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Analysis of Physical Training Influence on the Technical Execution of Yurchenko Handspring Vault

Vladimir POTOP[1]*, Sanda TOMA URICHIANU[2]

Abstract

This paper is intended to show the influence of the specific physical training on the technical execution of Yurchenko handspring vault at junior gymnasts aged 12 to 15 years. A number of 7 tests of motricity were used in this study: 3 tests for strength-speed of lower and upper limbs, 3 tests for complex, abdominal and back muscles strength and 1 test of specific endurance. The biomechanical analysis was carried out by means of Physics ToolKit program and movement postural orientation method, monitoring the key elements of the sports technique of Yurchenko handspring vault. The results of the study reveal the level of specific physical training of the junior gymnasts aged 12-15 years, the kinematic and dynamic analysis of sports technique key elements in terms of body segments trajectories, angular speeds and force momentum in Yurchenko handspring vault; there is also shown the dynamics of sports performances achieved in competitions. Also, the assessment of the specific physical training consistent with the biomechanical analysis of sports technique in Yurchenko handspring vault at junior gymnasts aged 12 to 15 years prove their influence on the technical training and the performances achieved in competition

Keywords: *Handspring vault, biomechanics, physical training, correlation, performance.*

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1. Introduction

At the present moment the artistic gymnastics has a new level of development since the modifications in the Code of Points have entailed significant changes in the content and construction of the exercise and in the composition requirements as well. Meanwhile, gymnastics has made remarkable progress and has demonstrated that it develops in line with the trends of high performance sport [1], [24].

In gymnastics polyathlon, the handspring vaults are the most dynamic, athletic and shorter event [27]. In performance sports activity, a special attention is paid to the acrobatic features of the vaults and the combination of these ones, while the difficulty and value of the vaults is assessed according to the height and length of the flights – especially the second one – and also depending on the twists performed in various axes during the flights [1], [13], [32].

One of the main tasks of physical training is to increase the effectiveness which entails a higher technicity of movement execution. In the practical activity of artistic gymnastics, the physical training has two forms [32]: general physical training and specific physical training. Hence a poor physical training of the female gymnasts leads to an incorrect and faulty technique and consequently to a failure in competition. Also, a good technical and physical training not supported by proper mental training leads to modest performances [11].

2. Problem Statement

According to the Code of Points of Women's Artistic Gymnastics, the handspring vaults are divided into 5 groups [5]; the round-off stretched salto backward vault (Yurchenko) belongs to group IV. All handspring vaults have one thing in common, determined by the phases that compose their full development, namely: running, hurdle onto springboard, first flight, support with hands on table (handspring), second flight and landing [10], [12], [28], [32].

Physical training is one of the most important factors of sports training in the achievement of high performance. The main objectives of physical training are the increase of athlete's physiological potential and the development of the biometric characteristics up to the highest level [4], [16], [29].

Physical training represents a process of educating the motor skills required by the correct acquisition of elements, connections and

combinations, as well as by the entire exercises in artistic gymnastics. It is strictly related to the technical, psychological, artistic, tactical and theoretical training [20].

An important part of physical training is the increase of athlete's possibility to apply the motor skills in training conditions and in the sports competitions. To this end, it is necessary to ensure the specific level of physical training, the interdependent connection of force and sports technique, the activity of the vegetative nervous system and the ideal development of the other motor skills [9], [20], [31].

The knowledge of the biomechanical characteristics and physiological stress of the body in gymnastics requires an accurate assessment of the effort made by athletes [6], [19], [29].

At the present moment, the issue of technical execution correctness in gymnastics is the main criterion for the inclusion of performances on a continuously ascending curve. The complexity of current gymnastics technique requires the use of a new „technology" able to decipher the internal mechanisms of the movement in order to know and use them for increasing performances. The modern trends come from the field of biomechanics as a scientific branch whose main target is the very discovery of these mechanisms [7], [30].

Handspring vaults are the event with a single basic technical structure and variants thereof, the handspring rollover. That is why in the most numerous studies and researches on the biomechanical issues of handspring vaults, the authors [3], [17] examine the elastic parameters of the springboard, the parameters of contact with the floor, the handspring and the landing parameters, also the correlation between the mechanical variables and the score of the vault.

In terms of Yurchenko vaults, most authors [14, [15], [18], [21], [25], [26] address various biomechanical aspects regarding the biomechanical comparison of Yurchenko vault and two associated teaching drills, the improvement of sports technique key elements based on biomechanical analysis, the kinematics of springboard phase, the e-learning by computer video analysis of the key elements of sports technique, the use of e-training in mathematical modeling of Yurchenko vault biomechanical characteristics etc.

3. Research Questions/Aims of the research

The purpose of the research is to highlight the dynamics of physical training and its influence on the biomechanical characteristics of Yurchenko handspring vault in junior gymnasts aged 12-15 years.

Hypothesis of the study. We believe that the correlative analysis of the physical training indicators and the biomechanical features of Yurchenko vault will show the level of connection between the indicators and their influence on the performances achieved in competition.

4. Research Methods

The research was carried out from 2012 to 2014 and included 7 athletes of 12 -15 years old, all of them components of junior national team of Romania. Methods of research used: theoretical-methodical analysis of specialized literature, method of tests, video computerized method [8], [23] using the biomechanical analysis program: "Kinovea" and "Physics ToolKit", method of movement postural orientation and evaluation of the sports technique key elements with complex coordination of movement structure [9], [24], statistical method by means of "KyPlot" program.

For highlighting the influence of physical training on handspring vaults technical execution, we analyzed 10 Yurchenko type handspring vaults(3 Yurchenko stretched salto YSS, 4 – YSS with 360° turn and 3 – YSS with 720° turn) in competition conditions, during Romanian National Championships, Bucharest 2014.

The control tests were applied as follows:

A. Strength-speed:
   1. Test 1 – standing long jump (2 attempts, cm);
   2. Test 2 – standing high jump (2 attempts, cm);
   3. Test 3 – rope climb with no leg support (seconds).

B. Strength:
   4. Test 4 – rib stall hanging leg raise in 30 seconds (no of reps);
   5. Test 5 – prone trunk extension in 30 sec. (no of reps);
   6. Test 6 – handstand on the beam (2 attempts, no of reps);

C. Specific endurance:
   7. Test 7 – handstand hold on the balance beam (2 attempts, seconds).

5. Findings

The phasic structure of the control exercises within the research focused on the biomechanical analysis of key elements of Yurchenko round-off vault with backward stretched salto, taking into account the functional structure and the causes as a whole, which are characteristic of the

translational movement with rotation of body segments around GCG axis (fig. 1).

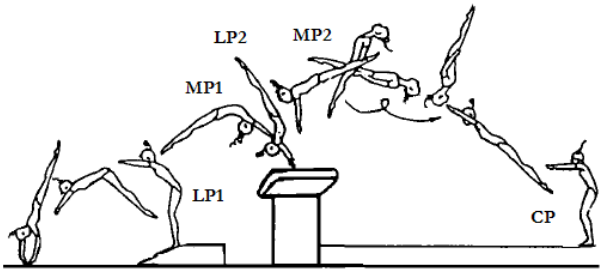

Fig. 1. Key elements of Yurchenko vault sports technique (Round-off, flick-flack on – stretched salto backwards)

Note: in preparatory phase – launching posture of the body (LP1), flip off of the springboard (preparatory movement) and multiplication of posture of the body – the 1st flight, half back rollover (MP1) and handspring on apparatus, flip off of the table (LP2); in basic phase – multiplication of posture of the body (MP2), the 2nd flight that highlights the shape of salto and the momentum of maximum height of GCG (1 ½ stretched salto backwards, 1 ½ stretched salto backwards with 360° and 720° turn); final phase – concluding posture (CP) of the body, moment of sticking the landing

Table 1. Results of physical training level of the female gymnasts aged 12-15 years

Control tests		Statistical indicators							
		$\bar{X}$		SD		Cv%		t	p
		IT	FT	IT	FT	IT	FT		
Force - Speed	Test 1(cm)	189.28	197.57	12.24	11.07	6.47	5.60	9.021	<0.001
	Test 2(cm)	31.71	36.28	2.87	1.79	9.05	4.96	9.505	<0.001
	Test 3(sec)	17.08	12.26	3.75	2.07	21.96	16.93	5.473	<0.01
Force	Test 4(no of reps)	19.50	20.71	1.26	0.76	6.45	3.65	3.545	<0.05
	Test 5(no of reps)	33.71	35.71	1.70	0.76	5.06	2.12	4.099	<0.01
	Test 6(no of reps)	14.14	16.86	3.28	2.79	23.24	16.58	4.214	<0.01
S. End.	Test 7(sec)	49.14	61.43	29.24	21.81	59.49	35.50	4.199	<0.01

Note: S. End. – Specific Endurance; no of reps – number of repetitions; IT – initial testing; FT – final testing; parametric t- Test: Paired Comparison for Means

Table 1 shows the results of physical training level in the gymnasts aged 12 to 15 in terms of force- (explosive) speed of the lower limbs, force of abdominal muscles, back muscles and scapular belt muscles and specific endurance of the sense of balance.

Table 2. Correlation of physical training indicators with Yurchenko vault biomechanical characteristics and the performances achieved in competition (n =10)

№	Indicators			Force - Speed Test 1 (cm)	Test 2 (cm)	Test 3 (sec)	Force Test 4 (reps no)	Test 5 (reps no)	Test 6 (reps no)	Specific Endur. Test 7 (sec)
1		IR (kg·m^2)		**.821	*.654	-.353	***-.943	.062	.412	.408
2	RM,	toes		.326	-.096	.368	*-.676	.101	.284	.430
3	(m)	should		.204	-.278	.299	-.237	.238	.170	.181
4		arms		.189	-.074	.438	-.404	.-142	-.009	-.026
5	KE,	LP1		.484	.195	.071	-.545	-.283	.519	.329
6	(deg)	MP1		-.563	-.571	.603	.209	-.198	-.187	-.027
7		LP2		.066	.081	-.005	-.288	-.611	.579	.421
8		MP2		.078	.388	-.304	-.167	-.406	.197	.115
9		CP		-.297	-.456	.368	.296	-.089	-043	-098
10		should,	x	-.608	-.144	-.032	*.709	-.526	-.287	-.468
11	LP1	m	y	***.890	*.647	-.466	**-.856	.210	.454	.404
12		GCG,	x	-.247	-.279	.233	.242	*-.643	.342	.052
13	MP1	m	y	.388	.500	-.378	-.335	.324	-.241	-.141
14		Toes,	x	*-.653	-.321	.127	*.690	-.178	-.441	-.437
15	LP2	m	y	***.919	**.768	-.563	*-.681	.213	.344	.259
16		GCG,	x	-.240	-.019	-.009	.074	.283	-.422	-.150
17	MP2	m	y	**.856	**.829	*-.661	*-.713	.357	.139	.139
18		Should,	x	.395	.528	-.433	-.404	.526	-.274	-.033
19	CP	m	y	-.105	-.571	.547	.185	.373	-.174	-.128
20	LP1	Should	rad/s	-.041	.410	-.458	.291	-.080	-.290	-.384
21		Should	rad/s	.255	.501	-.584	-.184	.074	.170	.198
22	MP1	Toes	rad/s	-.148	.206	-.491	.249	.214	-.259	-.152
23	LP2	Toes	rad/s	-.571	*-.726	**.777	.209	-.497	.174	.182
24		Should	rad/s	-.179	-.252	.561	-.045	-.024	-.352	-.224
25	MP2	Toes	rad/s	-.154	-.290	.129	.531	.248	-.397	-.535
26	CP	Should	rad/s	.010	.429	-.085	-.394	-.165	-.225	.019
27		Toes	rad/s	-.206	.205	.093	-.197	-.306	-.202	.008
28	LP1		N	.269	.542	*-.696	-.201	.009	.225	.213
29	MP1		N	.349	.060	.192	-.609	.134	.149	.278
30	LP2	GCG,	N	.337	.407	*-.683	-.219	.141	.441	.419
31	MP2		N	.002	-.398	.500	-.005	.354	-.237	-.150
32	CP		N	.439	**.813	-.497	*-.641	-.322	.108	.104
33	Results comp.(points)			.322	*.675	*-.652	-.252	-.012	-.002	-.015

Note: Parametric test linear correlation Pearson's; *** - p<0.001; ** - p<0.01; * - p<0.05

Table 2 presents the results of the correlation of physical training indicators with the biomechanical characteristics of Yurchenko handspring vault and the performances achieved in competition by the gymnasts of 12 to 15 years

old. We used "KyPlot" program for statistical calculation, Pearson's linear correlation parametric test, as follows:

1) Biomechanical indicators necessary for analysis: inertia of rotation (IR, kg·m2), radius of movement (RM, m) of body segments.

2) Angular characteristics of sports technique key elements (fig. 1): LP1 – launching body posture 1 – angle between joints of ankle – shoulders; MP1 – multiplication of body posture 1 – angle between toes - shoulders; LP2 – launching body posture 2 – angle between hand joint – foot 2; MP2 – multiplication body posture 2 – angle between hip - torso; CP – concluding body posture, landing– angle between hip – torso.

3) Spatial characteristics of body segments movement trajectory (m): LP1 – shoulders, MP1 – GCG, LP2 – toes, MP2 – GCG and CP – shoulders.

4) Characteristics of angular speed (rad/s): LP1 – shoulders, MP1 – shoulders and toes, LP2 – toes, MP2 – shoulders and toes and CP - shoulders.

5) Characteristics of force resultant of GCG (N) displacement in all key elements of vault phases.

6) Results obtained in competition in all-around finals and apparatus finals (handspring vaults) in the Women's Artistic Gymnastics National Championships of Romania, Bucharest, 2014.

6. Discussions

The comparative analysis of physical training level in 12 to 15 years old gymnasts was made by calculating the most usual statistical indicators and the significance of the differences between the averages of the research initial and final testing (2012 and 2014) by means of the parametric t - Student method.

The evaluation of force-speed development was made by applying 3 tests which pointed out the following values (table 1):

Test 1, force of lower limbs, evaluated by standing long jump, has an average of 189.28 cm in the initial testing with an increase by 8.29 cm in the final testing (194.9 cm), coefficient of variation (Cv%) - 6.47% and 5.60%, significant differences between tests at $p<0.001$ ($t=9.021$);

Test 2, force of lower limbs, evaluated by standing high jump, has an average of 31.71 cm in initial testing and an increase by 4.57 cm in final testing (36.28 cm), Cv – 9.05% and 4.96%, significant differences between tests at $p<0.001$ ($t=9.505$);

Test 3, force of upper limbs, evaluated by rope climbing with no leg support, has an average of 17.08 sec in initial testing and an improvement by 4.82 sec in final testing (12.26 sec), Cv – 21.96% and 16.93%, significant differences between tests at $p<0.001$ ($t=5.473$).

The evaluation of force development was made by applying 3 tests that highlighted the following values:

Test 4, abdominal force, evaluated by rib stall hanging leg raise in 30 seconds; it has an average of 19.50 reps in initial testing and an increase by 1.21 reps in final testing (20.71 reps), Cv - 6.45% and 3.65%, significant differences between tests at $p<0.05$ ($t=3.545$);

Test 5, back force, evaluated by torso extension in 30 sec, has an average of 33.71 reps in initial testing and an increase by 2 reps in final testing (35.71 reps), Cv – 6.06% and 2.12%, significant differences between tests at $p<0.01$ ($t=4.099$);

Test 6, complex force, evaluated by power handstand on balance beam, has an average of 14.14 reps in initial testing and an increase by 2.72 reps in final testing (16.86 reps), Cv – 23.24% and 16.58%, significant differences between tests at $p<0.01$ ($t=4.214$).

The evaluation of specific endurance development was made by applying only one evaluation test that highlighted the values as follows:

Test 7 , sense of balance, evaluated by keeping the handstand position on balance beam ; it has an average of 49.14 sec in initial testing and an increase by 12.29 sec in final testing (61.43 sec), Cv – 59.49% and 35.50%, significant differences between tests at $p<0.01$ ($t=4.199$).

During the correlative analysis there were selected 33 biomechanical indicators considered important for highlighting the influence of the correct technical execution of Yurchenko handspring vault. The data of the kinematic and dynamic characteristics indicators of Yurchenko handspring vault were processed by means of Physics Toolkit and Kinovea video computerized analysis programs in conformity with the analysis method of movement postural orientation sports technique [Boloban, 2013].

The results of the correlative analysis point out strong connections between (table 2):

- Test 1 and LP1 indicators (shoulders - Y, m) $r=.890$ and LP2 (toes - Y, m) $r=.919$ at $p<0.001$, IR (kg•m2) and MP2 (GCG – Y, m) $r=.856$ at $p<0.01$ and LP2 (toes – X, m) $r=.653$ at $p<0.05$;

- Test 2 and LP2 indicators (toes – Y, m) $r=.768$, MP2 (GCG – Y, m) $r=.829$ and CP (GCG – F, N) $r=.813$ and $p<0.01$; IR (kg•m2) $r=.654$, LP1 (shoulders – Y, m) $r=.647$, LP2 (toes – rad/s) $r=-.726$ and the result in competition (points) $r=.675$ at $p<0.05$;

- Test 3 and IR (kg•m2) indicators r=-.943 at p<0.001, LP1 (shoulders – Y, m) r=-.856 at p<0.01, RM (toes, m) r=-.676, LP1 (shoulders – X, m) r=.709, LP2 (shoulders – Y, m) r=-.681, MP2 (GCG – Y, m) r=-.713 and CP (GCG – F, N) r=-.641 at p<0.05;

- Test 4 and MP1 indicator (GCG – X, m) r=-.643 at p<0.05.

In terms of moderate connections between the analyzed indicators, it is also observed that there are more 23 cases with values of r=.500-.611 and the other indicators show poor or even non-existing insignificant differences at p>0.05.

7. Conclusions

The comparative analysis of physical training level of the female gymnasts aged 12-15 years highlights the dynamics of the explosive force of lower limbs and of force-speed of upper limbs, the abdominal and back force and the sense of balance.

The influence of physical training indicators on the kinematic and dynamic characteristics of Yurchenko handspring vault executed by gymnasts of 12-15 years old shows the connection between the analyzed indicators and their influence on the performances achieved in competition.

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References

[1] Arkaev L. J. & Suchilin N. G. Kak gotovit' chempionov. Teorija i tehnologija podgotovki gimnastov vyshej kvalifikacii. [How to create champions. Theory and technology of training. Top-class gymnasts]. Moscow: Fizkul'tura i sport. 2004

[2] Boloban V. N. Reguljacija pozy tela sportsmena. [Regulation of athlete's body posture]. Monograph. Kiev: Olympic Literature. 2013

[3] Boloban V, & Potop V. Osnovy makrometodiki obuchenija sportivnym uprazhnenijam (na materiale zhenskih vidov gimnasticheskogo mnogobor'ja) [Bases of macro-methods of sports exercise training (as exemplified in woman's all-around gymnastics)]. Science in Olympic sport. 2015 December 07(4). Pp. 55-66

[4] Bompa, T. O. Periodizare: Teoria şi Metodologia antrenamentului sportiv. [Periodization: Theory and Methodology of Training]. Bucharest: Ex Ponto Publishing House. 2002

[5] Code of Points 2017-2020, Fédération Internationale de Gymnastique (FIG), Women's Artistic Gymnastics, Part III, Apparatus, Section 10 – Handspring vaults; Part IV Tables of elements. 2017. pp. 40-43

[6] Cretu M. Perfecţionarea tehnicii giganticii înapoi şi a coborârii cu salt întins prin mijloace selecţionate pe criterii biomecanice [Improvement of the technique of back giant and back somersault dismount off uneven bars]. Publishing House of Piteşti University. 2004

[7] Creţu M, Simăn II, & Bărbuceanu M. Biomecanica giganticii inapoi la paralele inegale [Biomechanics of back giant on uneven bars]. Piteşti: Publishing House of Piteşti University. 2004

[8] Dorgan V. Progresul biotehnologic şi sportul de performanţă: tendinţe, legităţi, prognoze [Biotechnological progress and performance sport – trends, laws, prognosis]. Science of Physical Culture. Chişinău, USEFS. 2011. 8(2). pp. 27-32

[9] Dragnea A., & Teodorescu-Mate S. Teoria sportului. [Theory of Sport]. FEST Publishing House. 2002

[10] Gaverdovskij J. K. Teorija i metodika sportivnoj gimnastiki. [Theory and Methods of Artistic Gymnastics]: text book in 2 v. Moscow: Sov. Sport; vol. 1. 2014

[11] Grigore V. Gimnastica artistică – bazele teoretice ale antrenamentului sportiv [Artistic gymnastics – theoretical bases of sports training]. Bucharest: Semne; 2001

[12] Filipenco E, & Buftea V. Gimnastica [Gymnastics]. Notes of course for USEFS students regarding the base of the chosen sports event. Chişinău: USEFS; 2014.

[13] Filipenco E, Tomşa N, & Buftea V. Gimnastica [Gymnastics]. Theoretical and practical-methodical course programmed for handspring vaults. Chisinău: USEFS. 2014

[14] Kashuba V, Khmelnitska I, & Krupenya S. Biomechanical Analysis of Skilled Female Gymnasts' Technique in «Round-off, Flick-Flack» Type on the Vault Table. Journal of Physical Education and Sport (JPES); 2012, 12(4). pp. 431-435

[15] Koh M, Jenning L, Elliot B., & Lioyd D. A. Predicted Optimal Performance of the Yurchenko Layout Vault in Women's Artistic Gymnastics. Journal of Applied Biomechanics; 2003 (19). 187-204

[16] Manolachi V. Experimental argumentation of development of force and force-velocity abilities of judo players in the context of coaching process. Journal of Physical Education and Sport. (JPES), 2015, 15(3): 582-584.

[17] Penitente G., Sands W. C., McNeal J., Smith S. L., & Kimmel W. Investigation of Hand Contact Forces of Female Gymnasts Performing a Handspring Vault. International Journal of Sports Science and Engineering (IJSSE); 2010, 04(1). pp. 15-24

[18] Penitente G., Merni F., Fantozzi S., & Perretta N. Kinematics of the Springboard Phase in Yurchenko-Style Vaults. XXV ISBS Symposium 2007. Ouro Preto – Brazil. 2007. pp. 36-39

[19] Prassas S., Kwon Y. H., & Sands W. Biomechanics of artistic gymnastics. Journal of Sport Biomechanics; 2006(5). pp. 261-292

[20] Platonov V. N. Sistema podgotovki sportsmenov v olimpijskom sporte. Obschaja teorija i e practicheskoe primenenija. [Training System of Athletes in Olympic Sport. General Theory and its Practical Application] Kiev: Olimpijskaja literature. 2015

[21] Potop V, & Timnea O. Comparative biomechanical analysis of key elements in stretched salto backward Yurchenko vault. Journal of Physical Education and Sport (JPES). 2012, 12(4). pp. 521-525

[22] Potop V. Assessment of Physical and Technical Training Level in Basic Specialization Stage in Women's Artistic Gymnastics. Journal of Physical Education and Sport; 2013. 13(1). pp. 114-119

[23] Potop V. E-learning by computer video analysis the key elements of sports technique of Yurchenko vault in women's artistic gymnastics. The International Scientific Conference eLearning and Software for Education; Bucharest: "Carol I" National Defence University. 2013. Vol. 3. pp. 151-158

[24] Potop V. Bases of Macro-methods for Sports Exercises Learning (material from Women's Artistic Gymnastics). Monograph, Kiev: Education Literature Center; 2015

[25] Potop V., Mihailă J-M, & Urichianu A. Using e-training in mathematics modelling of the biomechanical characteristics of Yurchenko vault. The International Scientific Conference eLearning and Software for Education; Bucharest: "Carol I" National Defence University. 2015, Vol. 3. pp. 298-305

[26] Potop V, Dorgan V, & Jurat V. Improvement of Sports Technique Based on Biomechanical Indicators of Yurchenko Handspring Vault in Women's Artistic Gymnastics. European Journal of Interdisciplinary Studies; Jan-Apr 2017. 7(1). pp. 42-52

[27] Readhead Lloyd, Gymnastics. Skills. Technique. Training. Crowood sports guides. The Crowood Press. 2011. pp. 87
[28] Smolevskij V. M., & Gaverdovskij J. K.. Sportivnaja gimnastika [Artistic gymnastics], Kiev: Olimpijskaja literature. 1999. pp. 112-121
[29] Timnea O. C. Fiziologia efortului fizic [Physiology of physical effort]. Bucharest: Bren Publishing house. 2010
[30] Timnea O. C, & Baican M. S. Anatomie şi biomecanică [Anatomy and Biomechanics]. Bucharest: Discobolul Publishing House. 2017
[31] Triboi V. & Păcuraru A. Teoria şi metodologia antrenamentului sportiv [Theory and methodology of sports training]. Iaşi: PIM; 2013. p. 373
[32] Vieru N. Manual de gimnastică sportivă. [Handbook of sports gymnastics]. Bucharest: "Driada" Publishing House. 1997