ORIGINAL

Specifics of morphological factor among girls practicing artistic gymnastics at the stage of basic training

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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abstract

Background   The aim of the study was to determine the specificity of somatic build among girls practicing artistic gymnastics at the basic stage of training.

Material/Methods   The study involved 12 8–9-year-old girls practicing artistic gymnastics at BKSG „Zawisza". The girls had 3–4 years of professional training experience and were affected by a six-week training (3-4 hours a day). They had the level of youth class. Anthropometric measurements of selected somatic characteristics have been taken. The results were subject to anthropology-specific classifications and statistical analysis. With the use of an expert method, the rating of technical preparation among gymnasts was made. The evaluation was performed by a team consisting of five experts – licensed referees.

Results   The values of selected features and morphological indicators showed to be related to the gymnasts' technical level. Interdependence (p ≥ 0.05) was revealed in the body height, shoulders width and the shoulders indicator (a directly proportional character of correlation) and by the hips width (an inversely proportional correlation). The size of the critical correlation coefficient close to statistical significance was observed also for the body weight and for the thigh and lower leg perimeters. The results showed that during the early stages of training, requirements of the discipline favoured girls with bigger parameters of height, and weight – which does not coincide with the somatic model occurring among adult gymnasts.

Conclusions   In artistic gymnastics at early stages of education the requirements and specificity of the discipline (concerning the body height and the body weight) were not contiguous to the somatic model of mature artistic gymnasts. This aspect should be taken into account when conducting level-based assessments and projecting the development of young adepts of artistic gymnastics as well as developing classification programs in the youngest sport classes (choosing exercise elements which would be associated as little as possible with a somatic factor deviating from the model of the discipline) or enabling their performance on modified gymnastic equipment specially adapted to the children' capabilities.

Key words   female sporting gymnastics, somatic build, sports results

INTRODUCTION

When analysing specialist literature, we can find a large scope of information concerning the influence of specific physical effort on the development of a sports person's somatotype. Studies on the morphology of athletes practicing various sports disciplines in Poland have been conducted for decades.

Relatively much information concerning a morphological diversity among sport sections has been obtained – which has been diversified by sizes, proportions, components and the frequency of somatic types implementation, categorized according to various typological systems. Attempts to synthesize the problem were presented in separate publications [1, 2, 3, 4, 5, 6].

Today, the importance of morphological indicators is being discussed further. The above-mentioned problem concerns such issues as: the quality of morphological characteristics among representatives of different sport sections, the influence of sport training on sport persons' somatic build, updating and setting the direction towards changing their somatic build, morphological specificities of their physical fitness and the relationship between the selected somatic features and the level of their sports results [7, 8].

Physique, to a large extent determined genetically [9, 10], plays an important role in competitive sport [11]. The specificity of somatic build relies upon the character of performed work, and from the biomechanical point of view it is related to the efficiency of performing training exercises [12, 13].

An accurate choice of a sports discipline – i.e. based on physique characteristics – brings a substantial likelihood that a given athlete will, in the future, comply with discipline-characteristic criteria and will stand a chance of achieving success in sport [14, 15, 16, 17, 18].

Artistic gymnastics is classified as one of non-quantifiable sports, requiring high coordination skills. It is a very spectacular, yet difficult discipline, where competitors must undergo comprehensive general and special preparation, a discipline which is highly dependent on the proper technique and movement quality reflected by specific rules. In many studies as well as in methodical and training material is has been underscored that a discipline specificity requires proper development of particular body-parts, excellent coordination, high motor skills and proper mental preparation [19, 20, 21, 22].

It is claimed that success in this discipline depends on a comprehensive development of strength and endurance through speed-power workout and exercises that improve flexibility, coordination, etc. [21, 22, 23, 25].

Research results also indicate the existence of a specific structure, a determined size of the selected features and morphological indicators characterizing an athlete achieving high scores in this discipline [24]. Many researchers [26, 23, 26, 27, 28, 29] stress that morphological conditions affect the accelerated progress of sporting activities. Success in artistic gymnastics is fostered by specific body proportions, i.e. relatively long upper and lower limbs, increased shoulder width, shorter torso length and pelvis width [30]. These characteristics – in the case of women – are accompanied by lower parameters of body height and body weight [31, 32, 34].

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The model structure of female artistic gymnasts' physique has been changing over the years. This has been due to modifications in the technique of performing gymnastic figures, gymnastic equipment, judging criteria and the training system.

Gymnastics is also a sport of early specialization, where sports training begins at the age of 5–6 (or even earlier). This discipline is predestined for children, whose biological development is less evident than their peers' [23, 20, 21]. Although recruitment in artistic gymnastics is based on predispositions and body physique, it is targeted, and groups are quite homogeneous with the individual, genetically conditioned, development differentiating the tempo of morphological changes occurring in the bodies of young athletes. Thus, the selected children are characterized by different types of physiques. Therefore, a question arises whether at an early stage of sports training, the somatic structure can affect success in gymnastics. If so, which direction of state features at this stage is beneficial.

In context of the above, the aim of this study was to assess the specificity of somatic build among female artistic gymnasts at the basic stages of their sports training.

The proposed research problems have been defined in the form of the following questions:

What are the characteristics of female artistic gymnasts' somatic build at the stage of initial training?

At this stage of basic training, does the somatic build, expressed with the values of selected features and morphological indicators, show to be related to the gymnasts' technical level?

MATERIAL AND METHODS

The study involved 12 8–9-year-old girls, practicing artistic gymnastics at BKSG "Zawisza". The girls had 3–4 years of professional training experience, and were affected by a six-week training (3–4 hours a day). They had the level of youth class.

In order to assess physique specificities, anthropometric measurements of somatic features were conducted, including: width measurements (pelvis /is--is/, hips /ic-ic/, shoulders /a-a/), length measurements (upper limb /da III-a/, lower limb /B-tro/, torso /a-tro/, body height /B-V/), circumferences (shoulder, lower arm, thigh, shank, waist) and body weight. On the basis of parameter values, somatic build indicators were calculated: i.e. BMI, indicators for torso, shoulders and pelvis, upper limb and lower limb length, shoulder, lower arm, thigh and shank muscularity [35, 36].

The results were subjected to a standard statistical process, which calculated: the arithmetic mean (M), standard deviation (SD), coefficient of variation (V) and Spearman's rank correlation coefficient [37].

With the use of an expert method, evaluation of technical preparation among gymnasts was made. The evaluation was performed by a team consisting of five experts – licensed referees.

RESULTS

Tables 1 and 2 present basic numerical characteristics of selected physique features and morphological indicators of female gymnasts. Taking into account both groups, the analysed somatic build features (with the exception of high variability in shoulder width among girls attending the youth class) were characterized by small and moderate variability (V) – Tab. 1. In most cases, the girls presented the size of body mass and height belonging to younger age groups (based on a comparative analysis, own results – Resiak, Drabik, Niedzielska, Jankowski [38]).

Table 1. Numerical characteristics of selected features of the somatic body type among 8–9-year-old females in artistic gymnastics

Body Weight [kg]				
N	M	Min-Max	SD	V%
12	26.67	22.3-30.5	2.96	11.10
Body Height [cm]				
N	M	Min- Max	SD	V%
12	132.5	125-139	4.19	3.16
Upper Limb Length [cm]				
N	M	Min-Max	SD	V%
12	58.13	53.7-61.4	2.37	4.07
Lower Limb Length [cm]				
N	M	Min-Max	SD	V%
12	68.33	65.1-72.5	2.71	4
Torso Length [cm]				
N	M	Min.-Max.	SD	V%
12	37.33	35.5-39.8	1.31	3.5
Shoulders Width [cm]				
N	M	Min.-Max.	SD	V%
12	30.09	19.3-32.8	3.67	12.2
Pelvis Width [cm]				
N	M	Min.-Max.	SD	V%
12	19.65	18-21.1	0.95	4.8
Hip Width [cm]				
N	M	Min.-Max.	SD	V%
12	22.51	20-26.1	1.73	7.7
Shoulder Circumference [cm]				
N	M	Min.-Max.	SD	V%
12	18.96	16-21	1.54	8.1
Lower Arm Circumference [cm]				
N	M	Min.-Max.	SD	V%
12	19.42	17-21	1.37	7.07

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		Thigh Circumference [cm		
N	M	Min.-Max.	SD	V%
12	38.75	34-43	3.19	8.23
		Shank Circumference [cm]		
N	M	Min.-Max.	SD	V%
12	26.33	23-29	1.56	5.92
		Waist Circumference [cm]		
N	M	Min.-Max.	SD	V%
12	55.25	51-60	3.44	6.23

Table 2. Numerical characteristics of selected morphological indicators among 8–9-year-old females in artistic gymnastics

		BMI Index		
N	M	Min.-Max.	SD	V%
12	15.15	13.0-16.7	1.1	7.26
		Torso Indicator		
N	M	Min.-Max.	SD	V%
12	28.18	26.7-29.3	0.82	2.9
		Shoulders Indicator		
N	M	Min.-Max.	SD	V%
12	80.55	53.9-89.3	9.07	11.26
		Pelvis Indicator		
N	M	Min.-Max.	SD	V%
12	60.74	20.6-101.6	20.38	33.55
		Upper Limb Length Indicator		
N	M	Min.-Max.	SD	V%
12	43.89	41.0-46.8	1.62	3.69
		Lower limb length indicator		
N	M	Min.-Max.	SD	V%
12	51.57	48.9-53.3	1.42	2.6
		Shoulder Muscularity Indicator		
N	M	Min.-Max.	SD	V%
12	75.91	64.6-83.3	6.35	8.37
		Lower Arm Muscularity Indicator		
N	M	Min.-Max.	SD	V%
12	58.6	48.7-65.6	4.46	7.6
		Thigh Muscularity Indicator		
N	M	Min.-Max.	SD	V%
12	117.91	102.3-130.3	9.2	7.8
		Shank Muscularity Indicator		
N	M	Min.-Max.	SD	V%
12	74.48	67.0-79.4	4.27	5.7
		Rohrer's Index		
N	M	Min.-Max.	SD	V%
12	1.14	0.99-1.24	0.08	7.02

The range of differences reached four groups of age. Gymnasts 8 and 9 years old in 27.7% presented the body height characteristic of 7-year-old girls, and 16.6% presented the body height characteristic of their 8-year-old peers (Tab. 3).

Table 3. Individual results of body weight and height measurements among 8–9-year-old females gymnasts

Age	Body weight [kg]	Body height [cm]
8 y.o.	22.30	131.00
8 y.o.	25.40	127.00
8 y.o.	23.00	125.00
8 y.o.	24.10	130.00
9 y.o.	28.70	133.00
9 y.o.	30.50	135.00
9 y.o.	27.90	133.00
9 y.o.	27.00	136.00
9 y.o.	29.50	139.00
8 y.o.	28.50	136.00
9 y.o.	30.00	136.00
9 y.o.	23.10	129.00

Based on individual analysis of morphological indicators (Tab. 4) it was found that all the examined girls were characterized by the BMI characteristic of younger age groups. The scope of differences stretched to four age groups. In the study group, 100% gymnasts had a short trunk, 91.7% of the girls had broad shoulders. The majority of respondents were characterized by a narrow pelvis (91.7% of the study group), others (8.3%) had a wide pelvis. Gymnasts were also characterized by a varied size of the upper limb length ratio: 75% of the girls had short limbs, 25% had average limbs. The group did not show (by classification) a diversity index for the lower limb length – 100% of the girls were characterized by short lower limbs. In 50% the tested gymnasts were characterized by a slender and in 50% by a stocky arm build.100% of the girls had a slim forearm build. In 66.7% the tested girls presented a slim build of the thigh, and 33.3% of them had a stocky build. The girls were characterized by a slender build of the lower leg (100%). The whole group presented a leptosomatic body type.

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Table 4. Individual values of relevant morphological indicators among 8–9-year-old females gymnasts

Age	BMI Index	Torso Indicator	Shoulders Indicator	Pelvis Indicator	Upper Limb Length Indicator	Lower Limb Length Indicator	Shoulder Muscularity Indicator	Lower Arm Muscularity Indicator	Thigh Muscularity Indicator	Shank Muscularity Indicator	Rohrer's Index
8y.o.	13.0	28.7	76.9	66.8	41.0	49.8	69.6	55.4	107.9	68.1	0.99
8y.o.	15.6	28.5	81.8	71.3	46.8	52.8	78.4	62.0	117.7	75.0	1.24
8y.o.	14.7	28.4	83.1	67.8	44.4	52.1	75.6	59.9	114.3	77.4	1.18
8y.o.	14.3	27.5	53.9	101.6	45.4	52.4	71.2	56.4	110.8	70.2	1.10
9y.o.	16.2	28.9	85.2	61.8	43.0	51.2	81.6	61.2	129.9	77.1	1.22
9y.o.	16.7	27.0	89.3	64.4	43.5	53.0	83.3	62.7	124.6	78.4	1.24
9 y.o.	15.8	28.8	82.8	60.9	45.0	50.1	74.2	58.3	121.1	78.5	1.19
9 y.o.	14.6	27.6	81.3	60.7	45.0	53.3	64.6	48.7	102.3	67.0	1.07
9 y.o.	15.3	27.8	81.1	65.3	44.2	51.0	68.2	54.3	130.3	71.2	1.10
8 y.o.	15.4	26.7	88.7	59.6	41.5	53.0	82.6	65.6	114.3	75.5	1.13
9 y.o.	16.2	29.3	82.4	58.2	43.5	48.9	82.4	59.4	129.2	79.4	1.19
9 y.o.	13.9	28.9	80.2	20.6	43.4	51.3	79.2	59.4	112.5	76.0	1.08

Out of all the analysed somatic body type features (Tab. 5), interdependencies with the technical level performance have been observed in the body height (p ≥ 0.05).

