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Original article

CHARACTERISTICS OF THE FUNCTIONAL CAPACITY INDICES OF ELITE FEMALE GYMNASTS

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Abstract*

Aim. This paper aims mainly at revealing the level of development of the functional capacity indices of elite female gymnasts during an Olympic cycle of training.

Methods. This scientific approach included an experimental study based on the research topic "Control and Planning of the Training Process of Elite Female Gymnasts in an Olympic Cycle". The following methods have been used: bibliographic study of the theoretical, conceptual, methodological and practical issues analyzed in the specialized literature; pedagogical observation; method of specific tests; pedagogical experiment, statistical-mathematical and data graphical representation method. The experimental study was conducted over the period 2013-2016, with two research groups (experimental, n=10 and control, n=10). The functional capacities of the gymnasts during an Olympic cycle were assessed by testing the following physiological parameters: heart rate (BPM), blood pressure, mm.Hg.; exercise capacity index (ECI), Ştanghe test (sec.), Ghencea test (sec.), Functional condition of the cardiovascular system (Robinson).

Results. The data obtained demonstrate the improvement of the cardio-vascular system functional possibilities in the dynamics of an Olympic cycle. The training efforts have a significant influence on the functional condition of the body starting from the third macro-cycle of the Olympic cycle and the last macro-cycle (at the significance threshold of statistical values of $P<0.01$ and $P<0.001$ with probability 99 and 99.9%).

Conclusions. The adaptation of elite female gymnasts' body functions under the influence of different intensity efforts was determined by the degree of complexity of the competitive program routines.

The increase of training efforts intensity entailed the increase of body functional capacity of the gymnasts. Thus the dimensions of the functional possibilities in each Olympic macro-cycle are varied by sports training activity and always surpassed.

Keywords: gymnastics, training effort, functional capacity indices, cardio-vascular system, performance.

Introduction

The principles of sports training are characterized by certain pedagogical, psychological and physiological laws and rules. The physiological principles of the functional training are particularly important because the functional processes underlying the state of health and development of female gymnast's body play a major role for the effective achievement of training objectives (Dragnea, Teodorescu-Mare, 2002; Dorgan, 2008, Triboi, 2013; Platonov, 2015).

Artistic gymnastics is currently experiencing a new level of development in terms of content and assessment of exercises. The large number of events, different as for construction and requirements, determine the specific movements on apparatus. The effort in women's artistic gymnastics is represented in another manner in each event on the four apparatus, involving numerous muscle groups in a large variety of movements (high level of complexity) in a relatively mixed energetic system, but with net anaerobic predominance (Vieru, 1997; Arkaev, Sichilin, 2004; Grimalschi, 2015, Potop, 2015; Buftea, 2016;).

Performance gymnastics has known a swift development in recent years, especially since new technical requirements have occurred. Gymnasts, coaches and researchers as well are concerned with achieving perfection. In reaching this goal, a special role is played by gymnasts' somatic type. Extensive national and international researches established a general somatic type for gymnastics, and more recently for groups of test events (Cimpeanu, 2014). For a very high level of training, the morpho-functional integration of the locomotor system, a good joint mobility and muscle elasticity, resistance to high tractions and pressures, very good muscle strength, good neuro-muscular coordination etc are

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mandatory. At cardio-vascular system level, the stress is a little smaller and the respiratory system works more (on apparatus) with the thorax blocked. It should be noticed the high number of analytical repetitions until the automation of movements is reached (Grigore, 2001; Gaverdovskij, 2014).

The particular value of the performances achieved in artistic gymnastics is also given by the process of children's selection and training, because the selection represents the birth certificate of the performance, the basis, the foundation upon which rests the high performance. It is a compulsory, evolving, continuous process of finding, choosing and sorting the future talents according to certain control criteria, tests and norms well-established. The somatic aspect is an important criterion in the initial selection, but also throughout training because, as a result of body growth and development, deficiencies can occur in the locomotor system. (Niculescu, 2003).

