FEATURES FORCE BETWEEN THE FOOT AND PERFORMANCE OF SPECIAL-BASED TESTS YOUNG BASKETBALL PLAYERS

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Annotation. *Purpose*. A quantitative analysis of biomechanical force interactions between the foot and the support when the athletes special tests. *Material and methods*. In the experiment involved 30 young athletes aged 7-8 years who are at the stage of initial training. Subjects performed four tests: jump up from their seats repulsion two feet, jump up and down with one foot repulsion run, stop step, jump stop. *Results*. As a result of studies to obtain quantitative values of reference indices interactions as the maximum reaction force impulse force, force gradient, the reference duration, and other interactions. Revealed that when jumping forward and upward to run and jump and step stops the horizontal component of force production is from 38 to 73 % of the resulting value. *Conclusions*. Significant power load on the musculoskeletal system and in particular the foot of young basketball players can lead to abnormalities in the foot. In connection with what the training process should include funds for the correction and prevention of foot function.
Keywords: basketball, stop, support, strength, jump, stop, biomechanics.

Introduction

Natural human movements are conditioned by character of bio-mechanical interactions of his body with environment [1-3, 7, 14]. In such kinds of sports as track and fields, weight lifting, gymnastics, football, basketball and many other it is impossible to fulfill certain movement task without consideration of interactions between sportsman's feet and support, characteristic for the given kind of sports.

Basketball is such kind of sports, in which sportsman's supporting motor system endures great loads. Increasing rivalry at sport competitions results in rising of training load scope at all stages of many years trainings [2, 5, 6, 13, 15], that increases risks for sportsmen's health [4].

Specifics of a kind of sports often leads to motion functions' disordering, both of foot itself and supporting motor system in general that, in its turn, can negatively influence on sportsmen's health [2, 4, 8, 11].

For junior basketball players, at initial stage of trainings it is very important to form correct foot arch. However, the problem of factors, which influence on absence or presence of foot spring-support disorders at the stage of initial trainings in basketball has not been studied sufficiently yet. In particular, there are insufficient data about degree of load on supporting motor system of junior basketball players and there are no quantitative indicators of loads on foot with fulfilling of training and competition exercises [4, 9, 10, 12].

Alongside with it, for optimization of training process and prophylaxis of supporting motor system's disorders (in particular functions of foot) of junior basketball players it is necessary to have objective quantitative data about load on sportsmen's feet.

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Purpose, tasks of the work, material and methods

The purpose of the work is to study quantitative indicators of force interactions between foot and support of junior basketball players, when they fulfill special tests at initial stage of many years' trainings.

The methods of the research: for solution of our tasks we used analysis and generalization of scientific-methodic literature, pedagogic testing, strain-gauge – dynamo-metering, video-computer analysis of kinematic characteristics of movements, methods of mathematical statistics.

The researches were carried out on the base of laboratory of bio-mechanical researches in physical education and Olympic sports of scientific-research institute of National university of physical education and sports of Ukraine. In the research 30 basketball players of 7-8 years old took part.

Results of the research

For evaluation of load on feet of junior basketball players we fulfilled pedagogic testing. Sportsmen were offered those techniques of basketball game, which render the highest load on foot, videlicet:

- high jump from the spot, pushing with two legs;
- running high-forward jump, pushing with one leg;
- stop by step;
- stop by jump.

For obtaining of quantitative indicators of support interactions we used methodic of strain-gauge- dynamo-metering. Strain gauge platform "Kisler", which we used for registration of movements' power characteristics, permits to register power indicators both by all three axes and to obtain resulting indicator in three dimension space.

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We carried out analysis of quantitative indicators of support interactions in test "high jump from the spot". In this test, sportsmen pushed with two legs and resulting vector of support's response practically coincided with vertical axis; that is why we regarded only vertical component of the load.

We registered such characteristics of this test as: maximal force of support's response at pushing and at landing; impulse of force at pushing; gradient of force at pushing; duration of spring phases, phases of active pushing and flight; height of jump. The obtained data are presented in table 1.

