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Modeling physical training in young basketball players
Modelarea antrenamentului în pregătirea fizică a tinerilor baschetbalişti

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Abstract

Background. The importance of physical training in general and the level of explosive strength of the lower limbs in particular is a priority in achieving juvenile level sports performance.

Aims. This research aims to monitor the level of explosive power of the *Under 13* (U13) and *Under 14* (U14) teams using four tests measured with an Optojump Next System device.

Methods. Two tests to assess anaerobic alactacid power (Jumps 15/30 sec. test), a test to assess muscle strength and muscle fibre recruitment levels (Squat Jump test), and the Stiffness test to assess the level of reactive force and muscle elasticity were performed.

Results. After applying the tests, weaknesses or strengths of a team against the other team were found, and then, a plan for training and optimization adapted to increase the explosive force of the U13 team was developed. After implementing a physical training program adapted to the U13 team, the same tests were repeated. The data obtained validated the effectiveness of the proposed program.

Conclusions. After applying a power optimization program for the lower limbs to the experimental group, we observed an improvement of specific power in both anaerobic power tests and the Squat Jump test (SJ). The improvement was significant in the assessment of muscle elasticity (Stiffness test).

Key words: explosive force, power, Optojump Next System, lower limb, young basketball players.

Rezumat

Premize. Importanţa pregătirii fizice în general şi a nivelului forţei explozive la nivelul membrelor inferioare în special este prioritară în atingerea performanţei sportive la nivel juvenil.

Obiective. Cercetarea de faţă îşi propune monitorizarea nivelului forţei explozive la echipele *Sub 13 ani* (U13) şi *Sub 14 ani* (U14), cu ajutorul a patru teste măsurabile cu dispozitivul Optojump Next System.

Metode. Testul de 15 sec. sărituri succesive şi testul de 30 sec. sărituri succesive au fost alese pentru a monitoriza puterea anaerobă alactacidă, testul SJ (Squat Jump) a fost ales pentru a monitoriza forţa explozivă şi nivelul de racolare a fibrelor rapide, iar testul Stiffness a fost ales pentru a monitoriza nivelul forţei reactive şi al elasticităţii musculare.

Rezultate. În urma aplicării testelor s-au constatat deficienţele sau plusurile unei echipe faţă de cealaltă echipă, iar apoi s-a elaborat un plan de pregătire şi optimizare adaptat nevoilor de creştere a nivelului forţei explozive a echipei U13. După implementarea programului de pregătire fizică adaptat asupra echipei U13, au fost efectuate încă o dată aceleaşi teste. Datele obţinute demonstrează eficacitatea programului propus.

Concluzii. După aplicarea programului de optimizare a puterii la nivelul membrelor inferioare la grupa experimentală s-a observat o îmbunătăţire a puterii specifice în cele două teste care monitorizează puterea anaerob alactacidă precum şi la testul Squat Jump (SJ). Îmbunătăţirea este semnificativă la testul de evaluare a elasticităţii musculare.

Cuvinte cheie: forţă explozivă, putere, Optojump, membre inferioare, baschet.

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Introduction

Athletic performance, as a result of preparation, is achieved by manipulation methods that induce the body's adaptation to increasingly higher efforts (Bompa, 2003). Physical preparation should be in the service of technical training (Cometti, 2003). An important feature of training in sport performance is maximizing the importance and role of physical preparation in practice (Teodorescu, 1975). Consequently, the specialist, without neglecting the other aspects of training (technical and tactical, psychological, theoretical), should allocate an appropriate percentage of time to training the physical condition of the players, using a methodology of training with footholds in realities and development trends of the modern game and in the current guidelines for the training of basketball players and teams (Feflea, 2013). Physiological characteristics of the efforts required by specific actions of the basketball game are the result of the relationship between the characteristics of efforts and the energy potential of the athletes' body (Feflea, 2013). Strength training has become increasingly popular among coaches. If until recently strength training was specific only to athletes, it is now an important component in most sports for both injury prevention and recovery (Wernbom et al., 2007).

New trends in the basketball game highlight the need for a very good physical preparation of the players. Juvenile basketball is characterized by dynamism. Basketball requires strength, speed, agility and power (Siegler et al., 2003).

There are numerous studies that have explored the physical quality of basketball players and young adults (Ostoji et al., 2006; Ziv & Lidor, 2009; Torres-Unda et al., 2013).