Regarding the somato-functional type and its hereditary determination, a series of data was obtained by different methods. Among the main somatic features are those that characterize the locomotor system, more strongly conditioned genetically than the fat tissue. As for the physiological parameters of the somatic type which were addressed together with the morphological ones for didactical reasons, most of the authors focused on the somato-functional characters and on their correlation with different final motor acts as well. That is why these physiological parameters were studied in correlation with their determinism on the level of motor skills (Nicu, 1999).

The main goal of the paper is to highlight the level of development of functional capacity indices of elite female gymnasts throughout an Olympic cycle of training.

Hypothesis of the paper. We consider that the adaptation of the functions of elite female gymnasts' body under the influence of different intensity efforts will determine the degree of complexity of the routines of the competition program.

Methods

This scientific approach entailed an experimental study based on the research topic ”Control and Planning of the Training Process of Elite Female Gymnasts in an Olympic Cycle”. The following methods have been used during this research: bibliographic study of the theoretical, conceptual, methodological and practical essential issues exposed in the specialized literature; pedagogical observation; method of specific tests; pedagogical experiment, statistical-mathematical and data graphical representation method. The experimental study was conducted during the period 2013-2016, with two research groups (experimental group, n=10 and control group, n=10). The functional capacities of the gymnasts throughout an Olympic cycle were assessed by testing the following physiological parameters: heart rate (BPM), blood pressure, mm.Hg.; effort capacity index (ECI), Ştanghe test (sec.), Ghencea test (sec.); functional condition of the cardiovascular system (Robinson).

Results

The data obtained are shown in Table 1 and Figures 1 to 7.

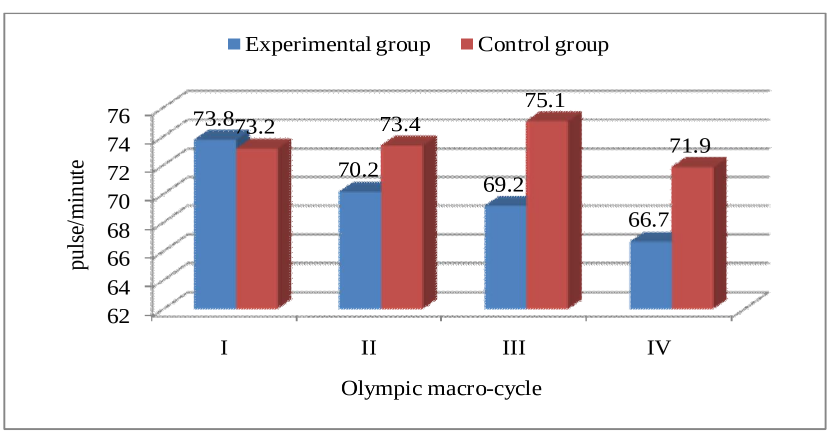

Fig. 1. Dynamics of heart rate of gymnasts in the Olympic cycle of sports training

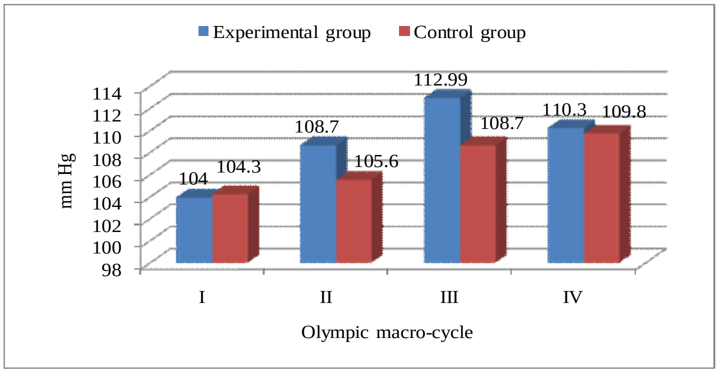

Fig.2. Dynamics of changes of systolic blood pressure of gymnasts in the Olympic cycle of sports training

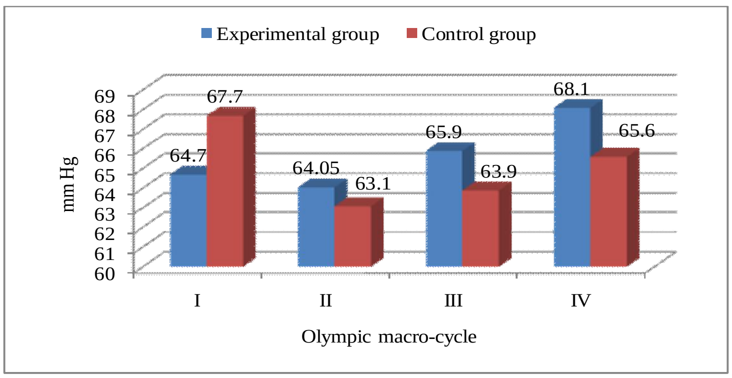

Fig.3. Dynamics of changes of diastolic blood pressure of gymnasts in the Olympic cycle of sports training

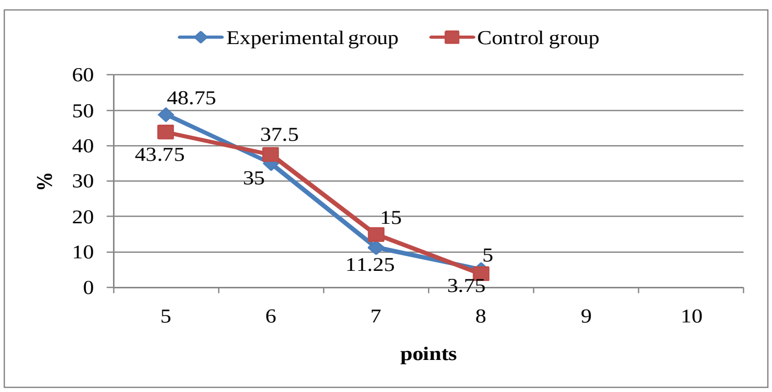

Fig.4. Dynamics of effort capacity of gymnasts in the Olympic cycle of sports training

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Table 1. Comparative analysis of the results of gymnasts' functional training indices

No	Parameters tested	Groups and statistics	Macro-cycle I and II				Macro-cycle II and III				Macro-cycle III and IV			
			Initial indices	Indices m. II	t	p	Indices m.II	Indices m.III	t	p	Indices m.III	Indices m.IV	t	p
			x±m				x±m				x±m			
1	Heart rate (pulse/minute)	E	73.80±1.2	70.20±0.57	4.88	<0.001	70.20±0.51	69.2±0.51	1.09	>0.05	69.2±0.51	66.7±0.31	4.09	<0.01
		C	73.20±1.23	73.4±1.03	0.32	>0.05	73.4±1.03	75.1±1.13	2.32	<0.05	75.1±1.13	71.9±0.41	4.12	<0.01
		t	0.34	2.79			2.79	4.75			4.75	3.30		
		p	>0.05	<0.05			<0.05	<0.001			<0.001	<0.01		
2	Blood pressure m m Hg – systolic	E	104.00±1.85	108.70±1.23	5.15	<0.001	108.70±1.23	112.99±2.05	3.70	<0.01	112.99±2.05	110.3±0.41	2.57	<0.05
		C	104.30±1.85	105.6±1.64	1.07	>0.05	105.6±1.64	108.7±1.54	3.41	<0.01	108.7±1.54	109.8±0.51	1.50	>0.01
		t	0.11	2.21			2.21	3.67			3.67	0.76		
		p	>0.05	<0.05			<0.05	<0.01			<0.01	>0.05		
3	Blood pressure m m Hg – diastolic	E	64.70±0.82	64.05±0.82	0.22	>0.05	64.45±0.82	65.9±0.41	1.40	>0.05	65.9±0.41	68.1±0.41	2.53	<0.05
		C	67.70±0.62	63.10±6.72	4.90	<0.001	63.10±0.72	63.9±0.41	1.05	>0.05	63.9±0.41	65.6±0.41	1.96	>0.05
		t	1.94	1.09			1.09	3.54			3.45	4.31		
		p	>0.05	>0.05			>0.05	<0.01			<0.01	<0.001		
4	Index of effort capacity	E	35.632±1.44	41.70±0.62	4.29	<0.001	41.70±0.62	50.2±0.51	9.16	<0.001	50.2±0.51	55.6±0.51	5.89	<0.001
		C	35.55±1.21	38.0±0.62	3.19	<0.01	38.0±0.62	44.0±1.13	6.81	<0.001	44.0±1.33	47.2±1.85	3.75	<0.01
		t	0.04	4.23			4.23	5.06			5.06	4.38		
		p	>0.05	<0.001			<0.001	<0.001			<0.001	<0.001		
5	Stanghe test (breathing retraining at inspiration) s	E	54.20±2.16	56.1±0.77	1.62	>0.05	56.0±0.72	56.5±0.41	0.44	>0.05	56.5±0.41	58.8±0.51	1.87	>0.05
		C	53.00±2.46	54.1±0.41	0.71	>0.05	54.1±0.41	54.5±0.62	0.44	>0.05	54.5±0.62	54.9±0.41	0.44	>0.05
		t	0.37	2.42			2.42	2.69			2.69	5.95		
		p	>0.05	<0.05			<0.05	<0.05			<0.05	<0.001		
6	Ghencea Test (breathing retraining at expiration) s	E	22.80±0.82	24.6±0.51	2.38	<0.05	24.6±0.51	28.8±0.31	4.89	<0.001	28.8±0.31	33.4±0.62	5.28	<0.001
		C	22.50±0.82	23.60±0.82	2.19	>0.05	23.60±0.82	25.3±0.82	3.38	<0.01	25.3±0.82	29.10±0.41	4.25	<0.001
		t	0.26	1.04			1.04	3.99			3.99	5.79		
		p	>0.05	>0.05			>0.05	<0.001			<0.001	<0.001		
7	Functional state of cardio-vascular system FCxTAS 100	E	76.87±2.53	75.04±1.10	1.10	>0.05	75.04±1.10	76.84±1.64	2.61	<0.05	76.84±1.64	73.57±0.41	6.17	<0.001
		C	76.94±2.61	77.18±0.88	0.14	>0.05	77.18±0.88	81.69±0.72	2.74	<0.05	81.69±0.72	78.94±0.60	3.03	<0.01
		t	0.02	1.52			1.52	3.71			3.71	5.39		
		p	>0.05	>0.05			>0.05	<0.05			<0.01	<0.001		

Note: Control group – 10. Experimental group – 10: f=20-2 ; P<0.05; 0.01;0.001; t= 2.101; 2.878; 3.922 f=9; P < 0.05; 0.01; 0.001 t= 2.262; 3.250; 4.000.

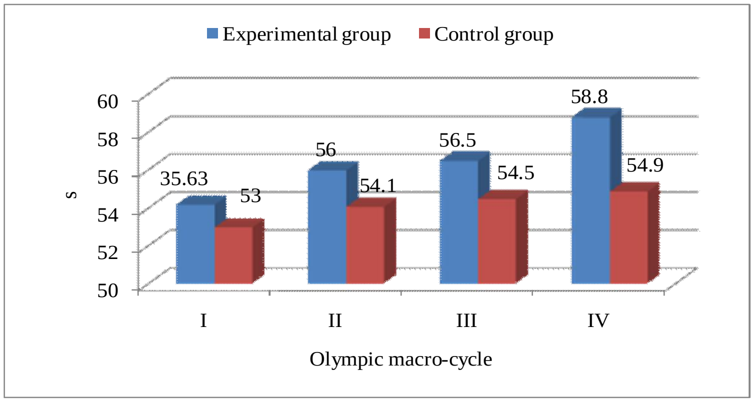

Fig. 5. Dynamics of changes of anaerobic capacities (Stanghe Test) of gymnasts in the Olympic cycle of sports training

Table 1 and Figures 6 and 7 show the indices of Stanghe Test and Ghencea Test that demonstrate the body capacities to perform intense physical efforts even in the case of oxygen deficiency. These indices depend on the intensity of the fermentative processes and the resistance of tissues to oxygen deficiency.

