10^{-6}$).

The statistical analysis of height values *for unpaired samples* evidenced:

- highly statistically significant differences between groups A15-A16 and A15-A17 (p<0.001)
- very statistically significant differences between groups C15-C17 (p<0.01)
- statistically significant differences between groups C15-C16 and C17-A17 (p<0.05).

Body mass index (Table III)

The statistical analysis of body mass index (BMI) values, *considering all groups*, showed no statistically significant differences between the groups (p=0.3281).

The statistical analysis of BMI values, *considering all control groups*, revealed no statistically significant differences between the groups (p=0.2829).

The statistical analysis of BMI values, *considering all athlete groups*, evidenced no statistically significant differences between the groups (p>0.05)

The statistical analysis of BMI values *for unpaired samples* showed no statistically significant differences between the groups (p>0.05).

b) *Comparative statistical analysis of exercise capacity in the studied groups*

Maximal oxygen consumption - VO_2 max (Table IV)

The statistical analysis of VO_2 max values, *considering all groups,* evidenced highly statistically significant differences between at least two of the groups ($p=1.07x10^{-8}$).

The statistical analysis of VO_2 max values, *considering all control groups*, showed statistically significant differences between at least two of the groups (p=0.0283).

The statistical analysis of VO_2 max values, *considering all athlete groups*, revealed highly statistically significant differences between at least two of the groups (p=0.0003).

The statistical analysis of VO_2 max values *for unpaired samples* showed:

- highly statistically significant differences between groups A15-A17 and C17-A17 (p<0.001)
- very statistically significant differences between groups A15-A16 and C16-A16 (p<0.01)
- statistically significant differences between groups C15-C16, C15-C17 and C15-A15 (p<0.05).

Maximal aerobic power (Table V)

The statistical analysis of maximal aerobic power (MAP), *considering all groups*, showed highly statistically significant differences between at least two of the groups (p<0.0001).

The statistical analysis of MAP values, *considering all control groups*, evidenced no statistically significant differences between the groups (p=0.4033).

The statistical analysis of MAP values, *considering all athlete groups*, indicated statistically significant differences between at least two of the groups (p=0.0206).

The statistical analysis of MAP values *for unpaired*

Table II

Comparative analysis of height values (measured in m) in the studied groups and statistical significance.

Group	Mean	SE	Median	SD	Min.	Max.	Statistical significance (p)	
C15	1.68	0.0294	1.70	0.0931	1.47	1.80	C15-C16: 0.0138	C15-A15: 0.183
A15	1.61	0.0408	1.61	0.1289	1.39	1.85	C15-C17: 0.0045	C16-A16: 0.2739
C16	1.78	0.0210	1.76	0.0665	1.68	1.87	C16-C17: 0.5285	C17-A17: 0.0113
A16	1.82	0.0284	1.81	0.0899	1.68	1.96	A15-A16: 0.0006	
C17	1.80	0.0208	1.78	0.0657	1.73	1.92	A15-A17: 3.75×10^{-5}	
A17	1.88	0.0223	1.88	0.0705	1.75	1.96	A16-A17: 0.0899	

Table III

Comparative analysis of BMI values (measured in kg/m^2) in the studied groups and statistical significance.

Group	Mean	SE	Median	SD	Min.	Max.	Statistical significance (p)	
C15	20.94	0.8746	20.45	2.7659	18.29	26.73	C15-C16: 0.2176	C15-A15: 0.7245
A15	20.60	1.6898	19.87	5.3437	13.15	29.50	C15-C17: 0.1655	C16-A16: 0.59
C16	22.82	1.0243	23.14	3.2392	18.62	28.06	C16-C17: 0.9061	C17-A17: 0.0577
A16	21.97	1.1706	21.47	3.7018	17.10	30.12	A15-A16: 0.516	
C17	22.65	0.9464	22.62	2.9928	18.38	28.48	A15-A17: 0.8764	
A17	20.31	0.6431	19.95	2.0335	17.24	23.55	A16-A17: 0.2363	

Table IV

Comparative analysis of VO_2 max values (measured in ml/min) in the studied groups and statistical significance.