Physical training can compensate, at one point, technical training. An inadequate physical preparation can affect the technical components of the game (free throws, assists, passing from attack to defense, defense itself). Physical performance is measured by the amount of acquired skills and motor abilities. It has been found that the most successful teams are those that possess the most explosive capabilities (Hoffman & Maresh, 2000; Hoffman et al., 1996).

At junior level, training models generally focus on increasing resistance, but not enough attention is paid to high intensity training (Sampaio et al., 2004; Siegler et al., 2003).

Running speed and explosive force develop after 13 years of age, and strength and other motor skills significantly improve after mid-childhood (Malina et al., 2004).

The combination of power, strength and coordination is carefully monitored and coached in all sports. A similar study was done by Castagna et al., (2009), which assesses aerobic capacity and the explosive power of the lower limbs in amateur basketball players in Italy.

Objectives

The importance of physical preparation in general and the level of explosive force of the lower limbs in particular is a priority in achieving juvenile level sports performance. The research aims to monitor the level of explosive force in basketball players under 13 years old (U13) and under 14 years old (U14).

Hypothesis

Plyometric exercises contribute to improving the explosive strength of the lower limbs. In this work we aimed to analyze the explosive force level of U13 and U14 basketball players, and to propose a training program with exercises specific to the basketball game that helps to improve the explosive strength and motor memory of players.

Material and methods

Research protocol

We mention that in agreement with the Declaration of Helsinki, the Amsterdam Protocol and the Directive 86/609/EEC, all study procedures were approved by an ethics commission within the Faculty of Physical Education and Sport concerning investigation on human subjects, and that we obtained the written consent of the subjects and their parents.

a) Period and place of the research

The research was conducted in Târgu Mureş, from September to June 2013.

b) Subjects and groups

The research group consisted of 22 male subjects, aged between 13-14 years, members of the Basketball Club Mures team (BCM - 11 subjects) and „Szasz Adalbert" Sports High School (LPS - 11 subjects) in Tg. Mures, participants in the National Basketball Championship, U13 and U14 categories. The subjects of the LPS team were the experimental group (E) and the subjects of the BCM team, the control group (C).

In the experimental group, a training program addressing the weaknesses identified (recruitment of fast muscle fibers and muscle elasticity) was proposed and implemented by using exercises that mimic specific movements from the game of basketball, because using them will also improve motor memory.

The program contains the following exercises performed in series and repeated 4 times (Table I):

Table I

Program to optimize the power of legs.

Technical description	Dosage
Ex.1 Semigenuflexion followed by vertical jump, hands rest on espaliers	10 repetitions - 4 series
Ex.2 Jumping on two feet, moving forward	10 repetitions - 4 series
Ex.3 Jumping over fences on two feet (10 fences - 40 cm high)	10 repetitions - 4 series
Ex.4 On the gym bench, successive jumps changing legs	10 repetitions - 4 series
Ex.5 Jumping on the gym bench (20 cm high) with legs stretched	10 repetitions - 4 series
Ex.6 Successive jumping on one foot, moving forward	10 repetitions right - 4 series 10 repetitions left- 4 series

In the LPS team (E), the program for optimizing leg power was applied 2 times a week.

In the BCM team (C), no program was applied, the players continued the specific preparation without the

introduction of a separate physical training workout.

c) Tests applied

For evaluating the explosive strength of the lower limbs of young basketball players, we selected 4 tests from the Bosco Protocol, measurable with the Optojump Next System device:

1. Repetitive jumps 15 sec (RJ 15 sec.) – which assess anaerobic alactacid power. This test involves performing successive jumping on the spot by bending and extending the knees. The aim is to achieve the greatest number of jumps with the highest detachment for 15 sec. The height of the jump is automatically calculated by the device software by determining the time of flight (Tf) and the time of contact (Tc) (Bosco et al., 1983).

2. Repetitive jumps 30 sec (RJ 30 sec.) – which assess anaerobic alactacid power. During this test, the athlete performs a great number of successive jumps by bending and stretching the knees for 30 seconds. The height of the jump is automatically calculated by the device software by determining the time of flight (Tf) and the time of contact (Tc) (Bosco et al., 1983).

3. Squat jump test (SJ) – to assess muscle strength and the level of recruitment of fibers. The test is performed from sitting position with knees bent at 90 degrees, hands on hips. From this position, the subject jumps vertically without moving the arms. After each jump, the subject must reach its original position.

4. Stiffness test (ST) - to assess muscle elasticity, which consists of performing five successive jumps and recording the time of flight (Tf) and the time of contact (Tc). The best ratio between the two parameters is considered as representative of the explosive power of the lower limbs (Bosco et al., 1983).

All tests used in this study are specific for assessing the explosive power of the lower limbs. Data collection was performed by the same evaluator in all tests and for all moments of evaluation in this study. The tests were always applied during the usual training program of the studied team (experimental group) and were preceded by a standardized warm-up.

Specific power (W/kg) is calculated using the formula (1):

$$Specific\ power = \frac{g^2 \times \sum T_f (\sum T_f + \sum T_c)}{4 \times nr.jumps \times \sum T_c} \quad (1)$$

where g = gravitational force,

$\sum T_f$ = sum of values of the time of flight (Tf) for every jump of the test (s)

$\sum T_c$ = sum of values of the time of contact for every jump of the test applied (s)

no. jumps = number of jumps performed during the test

d) Statistical processing

For statistical calculation, we used SPSS 20.0 for Windows, and the data were represented as mean and standard deviation, based on which parametric t tests comparing the averages were applied. The t test for independent samples was applied to check whether there were significant differences between the groups.

With the Optojump device software, the best and worst value, the mean and standard deviation for all parameters were calculated. For the analysis of data of each player, the t-test for independent variables was applied (Bosco et al., 1983).

Results

The results are presented in (Tables II-VIII, Figs. 1, 2).

Table II

Scoring scale, after (1).

Power average (w/kg)	Poor 1	Mediocre 2	Medium 3	Good 4	Excellent 5
15 sec. jump test (power)	< 25.0	25.1-28.3	28.4-31.6	31.7-34.9	> 35.0
30 sec. jump test (power)	<20.0	20.1-23.3	23.4-26.6	26.7-29.9	>30
Squat jump test (cm)	< 32	32-37	38-42	43-47	> 47
Stiffness	<36	36-39	40-46	47-54	>55

Table III

The result for the control group at the initial and final testing.

Tests		Characteristics	Initial testing				Final testing			
			∑	Average	Min	Max	∑	Average	Min	Max
15 sec. Repetitive jump test	T1	Specific power (w/kg)	260.14	23.65	18.60	33.14	270.99	24.64	19.30	35.33
		Average power (w/kg)	268.98	24.45	20	38.16	282.82	25.71	20.33	39.71
30 sec. Repetitive jump test	T2	Specific power (w/kg)	243.91	22.17	18.25	28.11	253.26	23.02	18.44	29.56
		Average power (w/kg)	244.76	22.25	18.02	30.03	254.45	23.21	16.42	32.30
SJ test	T3	h(cm)	438.9	39.9	34.6	45.5	446.60	40.60	35.00	47.10
STIFFNESS test	T4	Specific power (w/kg)	309	28.09	20.46	35.63	317.08	28.82	21.32	37.33
		Average power (w/kg)	360.99	32.82	22.25	42.91	269.71	33.62	24.31	42.30

Table IV

The result for the experimental group at the initial and final testing

Tests		Characteristics	Initial testing				Final testing			
			∑	Average	Min	Max	∑	Average	Min	Max
15 sec. Repetitive jump test	T1	Specific power (w/kg)	237.83	21.62	14.11	28.66	237.75	21.61	15.66	28.72
		Average power (w/kg)	237.59	21.60	14.87	27.52	238.05	21.65	14.98	27.33
30 sec. Repetitive jump test	T2	Specific power (w/kg)	222.27	21.60	14.87	27.52	222.53	20.23	14.74	25.71
		Average power (w/kg)	224.81	20.44	15.3	26.69	223.07	20.27	15.67	26.77
SJ test	T3	h(cm)	434.7	39.52	26.08	50.2	388.7	38.87	23.3	51
STIFFNESS test	T4	Specific power (w/kg)	328.80	29.89	21.46	38.46	328.89	30.26	22.97	38.99
		Average power (w/kg)	382.69	34.79	24.07	47.03	381.78	34.70	24.17	48.15

Table V
T test for paired samples - control group

Pairs	Control group	Mean	Std. deviation	Sig. (2-tailed)
Pair 1	controlTIE1spPower - controlTFE1spPower	-.98555	1.32022	.033
Pair 2	controlTIE1avgPower - controlTFE1avgPower	-1.25800	1.30224	.009
Pair 3	controlTIE2spPower - controlTFE2spPower	-.85018	.97170	.016
Pair 4	controlTIE2avgPower - controlTFE2avgPower	-.88100	1.62482	.102
Pair 5	controlTIE3h - controlTFE3h	-.70000	1.32061	.109
Pair 6	controlTIE4spPower - controlTFE4spPower	-.72927	.96463	.031
Pair 7	controlTIE4avgPower - controlTFE4avgPower	-.80027	1.14917	.044

* 95% Confidence interval of the difference

Table VI
T test for paired samples – experimental group

Pairs	Experimental group	Mean	Std. deviation	Sig. (2-tailed)
Pair 8	expTIE1spPower - expTFE1spPower	.00827	.83015	.974
Pair 9	expTIE1avgPower - expTFE1avgPower	-.04200	1.10962	.903
Pair 10	expTIE2spPower - expTFE2spPower	-.02300	.77678	.924
Pair 11	expTIE2avgPower - expTFE2avgPower	.15818	.36441	.181
Pair 12	expTIE3h - expTFE3h	.70909	1.74095	.207
Pair 13	expTIE4spPower - expTFE4spPower	-.37227	.63926	.082
Pair 14	expTIE4avgPower - expTFE4avgPower	.08273	1.60578	.868

* 95% Confidence interval of the difference

Table VII
Final result for the LPS team – E group

Name of player	T1 15 sec. Repetitive Jump test		T2 30 sec. Repetitive Jump test		T3 SJ test	T4 STIFFNESS test	
	Specific power (w/kg)	Avg. power (w/kg)	Specific power (w/kg)	Avg. power (w/kg)	H (cm)	Specific power (w/kg)	Avg. power (w/kg)
BT.	18.606	20	18.255	18.02	37.4	20.465	22.25
CŞ	23.52	25.04	22.097	22.17	37.2	27.229	38.38
PL	33.142	38.26	27.804	30.03	44.6	35.639	40.03
ŞL	21.918	23.45	19.848	20.66	35.3	26.597	33.07
BB	26.491	28.42	28.112	27.68	45.5	34.303	42.91
PV	25.283	24.29	23.261	22.94	44.3	28.184	31.45
PD	22.126	21.49	20.802	20.49	34.6	23.224	27.52
MR	21.898	21.2	19.251	19.01	38.2	26.476	28.89
MI	20.736	20.06	18.608	18.46	35.2	21.556	24.83
KA	25.766	24.87	21.243	21.04	41.7	31.199	33.48
SB	20.659	21.9	24.63	24.26	44.9	34.128	38.18

Table VIII
Final result for the BCM team – C group

Name of player	T1 15 sec. Repetitive Jump test		T2 30 sec. Repetitive Jump test		T3 SJ test	T4 STIFFNESS test	
	Specific power (w/kg)	Avg. power (w/kg)	Specific power (w/kg)	Avg. power (w/kg)	H (cm)	Specific power (w/kg)	Avg. power (w/kg)
SAT	28.66	27.52	25.716	26.69	50.2	37.829	38.03
MD	21.592	20.83	19.618	19.32	35.2	28.671	28.73
HT	20.375	19.72	18.379	19.33	46.4	24.231	37.74
HA	23.316	22.57	22.067	22.88	42.8	26.333	28.44
BB	20.558	19.61	19.868	19.49	40.5	33.994	34.14
PV	22.352	21.42	20.186	19.98	35.6	21.469	31.6
PD	21.114	22.8	21.024	20.65	39.4	33.61	38.97
MR	14.113	14.87	14.789	15.3	26.8	24.047	24.07
MI	22.679	21.66	21.455	20.99	42.2	28.068	34.07
KA	22.069	23.99	21.054	20.66	37.6	38.466	47.03
SB	21.009	22.6	18.122	19.52	38	32.085	39.87