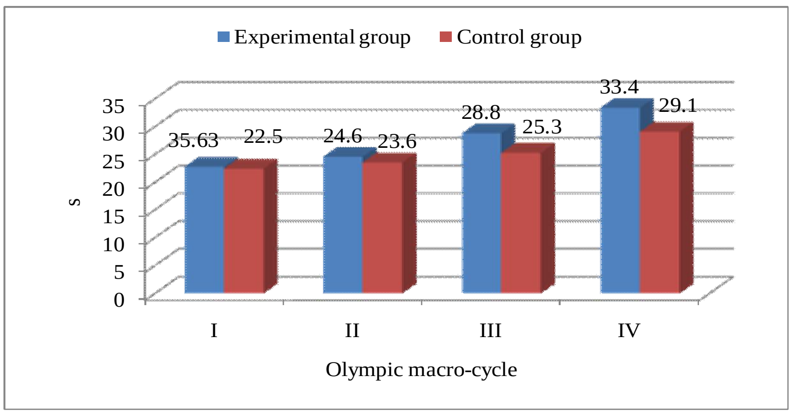

Fig. 6. Dynamics of changes of anaerobic capacities (Ghencea Test) of gymnasts in the Olympic cycle of sports training

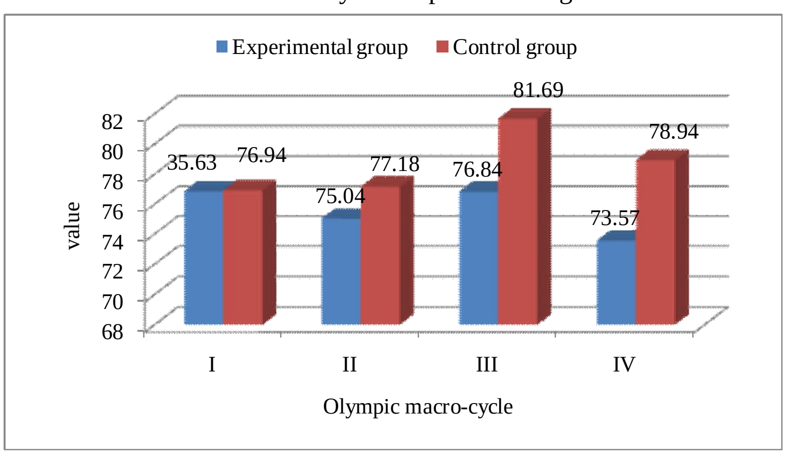

Fig. 7. Indices of functional state of cardio-vascular system of gymnasts in the Olympic cycle of sports training

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Discussion

The results of the cardio-vascular system functional status of the gymnasts belonging to the examined groups are presented in table 1. The data obtained show that the indices of the cardio-vascular status have a level that does not exceed the average values in both groups. There is a better status in the experimental group which statistically differs from the control group. The data are significant: $P<0.05$ in the 3rd macro-cycle, t=3.71; $P<0.01$ in the 4th macro-cycle compared to the 3rd macro-cycle with the significance of t=5.39; $P<0.001$.

The changes of heart rate during the multi-annual training sessions occurred in both examined groups after the first Olympic macro-cycle (fig. 1). In the experimental group – initially with the mean of 73.80 beats/min up to the mean of 70.20 beats/min in the second macro-cycle t=4.88; $P<0.001$. In the 3rd and 4th macro-cycle, the heart rate decreases up to an average value of 66.7 BPM because of the increase of lungs vital volume, which has also influenced the increase of the functional capacity of gymnasts' bodies during the annual macro-cycles of training.