Group	Mean	SE	Median	SD	Min.	Max.	Statistical significance (p)	
C15	1970	97.8093	1950	309.3003	1600	2600	C15-C16: 0.0217	C15-A15: 0.0408
A15	2360	145.4495	2200	459.9517	1800	3400	C15-C17: 0.0187	C16-A16: 0.0016
C16	2360	119.4432	2450	377.7124	1700	2800	C16-C17: 0.8662	C17-A17: 0.0002
A16	3040	139.2041	3050	440.2020	2100	3600	A15-A16: 0.0034	
C17	2390	128.6252	2350	406.7486	1800	3200	A15-A17: 0.0004	
A17	3140	88.4433	3200	279.6824	2600	3600	A16-A17: 0.5534	

samples revealed:

- highly statistically significant differences between groups C15-A15, C16-A16 and C17-A17 ($p<0.001$);
- very statistically significant differences between groups A15-A16 ($p<0.01$).

a) Statistical analysis of correlation between the studied indicators (Table VI)

Discussion

In the literature, the majority of the authors have studied the exercise capacity of adult and young basketball players aged over 18 years, at various levels (middle level – national teams).

Physiological anthropometric indicators may significantly contribute to the improvement of selection procedures in the case of adolescent basketball players.

Our data are in accordance with the literature data regarding height, for groups A16 and A17 (Gurău, 2002), and body mass, for groups A15, A16 and A17 (Cordun, 2009).

Studies carried out by Jelicic et al. (2002) using anthropometric measurements in young basketball players show that players in the center position are characterized by a prominent size of the skeleton in longitudinal and transverse plane, as well as of the circumference, but they present no significant differences compared to players in the forward position. Center players are predominantly ectomorph compared to the other players, while players in the guard position are predominantly mesomorph.

In a study performed by Torres-Unda et al. (2013), following anthropometric determinations, it was found that weight, height and muscle percentage were higher in elite basketball players. These indicators associated with maturity are important for determining success.

Faludi et al. (1999), in a study on aerobic exercise capacity in mini-basketball players (7-9 years) show that this is determined by a number of factors such as: the genetic factor, physical development, and exercise tolerance. The results of the study demonstrated that the study group had a better exercise tolerance and cardiorespiratory capacity than the control group. The performance of the first group was not due to the degree of physical development.

Training exercise, particularly in junior players, is below the level of exercise during the game and should be raised to higher physiological rates, according to the specificity of the basketball play. This attitude of continuous correction, adjustment to the ”physical reality” in the field will be a determining factor for constant progress (Feflea, 2009).

A study on the recovery period after maximal exercise in male basketball players carried out by Gocentas & Andziulis (2004) shows that total recovery time was long, 1200s, but certain processes were completed earlier: accumulation of lactic acid at 95s, oxygen uptake at 620s, normalization of heart rate at 730s.

A meta-analysis conducted by Ziv & Lidor (2009) regarding sports performance in basketball players found that maximal aerobic capacity values ranged between 44-54 and 50-60 ml O_2/kg/min. Play leaders performed higher intensity exercise than forwards and centers during a game.

Castagna et al. (2009) examined VO_2 max in basketball players. Values during training were 60.88±6.26 and 50.33±3.98 for juniors and seniors, respectively. The results show that a value of 50 ml x kg x min is sufficient to practice middle level basketball.

In a study on aerobic exercise capacity based on the Astrand-Ryhming test applied before and after training for 21 days, Boroş-Balint (2012) evidenced an increase in post-training VO_2, which indicates a good adaptation of

Table V

Comparative analysis of MAP values (measured in ml/kg) in the studied groups and statistical significance.

Group	Mean	SE	Median	SD	Min.	Max.	*Statistical significance (p)*	
C15	33.49	0.6505	33.91	2.0570	28.75	35.56	C15-C16: 0.2713	C15-A15: < 0.0001
A15	45.31	0.8569	45.31	2.7097	38.60	48.08	C15-C17: 0.2544	C16-A16: 4.62×10^{-8}
C16	32.76	0.7823	32.33	2.4740	28.42	37.10	C16-C17: 0.8909	C17-A17: 9.59×10^{-9}
A16	42.10	0.4889	42.18	1.5461	39.74	45.21	A15-A16: 0.0052	
C17	32.63	0.5704	32.60	1.8039	30	35.38	A15-A17: 0.2176	
A17	43.81	0.8664	44.33	2.7397	39.47	47.76	A16-A17: 0.1081	

Table VI

Statistical analysis of correlation between the values of the studied indicators.

