Anthropometrical Characteristics and Somatotype of Junior Rhythmic Gymnasts of Republic of Croatia

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Abstract: Aim of this study was to determine anthropometric measures (body height, body mass and body mass index) and somatotype (endomorph, ectomorph, mesomorph) of junior rhythmic gymnasts of Republic of Croatia, for every program level (A, B and C). The purpose was to determine if there are differences in morphological characteristics of junior rhythmic gymnasts of Republic of Croatia, for every program level (A, B and C), biological age and ranking achieved on competition. There were statistical differences between junior rhythmic gymnasts regarding biological age and program level, but not in regard to ranking achieved on competition. Average height of the rhythmic gymnasts is 160 centimetres, average body mass is 48 kilograms and body mass index are approximately 18 kg/m^2. Somatotype of rhythmic gymnasts of A program was 2,23-2,81-4,43.

1 INTRODUCTION

Relevancy of morphological characteristics (somatotype and body composition) in total equation/formula of success is observable in conventional sports in particular, where harmony of the body and aesthetics of movement structures are a primary element of evaluation for the judges, who then determine the score. Importance of specific body constitution of rhythmic gymnasts for achieving a high level of performance execution was documented by many authors (Claessens et al., 1991, 1992, 1997). Typical body constitution for a specific discipline has a positive impact on execution and is a factor which prevents injuries in sports (Poliszczuk and Broda, 2010).

Vandorpe et al. 2011, Zuniga et al. 2011, Siatras et al. 2009, 2010 agree that morphological characteristic in aesthetical activities are important factors in improvement of execution, and differentiating between elite and sub-elite athletes, which is additionally supported by studies from Menezes and Filho, 2006, Quintero et al., 2011, Purenović-Ivanović and Popović, 2014, Arriaza et al., 2016. Choreographies of conventional movement structures (such as rhythmic gymnastics, dancing, figure skating and other) have to be in accordance to morphological characteristics of the performer (Miletić, 2007).

2 METHODS

Subjects

Study was carried out on registered junior rhythmic gymnasts in Republic of Croatia, and the following clubs have been encompassed: KRG Leda, Zagreb, GK Maksimir, Zagreb, GK Aura, Zagreb, KRG Zagreb, Zagreb, GK Vindija, Varaždin, KRSG Poreč, Poreč, KRSG Gazela, Pula, GK Šibenik, Šibenik, and GK Dišpet, Šibenik.

Sample was comprised of 55 female rhythmic gymnasts, divided into three groups. First group (n1=15, body mass 46,88±8,87; body height 161,01±8,67; body mass index 17,92±1,95) was comprised of rhythmic gymnasts of the highest program level in rhythmic gymnastics - A program (international program), which is the most demanding. Second group (n2=20, body mass 46,34±8,26; body height 158,32±6,25; body mass index 18,36±2,24) was comprised of rhythmic gymnasts of B program level (national program), and the third group (n3=20, body mass 50,90±7,51; body height 161,51±5,24; body mass index 19,45±2,40) was comprised of rhythmic gymnasts of C program level (school program), which is the lowest program level.

Age of rhythmic gymnasts in the sample was equable, which presents and important prerequisite for data analysis, average age 13-15 years.

Sample of Variables

Sample of variables was comprised from three criteria variables: program level, subject age and their ranking on competition.

Predictor variables were comprised from 4 measures of morphologic characteristics: body mass, body height, body mass index and somatotype (endomorphic somatotype component - pronouncedly displays subcutaneous fat tissue, which is determined through addition of upper arm, abdomen and back skin crease; mesomorphic component - pronouncedly displays how developed is the musculoskeletal system, and is determined through body height, diameter of knee and elbow, corrected upper arm circumference and corrected lower leg circumference; ectomorphic component - displays linearity of the body and is determined with ponderal index, through relation of body mass and body height. Measurement of morphologic characteristics was conducted in accordance with International Biological Program (IBP – International Biological Program) instructions, which prescribes measurement methodology and predicts measuring the left side of the subject's body (Mišigoj-Duraković et al., 1995). To determine the somatotype of rhythmic gymnasts, Heath and Carter method (1967) was used. Biological age of subjects was determined in a way that time was calculated in months which have passed from the year of first menstruation (menorrhea), until the date of the conduction of tests.

Testing Protocol Description

Tests were conducted in the pre-competition period on all subjects with the same assessors and with uniform measurement procedure. Most of the measurements for the purpose of this study were conducted in the diagnostic centre at Faculty of Kinesiology, University of Zagreb. Some measurements were conducted in rhythmic gymnastics clubs from which the subjects originate. Measurements were performed by a team of educated and professional assessors. The assessors are professors of kinesiology and formerly educated graduates of Faculty of Kinesiology. After the measurements were finished, data from worksheets were entered into a computer for further analysis.

Data Analysis Methods

Analysis of data was conducted with Statistica for Windows, ver 10.0. Descriptive statistical parameters were calculated: arithmetic mean (AS), standard deviation (SD), minimal (MIN) and maximal (MAX) results, range (RAS), