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Original article

STUDY ON THE SOMATO-FUNCTIONAL CHANGES OF THE JUNIOR FEMALE GYMNASTS AGED 12 TO 15 YEARS

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Abstract

Objective. The aim of this study was to assess the level of the somato-functional development and to analyze the relationship between their indicators in junior female gymnasts aged 12 to 15 years.

Methods. A number of 6 gymnasts of 12 to 15 years old (members of the Romanian junior team of women's artistic gymnastics) participated in this study. The somato-functional data were collected from the individual data sheets of the gymnasts after the medical examination made in the National Institute of Sports Medicine focusing on the anthropometric data, functional explorations and correlation between the studied indicators.

Results. The results of the anthropometric and functional indices of the junior female gymnasts aged 12 – 15 years reveal changes of the means relative to the standard deviation and differences between tests of t – parametric test related to the significance threshold of $p < 0.05$ and correlative connections in initial testing between the functional indices in lying down position at the diastolic blood pressure (DBP) and the somatic indices (SI): SI2, $R = -0.88$, SI5, $R = -0.85$, SI6, $R = -0.95$, SI7, $R = -0.96$, SI8, $R = -0.81$ and between DBP in orthostatism and SI9, $R = -0.87$. As for the final testing, in lying down position at the diastolic blood pressure (DBP) and SI2, $R = -0.82$, SI5, $R = -0.86$, SI6, $R = -0.92$, SI7, $R = -0.97$ and SI8, $R = -0.81$ and between SPB in lying down position and SI10, $R = -0.84$.

Conclusions. It has been confirmed that the performance artistic gymnastics has an influence on the somato-functional changes of the junior female gymnasts aged 12 to 15 years and that there are significant correlative connections between the studied indices.

Key Words: anthropometric data, functional explorations, statistical analysis, junior female gymnasts.

Introduction

As an aesthetic sport, the artistic gymnastics presents special movements of the body with technical character, in a beautiful form, easy execution, amplitude and expressiveness. In this sense, artistic gymnastics is characterized by motor coordination, emotional balance, resistance to stress, concentrated attention, vestibular balance etc., somatic biotype of small – medium size, underweight, very well-developed muscle strength. In order to ensure a very high level of training, a morpho-functional integrity of the locomotor system is required, along with good joints mobility and muscles mobility, resistance to tractions and high pressures and very good neuromuscular coordination. At the level of the cardio-vascular system, the stress is slightly smaller; regarding the respiratory system, much work was done (on apparatus) with the thorax blocked (Grigore, 2001; Potop, 2014).

Due to the specificity of the movements on the

gymnastics apparatus, the effort is distributed differentially on each one of the 4 apparatus in women's artistic gymnastics and 6 apparatus in men's artistic gymnastics. By alternating the static effort with the dynamic one during the whole training session, it can be stated that the aerobic type effort is of medium intensity; as for the effort on apparatus and the character of the exercises, we find out that some of them have maximum intensity of anaerobic type (Grigore, 1998; Potop, 2008).

According to Dradan, (1994), the special value of the performances in artistic gymnastics is also due to the process of selection and training. This process is called by some authors "talents identification" and is based on certain criteria that have been systematized as follows (Avramoff, 1982): medico-biological, psychological and medico-pedagogical ones (Potop, 2014; Smindu, 2018; Sukanti, Pranatahadi, 2018).

The knowledge of the biomechanical particularities (Prassas, Kwon, Samds, 2006; Potop,

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Grad, Boloban, 2013), in accordance with the trends of technical improvement (Gaverdovskij, 2007; Suchilin Arkaev, 2010) and the physiological demands to the body in artistic gymnastics entails the correct assessment of the efforts made by the gymnasts (Korobeynikov, Korobeynikova, Potop, Nikonorov, et al. 2018; Moeskops, Oliver, Read, Cronin, et al. 2018).

The *objective* of this study is to assess the level of the somato-functional development and to analyze the relationship between their indicators in junior female gymnasts aged 12 to 15 years.

Hypothesis of the study. We assumed that the practice of performance artistic gymnastics influences the somato-functional changes in junior female gymnasts of 12 to 15 years old and that there will be significant correlative connections between the analyzed indices.

Methods

The following methods were used to achieve the tasks and the purpose of the research: bibliographic study of the specialty literature; pedagogical observation; method of tests and measurements for somato-functional evaluation. The study had 6 subjects – gymnasts of 12- 15 years old, members of the Romanian junior team of women's artistic gymnastics. The somato-functional data were collected from the individual data sheets of the gymnasts after the medical examination performed in the National Institute of Sports Medicine, Bucharest from 17.03.2017 - initial testing to 17.10.2017 –final testing.

a) *Anthropometric and dynamometric data:* Height, (cm); Chest, (cm); Full arm span, (cm); Mobility, (cm); Weight, (kg); Thoracic perimeter, cm (at rest, inspiration, expiration, thoracic amplitude); Strength (dynamometry), kg - hand flexors (right hand and left hand) and strength (dynamometry), kg – lumbar muscles.

b) *Functional explorations:* Ruffier Test (P1, pulse/min; P2, pulse/min; P3, pulse/min; Ruffier index); Lying down – orthostatism test (heart rate (HR), pulse/min; systolic blood pressure (SBP), mmHg; diastolic blood pressure, (DBP), mmHg).

The method of statistical-mathematical calculation and graphical representation was applied with the help of KyPlot and Microsoft Excel programs, using the following statistical indicators: M - mean, \pm SD – standard deviation, R linear correlation coefficient - Pearson, t –parametric test, Paired Comparison for Means and R, Pearson.

Results

Table no 1 shows the results of the changes in the somatic development indices of junior female gymnasts aged 12 to 15 years, highlighting the changes of the means related to the standard deviation and the differences between tests of t – parametric test relative to the significance threshold of $p < 0.05$.

The results of the statistical calculations point out differences in the final testing. The height (cm) had an increase by 1.3 cm and significant differences at $p < 0.05$; the chest (cm) had an increase by 1.05 cm ($p < 0.05$); the full arm span (cm) had an increase by 2.65 cm ($p < 0.01$); the mobility of the spine (cm) decreased by 0.33 cm ($p > 0.05$); the weight (kg) increased by 2.32 kg ($p < 0.001$); the thoracic perimeter (cm) at rest had an increase by 3.66 cm ($p < 0.001$), at inspiration – an increase by 4.33 cm, ($p < 0.001$), at expiration - an increase by 4.67 cm; the thoracic elasticity had an increase by 1.33 cm ($p > 0.05$); the strength of the palmar flexors of the right hand (kg) increased by 1.66 kg ($p > 0.05$) while the left hand had a decrease by 2,33 kg ($p < 0,05$); the strength of the scapular muscles had an unchanged value of 1.00 kg and the strength of the lumbar muscles increased by 2.17 kg ($p > 0.05$).

Table no 1. Results of the changes of the somatic development indices in junior female gymnasts aged 12 to 15 years (n = 6)

Variables	M \pm SD		t	P value	
	Initial testing	Final testing			
Height, (cm)	145.98 \pm 4.67	147.28 \pm 4.81	-3.56	0.02	
Chest, (cm)	75.95 \pm 3.19	77.00 \pm 3.29	-2.99	0.03	
Arm span, (cm)	147.82 \pm 3.73	150.47 \pm 4.04	-5.33	0.003	
Mobil., (cm)	23.83 \pm 1.72	23.50 \pm 3.14	0.25	0.81	
Weight, (kg)	37.13 \pm 3.51	39.45 \pm 3.84	-10.19	0.0002	
Thoracic perimeter (cm)	Rest	73.67 \pm 3.78	77.33 \pm 3.01	-7.42	0.0007
	Insp.	77.67 \pm 3.72	82.00 \pm 3.03	-8.76	0.0003
	Expir.	68.00 \pm 4.82	72.67 \pm 3.34	-3.57	0.02
	Thor.elas	8.00 \pm 1.09	9.33 \pm 1.03	-2.17	0.08
Strength,	R flexors	19.67 \pm 1.51	21.33 \pm 3.07	-2.07	0.09

(kg)	L flexors	19.50±2.07	17.17±2.23	3.5	0.02
	Scapular	1.00±0.00	1.00±0.00	-	-
	Lomb.	53.33±9.67	55.5±13.69	-0.88	0.42

Mobil. – mobility; Insp.-inspiration; Expir.-expiration; Thor.elas – thoracic elasticity; M, mean; SD, standard deviation; n, number of subjects; t –parametric test, Paired Comparison for Means

In table no 2 are shown the results of the differences of the functional indices in junior female gymnasts aged 12-15 years, highlighting the changes of the means related to standard deviation in Ruffier

test, the heart rate and blood pressure in standing up and lying down position and the differences between tests of t –parametric test relative to the significance threshold of $p < 0.05$.