In this test we registered maximal support's response at pushing and landing equal to 1388 N and 2781 N accordingly. These values of load exceed sportsman's weight 3 and 6 times. Besides, gradient of force was 3431 $N \cdot sec.^{-1}$ that witnesses about expressed speed-power character of the load. However it should be considered that load is spread on two feet relatively equally and is directed practically vertically; therefore it is partially absorbed by arches of both feet. Besides, we registered the height of jump, which was the main criterion of this test's efficiency.

Table 1

Indicators of test "high jump from the sport, pushing with two legs" (n=30)

Indicator	x	S	m	V
Sportsman's weight (N)	**485**	47.59	8.70	9.81
Maximal force of support's response at pushing (N)	**1388**	122.65	22.42	8.84
Gradient of force ($N \cdot sec^{-1}$)	**3431**	273.83	50.06	7.98
Force impulse (N·sec.)	**981**	102	18.647	10.4
Maximal force of support's response at landing (N)	**2781**	234.76	42.92	8.44
Duration of springing phase (sec.)	**0.19**	0.02	0.004	10.5
Duration of phase of active pushing (sec.)	**0.34**	0.04	0.007	11.8
Height of jump (m)	**0.35**	0.3	0.01	9.02

We also obtained data about close positive connection between power characteristics of high jump from the spot and sportsmen's weight (r=0.96). Therefore, in the future, with increasing of height-weight indicators of junior basketball players, load on foot will increase.

Having fulfilled preliminary analysis of running high-forward jump we came to conclusion that in this test it is necessary to study both resulting load and its components in horizontal and vertical planes. It is connected with the fact that vector of resulting force of support's response is directed under angle to sagittal and zenith planes.

The data are given in table 2.

Table 2

Indicators of test "running high-forward jump, pushing with one leg" (n=30)

Indicator		x	S	m	V
Jump height (m)		**0.19**	0.027	0.005	14.21
Jump length (m)		**0.96**	0.15	0.027	15.62
Length of trajectory of GMC travelling in jump (m)		**1.39**	0.14	0.025	10.07
Phase of active pushing (sec.)		**0.16**	0.021	0.003	13.12
Resulting vector	Maximal force of support's response (N)	**1126.2**	105.6	19.3	9.38
	Gradient of force ($N \cdot sec^{-1}$)	**6255**	726.1	132.7	11.6
	Impulse of force (N·sec)	**992**	102.6	18.75	10.34
Horizontal component	Maximal force of support's response (N)	**205.3**	20	3.65	9.74
	Gradient of force ($N \cdot sec^{-1}$)	**1138.1**	109.1	19.9	9.58
	Impulse of force (N·sec)	**176.8**	18.81	3.43	10.63
Vertical component	Maximal force of support's response (N)	**934.1**	225.6	41.24	24.15
	Gradient of force ($N \cdot sec^{-1}$)	**5188**	607.3	111.02	11.7
	Impulse of force (N·sec)	**814.8**	78.9	14.4	9.68

In test running high-forward jump criteria of effectiveness are jump height and length as well as length of trajectory of GMC in jump. Indicators of maximal force of support's response in horizontal direction was 205.3 N, in vertical – 934.1 N, resulting – 1126.2 N. Besides, owing to reducing of active pushing phase force gradient increased up to 6255 $N \cdot sec.^{-1}$. It should be noted that in this test there appeared horizontal component of load on foot, besides, all load is endured by one leg.

We also studied bio-mechanical indicators of stops by step and by jump. From bio-mechanical point of view integral criterion of effectiveness of stops' fulfillment can be acceleration of sportsman's GMC. For determination of these indicators we used system of video-computer analysis of movements «Qualisis».

With fulfillment of stop by step (see table 3) we registered acceleration of sportsman's GMC equal to 40.12 $m \cdot sec.^{-2}$.