It should be mentioned that the blood pressure increases up to a certain frequency in relation with the increase of heart rate (Potop, Grogore & Moraru, 2014; Cîmpeanu, 2014). If the heart rate goes beyond a certain limit, the cardiac rhythm gets too fast and the blood pressure may drop. This has happened in the experimental group, revealing changes after the 3rd macro-cycle of the Olympic cycle.

The exercises of women's artistic gymnastics, related to the intensity and duration of training session, produce a decrease of the systolic blood pressure from the average of 112.99 mmHg up to the average of 110.3 mmHg in the 4th macro-cycle IV. t=2.57. $P<0.05$. This hypotensive effect occurred in the cases when special efforts of the cardio-vascular system were required.

Until the third macro-cycle, the systolic blood pressure increases rapidly in relation with the increase of effort intensity. The diastolic blood pressure drops under the initial values before the effort. The pulse return time decreases considerably, at first an average of 73.8 pulse/min and in the end an average of 66.7 pulse/min., namely a decrease by 7.1 pulse/min (a decrease of 9.62%). The minimum blood pressure of the gymnasts in the control group begins to change significantly compared to the gymnasts of the experimental group starting with the third macro-cycle with statistic significance of P<0.01-0.001. The effort capacity indices (Table 1) were calculated after a standard effort of 5 min of steps up onto the gymnastics bench and down; the pulse is measured after 1 min of rest.

Statistical data show that at the initial testing in the first macro-cycle of the Olympic cycle the differences between the results of both groups were insignificant: t=0.04; $P>0.05$. Both examined groups had the same characteristics of the capacity for effort.

Significant statistical differences in the experimental group can be observed in the 2nd, 3rd and 4th macro-cycle. If in the 2nd macro-cycle the gymnasts had an average capacity of 41.7 points, in the 3rd macro-cycle the result increased significantly up to a good training, accumulating an average of 50.2 units, increasing this result to under very good training – 55.6 units (t=5.89. $P<0.001$). The control group achieved a medium training of 47.2 units. We conclude that at $P<0.001$ the difference noticed between the two examined groups is significant and the mull hypothesis is asserted.

The Stanghe test demonstrates that during the 1st to 3rd year of the Olympic cycle, the ability to activate under conditions of oxygen deficiency increased from an average of 54.20 s up to 56.10s. (t=1.62. $P>0.05$). Throughout the Olympic cycle, the Ghencea test values tend to increase insignificantly, given the fact that the difference between the first macro-cycle (54.20) and the 4th macro-cycle (an average of 58.8 s.) shows an increase by 4.6s with significance coefficient of t=2.74. $P<0.05$. The gymnasts of the control group have an insignificant increase, initially 53.00 and finally 54.9 ($P>0.05$). The significant difference between the research groups with the coefficient of P<0.05-0.001 demonstrates the superiority of the experimental group in increasing the functional status of the respiratory system. The exercises on gymnastics apparatus recommended according to the proposed model entailed the improvement of anaerobic capacity of gymnasts' body (fig. 5).

The results obtained demonstrate the improvement of the functional possibilities of the cardiovascular system in dynamics during the Olympic cycle. Thus we conclude that the training efforts have a significant influence upon the body functional status, starting from the 3rd macro-cycle of the Olympic cycle and the 4th macro-cycle (at the significance threshold of the statistical values of $P<0.01$ and $P<0.001$ with probability 99 and 99.9%).

Conclusions

The adaptation of elite gymnasts' body functions under the influence of different intensity efforts was determined by the degree of complexity of the routines of the competition program.

Obviously, during the multi-annual training process throughout the Olympic cycle, the functional capacity of gymnasts' body increased as the intensity of training efforts increased.

Consequently, the dimensions of the functional possibilities in each Olympic macro-cycle are varied by sports training activity and always exceeded.

Acknowledgments

This case study is an advanced stage of the pedagogical experiment of the post-doctoral thesis. We express our gratitude to the Gymnastics Federation of the Republic of Moldova and especially to the coaches of sports clubs in the country and abroad who helped us to carry out this research.

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