Table 5. An assessment of correlations between the selected somatic build values among 8–9-year-old female gymnasts and their technical level

Somatic features	Youth class
Body weight	0.47
Body height	0.58*
Upper limb length	0.26
Lower limb length	0.28
Torso length	0.42
Shoulders width	0.56*
Pelvis width	-0.59*
Hip width	-0.07
Shoulder circumference	0.34
Lower arm circumference	0.13
Thigh circumference	0.40
Shank circumference	0.47
Waist circumference	0.24

* statistically significant at p < 0.05
** statistically significant at p < 0.01

The alternating statistical layout of correlation coefficient critical values, being close to statistical relevance of body height and body weight in both groups, proved the importance of values of these features, backed by the effects of sporting activity at the presented stage of sports training. However, a correlation in this (youth) class concerned the pelvis width and the shoulders width ($p \geq 0.05$). Additionally, in the youth class, correlation coefficient critical values close to statistical relevance to circumferences were identified: i.e. thigh and shank circumferences. The correlation of the above-mentioned somatic build values (with an exception of the shoulders width) was identified as directly proportional.

Out of all morphological indicators in the youth class interdependencies with the technical level (Tab. 6) have been observed in the shoulders indicator ($p \geq 0.05$). The correlation was directly proportional to the level of sport performance presented by the examined gymnasts.

Table 6. An assessment of correlations between the selected somatic build indicators among 8–9-year-old females gymnasts and their technical level

Morphological indicators	Youth class
Shoulder muscularity indicator	0.27
Lower arm muscularity indicator	-0.01
Thigh muscularity indicator	0.22
Shank muscularity indicator	0.29
Upper limb length indicator	-0.21
Lower limb length indicator	-0.02
Torso indicator	0.47
Shoulders indicator	0.58*
Pelvis indicator	0.26
BMI index	0.28
Rohrer's index	0.42

* statistically significant at $p < 0.05$
** statistically significant at $p < 0.01$

DISCUSSION

Although in groups of female gymnasts the analysed values of somatic build features (apart from high variability regarding the shoulders width) were characterized by small or moderate variability – which testifies to homogeneity within groups – the study results indicated the importance of morphological features and indicators in competitive sport.

The relation with the technical level was shown by the body height, the shoulders width, the pelvis width and the shoulders indicator ($p \geq 0.05$).

The results of the correlation coefficient close to statistical significance for body weight, testified to the importance of the size of this feature with the effects of sporting activities at the training stage presented by the gymnasts.

In addition, the critical value of the correlation coefficient close to statistical significance was observed for circumferences of thighs and the lower leg. With the exception of the pelvis width, the correlation had a directly proportional nature – meaning that gymnasts with bigger parameters of listed morphological characteristics and indicators (including height and weight) presented a higher technical level.

Thus, if the desired specificity of a gymnast body as shown by previous research (e.g. based on the characteristics of the best athletes in the discipline) is low and average height and weight, it can be concluded that at early stages of education the requirements and specificity of the discipline are not contiguous to the somatic model of adult gymnasts (concerning the body height and the body weight). It should be remembered when conducting level-based assessment and projecting the development of young adepts of artistic gymnastics. This aspect should also be taken into account in terms of developing classification programs in the youngest sport classes, selecting elements during which as little as possible would share the morphological factor that diverges from the discipline model. Modification of the basic gymnastic equipment should also be considered to help children with small height and low weight in performing exercises.

CONCLUSIONS

The measurements of selected features and morphological indicators were related to gymnasts' technical level.

From the somatic build characteristics which were adopted for the analysis, interdependence was shown between: body height ($p \geq 0.05$), pelvis and shoulders width ($p \geq 0.05$).

Correlation coefficient critical values close to statistical relevance were identified for body weight, thigh and shank circumferences.

Out of all morphological indicators, correlation with the technical level of sport performance was identified for: shoulders indicator ($p \geq 0.05$).

The correlation of the above-mentioned somatic build values (with an exception of the shoulders width) and morphological indicators showed a directly proportional character of the significance with the technical level.

In artistic gymnastics at early stages of education the requirements and specificity of the discipline (concerning the body height and the body weight) were not contiguous to the somatic model of mature artistic gymnasts.

This aspect should be taken into account when conducting level-based assessments and projecting the development of young adepts of artistic gymnastics as well as developing classification programs in the youngest sport classes (choosing exercise elements which would be associated as little as possible with a somatic factor deviating from the model of the discipline) or enabling their performance on modified gymnastic equipment specially adapted to the children' capabilities.

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