Table no 2. Results of the changes of the functional indices in junior female gymnasts aged 12 to 15 years, n = 6

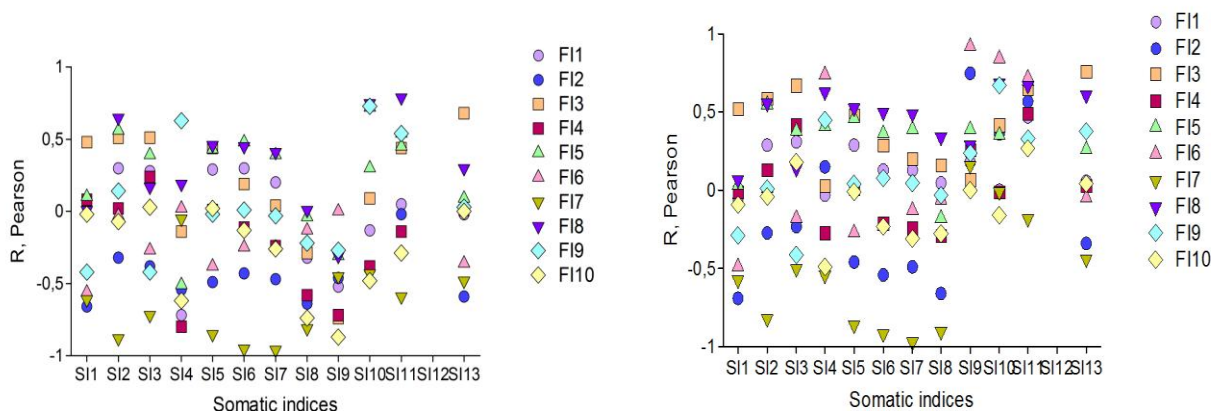
Variables	M ± SD		t	P value	
	Initial testing	Final testing			
Ruffier test	P1, pulse/min	78.00±4.19	79.33±4.91	-0.36	0.73
	P2, pulse/min	119.67±4.80	124.67±12.2	-0.80	0.46
	P3, pulse/min	79.33±3.93	80.00±7.16	-0.24	0.82
	IR, units	6.67±1.87	6.17±2.32	0.36	0.73
Lying down	HR, pulse/min	71.00±7.01	73.00±7.97	-0.5	0.64
	SBP, mmHg	100.83±4.92	105.83±9.70	-1.46	0.20
	DBP, mmHg	59.17±2.04	59.17±4.92	0.00	1.00
Ortho	HR, pulse/min	77.67±6.98	79.00±15.84	-0.19	0.85
	SBP, mmHg	105.83±6.65	101.67±7.53	1.58	0.18
	DBP, mmHg	52.5±4.18	62.00±4.89	0.17	0.87

RI –Ruffier index; HR – heart rate, DBP –diastolic blood pressure, SBP –systolic blood pressure, M, mean; SD, standard deviation; t –t parametric test, Paired Comparison for Means

The results of the statistical calculations reveal differences in final testing: Ruffier test had an increase by 1.33 pulse/min at P1 (pulse/min) and insignificant differences at $p > 0.05$; at P2 (pulse/min) it had an increase by 5.0 pulse/min ($p > 0.05$); at P3 (pulse/min) the increase was by 0.67 pulse/min ($p > 0.05$) and Ruffier index (IR) had a decrease by 0.5 units ($p > 0.05$); at the lying down-standing up test, in lying down position there was an increase by 2.00 pulse/min of the heart rate (HR, pulse/min) ($p > 0.05$);

the systolic blood pressure (SBP, mmHg) had an increase by 5.00 mmHg ($p > 0.05$); the diastolic blood pressure (DBP, mmHg) had the same values ($p > 0.05$). In orthostatism, the HR (pulse/min) had an increase by 1.33 pulse/min ($p > 0.05$), the SBP (mmHg) had a decrease by 4.16 mmHg ($p > 0.05$) and the DBP (mmHg) had an increase by 9.5 mmHg ($p > 0.05$).

Figure 1A and B show the results of the correlation between the variables of the somatic indices and functional indices, highlighting the values of the correlation coefficient R, Pearson related to $p < 0.05$.