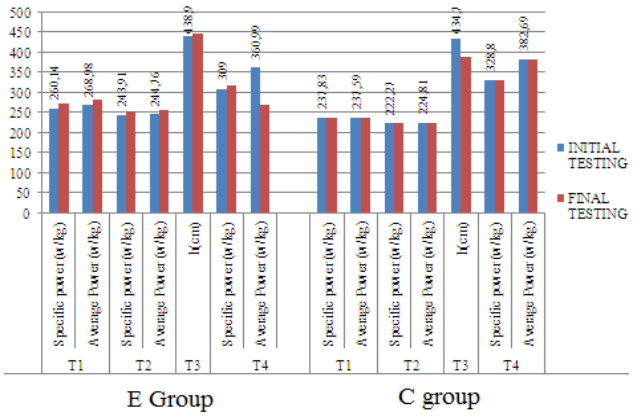

Fig. 1 – Comparative chart of statistical parameter "Σ" for both teams, at the initial and final testing.

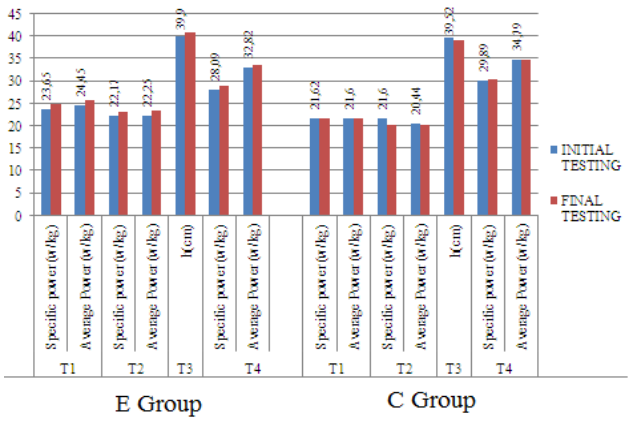

Fig. 2 – Comparative chart of statistical parameter "Average" for both teams, at the initial and final testing.

Discussions

In Table II, the scoring scale is presented, and in Tables III and IV, the results for each team are compared both at the initial testing and the final testing.

By analyzing the results of the LPS team – E group, we can see that in the first test, the best value of specific power was obtained by player no. 3 with 33.142 w/kg (Table VII) compared to 28.600 w/kg (player 1 - Table VIII). In the second test, the highest value for LPS was 28.112 w/kg (player 5 - Table VII) compared to 25.7161 w/kg (player 1 - Table VIII). For the third test, the best value was that of player 11 of BCM, 50.2 cm (Table VIII) versus 44.9 (player 1 LPS - Table VII). At the last test, the best value was 38.466 w/kg (player 1 - tableVIII) versus 35.639 w/kg (player no. 3 - Table VII).

For data analysis, we made a comparison between the two teams. We extracted specific power using formula no. 1 and average power for both teams. All comparisons are shown in Figs. 1 and 2.

In terms of tests carried out to monitor the explosive power of the lower limbs, the LPS team had a higher value in tests 1, 2, 3, and a lower value in test 4, which assesses muscle elasticity.

In the SJ test, LPS values were lower compared to the BCM team. This shows that LPS had deficiencies in fast fiber recruitment (measured by the SJ test) and low muscle elasticity (assessed by the Stiffness test).

After applying the program for optimizing leg power to the LPS team two times a week, the following were observed:

The LPS team improved specific power in the 2 tests that monitor anaerobic alactacid power. An increase in test 3 (SJ test) monitoring the recruitment of fast fibers was also found. At the last test, which assesses muscle elasticity, a significant improvement of this parameter was observed.

In the BCM team, who followed no program, specific training was continued without introducing a separate physical workout. The following aspects were observed in the final testing: the power level in the tests performed remained within the same limits, with insignificant increases and decreases. All these data were confirmed by the t-test for paired samples for each group.

Although speed is a complex skill (Moreno, 1994), a short time of contact during explosive actions can have a positive influence on speed. We believe that the implementation of a program to optimize explosive strength in the legs, performed 2 times a week, can have beneficial effects on the explosive power of the lower limbs, resulting in increased performance in the game of basketball.

Conclusions

1. The introduction of a specific physical training program contributes, in both U13 and U14 age groups, to improving the motor ability of the players and increasing motor skill indices.

2. In the case of U13 and U14 juniors, performing exercises that mimic specific movements from the basketball game will improve their motor memory.

Conflicts of interests

There were no conflicts of interests.

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