Indicator \ Group	C15		C16		C17		A15		A16		A17	
Age – body mass	0.5688	***	0.5825	***	0.0083	*	0.6162	***	-0.0345	*	0.2403	*
Age – height	0.656	***	0.6033	***	-0.0608	*	0.2160	*	0.4145	**	0.3039	**
Age – BMI	0.3939	**	0.4882	**	0.0808	*	0.3794	**	-0.3104	**	0.0253	*
Age – HR	0.2457	*	0.1765	*	0.1013	*	-0.1625	*	0.6600	***	0.3129	**
Age – VO_2 max	0.5139	***	0.4235	**	-0,0562	*	0.5643	***	-0.1693	*	0.0345	*
Body mass – height	0.8313	****	0.7600	****	0,9301	****	-0.0810	*	0.2734	**	0.5495	***
Body mass – BMI	0.6667	***	0.9439	****	0.9774	****	0.7915	****	0.7970	****	0.7802	****
Body mass – HR	0.0572	*	0.1414	*	0.3052	**	-0.1938	*	-0.0047	*	0.6799	***
Body mass – VO_2 max	0.9846	****	0.9149	****	0.9700	****	0.9487	****	0.9666	****	0.8451	****
Height – BMI	0.2492	*	0.5060	***	0.8370	****	-0.6532	***	-0.3572	**	-0.0908	*
Height – HR	0.0136	*	0.2933	**	0.1168	*	0.0928	*	0.3867	**	0.2989	**
Height – VO_2 max	0.7837	****	0.6803	***	0.9631	****	0.0165	*	0.2110	*	0.5532	***
BMI – HR	0.2203	*	0.0421	*	0.3403	**	-0.1244	*	-0.2889	**	0.5964	***
BMI – VO_2 max	0.6728	***	0.8806	****	0.9171	****	0.6578	***	0.8102	****	0.5993	***
HR – VO_2 max	0.0701	*	-0.0780	*	0.1379	*	-0.4154	**	-0.2253	*	0.2436	*

Correlation: **** very good, *** good, ** acceptable, * weak.

the body regarding maximal O_2 uptake, O_2 transport and consumption systems for exercise.

The research performed by Vamvakoudis et al. (2007) was aimed at determining the effects of basketball training on maximal aerobic power, isokinetic strength, mobility and body fat index. On the initial test, basketball players had a lower heart rate and a higher VO_2 compared to the control group. After 18 months, there were no significant differences in isokinetic strength and mobility between the two groups, but basketball players had a lower body fat index.

Sallet et al. (2005) evaluated the physiological characteristics and physical capacities of basketball players competing in the first and second basketball divisions and their correlation with the position of each player and the level of play: centers had a lower maximal speed than play coordinators and forwards; the VO_2 max level of first league players was significantly lower than that of lower division players, and the fatigue index was higher in first division players; the general aerobic capacity was similar between players competing in different positions, despite certain differences between athletes, determined by individual physiological capacities.

Castagna et al. (2008) examined the effects of maximal aerobic power on the repeated sprint ability (calculated as the decrease of performance and total sprint time) in young basketball players. The results of this study indicate that VO_2 max is not a predictive factor for the repeated sprint ability in young basketball players. The high blood lactate concentrations found at the end of the repeated sprint ability protocol suggest its use for the development of lactate tolerance in trained basketball players.

Hoffman et al. (1999) studied the effect of aerobic capacity on performance, fatigability and heart rate recovery after high intensity anaerobic exercise in national level basketball players. A weak or no correlation was evidenced between aerobic capacity and recovery indicators after high intensity exercise in basketball players.

Tavino et al. (1995) monitored the effects of basketball training in the pre-season period and during a season on the aerobic capacity, anaerobic capacity and body composition in basketball players aged between 18 and 22 years. The tested parameters included body fat percentage, a functional capacity test, and an anaerobic capacity test. The study included three testing phases (during the pre-season, 5 weeks after pre-season training, at the end of the season). The results suggest that the players had significant body fat decreases. Aerobic capacity did not improve during the pre-season period. The players also lost their aerobic capacity during the season.

Conclusions

The following changes were found in the athlete groups:

1. Insignificant increases in body mass, height and body mass index in the athlete groups compared to the non-athlete groups, except for the 17-year groups for height.

2. Significant increases in VO_2max and maximal aerobic power in athletes, compared to non-athletes of the same age.

Conflicts of interests

Nothing to declare.

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