A - initial testing

B - final testing

Figure no 1. Results of the correlation between the variables of the somatic indices and functional indices of the junior gymnasts of 12 -15 years old. SI1-13 –somatic indices (table 1); FI1-10 – functional indices (table 2)

The results of the correlative analysis highlight significant connections at $p < 0.01$ and $p < 0.05$ in the initial testing, as shown in figure 1A, between the functional indices in lying down position at the diastolic blood pressure (DBP) and the somatic indices Chest (SI2, $R = -0.88$), Weight (SI5, $R = -0.85$), Thoracic perimeter: at rest (SI6, $R = -0.95$), at inspiration (SI7, $R = -0.96$) and expiration (SI8, $R = -0.81$), between DBP in orthostatism and the thoracic elasticity (SI9, $R = -0.87$). In final testing there are significant connections at $p < 0.01$ and $p < 0.05$, presented in figure 1B between the functional indices in lying down position at the diastolic blood pressure (DBP) and the somatic indices Chest (SI2, $R = -0.82$), Weight (SI5, $R = -0.86$), Thoracic perimeter: at rest (SI6, $R = -0.92$), at inspiration (SI7, $R = -0.97$) and expiration (SI8, $R = -0.81$), between SBP in lying down position and the strength of the palmar flexors of the right hand (SI10, $R = -0.84$)

artistic gymnastics (Nassib, Mkaouer, Riahi, Wali, et al. 2019); to characterize the evolution of height and weight and somatotype and body composition in elite male gymnasts (Iruña Amigó, Busquets Faciabén, Marina Evrard, Galilea Ballarini, Carrasco Marginet, 2009).

A similar study referring to the somato-functional particularities of the junior female gymnasts aged 12 to 15 years, study conducted in the Romania national team throughout the period 2012 – 2013 (Potop, Grigore, Moraru, 2014), reveals higher values of the somatic indices (chest – 1.68 cm; height – 2.22 cm; full arm span – 3.31 cm; thoracic perimeter: at rest – 5.97 cm, at inspiration – 5.14 cm, at expiration – 7.81 cm and thoracic elasticity – 1.83 cm); strength of the palmar flexors of the right hand – 2.54 kg. There were recorded smaller values of the spine mobility – 0.14 cm, of the strength of left hand flexors - 1.47 kg and strength of the lumbar muscles -3,71 kg.

Discussion

In the context of artistic gymnastics, the influence of the intense training on the growth and development of male and female gymnasts is often discussed (Kalichová, Hedbávný, Pyrochtořová, Přihonská, 2019).

The specialized literature tried to evaluate the effects of intensive physical exercise and acute psychological stress during high level athletic competition as reflected on the levels of salivary cortisol in elite artistic gymnasts (Georgopoulos, Rottstein, Tsekouras, Theodoropoulou, A. et al. 2011); to investigate the most appropriate aptitudes for top-level sporting results in order to identify the physical profile of talents identified in women's

There are few studies that present the anthropometric characteristics and the performances of the female gymnasts. The authors Kaur and Koley, (2019b) made a review of the specialized literature in this regard and found out that only 16 studies out of 76 papers met these criteria. Regarding various anthropometric characteristics such as body size and composition affect the functional parameters (physical capacity), fitness (explosive strength, maximum speed, anaerobic and aerobic capacity) and agility that will benefit positively in enhancing the performance in gymnastics.

As for the estimation of back strength and its correlations with the selected anthropometric variables and performance tests in Indian state and national level gymnasts, Kaur and Koley, (2019a),

point out that the back strength was positively correlated with all selected traits except BMI, percent body fat and chest circumference-expanded.

Concerning the “Control and Planning of the Training Process of Elite Female Gymnasts in an Olympic Cycle”, V. Buftea (2017) explains the improvement of the functional capacity of the cardiovascular system in the dynamics of an Olympic cycle.

The results of the somatic development of the 12 to 15 years old female gymnasts highlight the increase of the somatic indices (height, chest and full arm span) in compliance with the body weight, the insignificant decrease of the spine mobility and the increase of the thoracic amplitude and perimeters, The segmental strength shows an increase of the lumbar strength and a disproportionate strength of the palmar flexors (increase in the right hand and decrease in the left hand).

The results of the functional development found out by functional explorations using Ruffier test reveals an improvement of the effort capacity even if the functional parameters have higher values in final testing and in the lying down – orthostatic test the indices of the heart rate and blood pressure have higher values in lying down position in final testing. At the end of the study we can conclude that the performance artistic gymnastics influences the somato-functional changes in junior female gymnasts of 12 to 15 years old and that there are significant correlative connections between indices.

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