Table 3

Indicators of test "stop by step" (n=30)

Indicator		x	S	m	V
Acceleration of sportsman's GMC (m·sec.$^{-2}$)		**-40.12**	3.29	0.6	8.94
Phase of interaction with support (sec.)		**0.21**	0.019	0.003	9.04
Resulting vector	Maximal force of support's response a (N)	**2477.9**	66.3	12.13	2.68
	Gradient of force (N·sec^{-1})	**11795**	194.9	35.6	1.65
	Impulse of force (N·sec)	**520.3**	45.6	8.33	8.76
Horizontal component	Maximal force of support's response (N)	**1764.6**	232.8	42.57	13.19
	Gradient of force (N·sec^{-1})	**8400.5**	1001.2	183.03	11.91
	Impulse of force (N·sec)	**347.9**	27.6	5.04	7.93
Vertical component	Maximal force of support's response a (N)	**746.5**	49.8	9.11	6.67
	Gradient of force (N·sec^{-1})	**3554.8**	296.5	54.2	8.34
	Impulse of force (N·sec)	**123.5**	10.3	1.88	8.34

The main characteristic of this technical element is that horizontal maximal force of support's response exceeds vertical component more than 2 times. Besides, in this test we registered higher indicators of resulting maximal force of support's response 2477.9 N and gradient of force 11795 N·sec.$^{-1}$.

With total duration of phase of interaction with support equal to 0.21 seconds, value of horizontal component 1764.6 N is observed already after 0.08 second after beginning of this phase of movement. Vertical component reaches maximum (746.5 N) after 0.14 second. Stop by step is an element, in which we registered the highest load on feet of junior basketball players in horizontal plane.

Stop by jump also renders significant load on foot. In table 4 we present bio-mechanical indicators of this technical element.

Table 4

Indicators of test "stop by jump" (n=30)

Indicator		x	S	m	V
Acceleration of sportsman's GMC (m·sec.$^{-2}$)		**-36.8**	4.31	0.79	10.74
Phase of interaction with support (sec.)		**0.18**	0.015	0.002	8.33
Resulting vector	Maximal force of support's response a (N)	**3043**	368.8	67.43	12.12
	Gradient of force (N·sec^{-1})	**16905**	1726.2	315.5	10.21
	Impulse of force (N·sec)	**522.5**	54.6	9.98	10.04
Horizontal component	Maximal force of support's response (N)	**488.9**	44.5	8.14	9.11
	Gradient of force (N·sec^{-1})	**2716.6**	234.9	42.9	8.64
	Impulse of force (N·sec)	**82.44**	11.2	2.04	13.58
Vertical component	Maximal force of support's response a (N)	**1962.8**	88.5	16.17	4.51
	Gradient of force (N·sec^{-1})	**10900**	499.8	92.37	4.58
	Impulse of force (N·sec)	**353.2**	20.91	3.82	5.92

In stop by jump we registered acceleration of sportsman's GMC equal to -36.8 m·sec.$^{-2}$ that is by 4.04 m·sec.$^{-2}$ less, than in stop by step. Thus, we can say about a little higher effectiveness stop by step.

In spot by jump maximal resulting force of support's response is 3043 N, and gradient of force 16905 N·sec.$^{-1}$.

In contrast to stop by step maximal values of vertical and horizontal components of forces of support's response are observed simultaneously in 0.1 second after starting of phase of interaction with support. Indicators of maximal force by vertical axis equal to 1962.8 N, and by horizontal axis – 488.9 N. with stop by jump greater load on foot is directed vertically.

Conclusions:

We determined quantitative indicators of power characteristics of interactions between foot and support of junior basketball players. Values of maximal support interactions in tests were from 1348 to 3043 N. We determined that with fulfillment of running high-forward jumps and stops by jump and step horizontal component of power indicators was from 38 to 73% of resulting value.

We found close positive interconnection between power characteristics of tests of sportsmen weight (r=0.91), therefore, with increasing of height-weight data of junior sportsmen, load on foot will also increase.

Significant power loads on supporting-motor system and in particular on foot of a basketball player can result in disordering of foot functions. In connection with this it is necessary to include means for correction and prophylaxis of foot functions in training process.

The prospects of further researches. At next stages of our researches we plan to evaluate status of junior basketball players' feet and determine its influence on results of our tests.

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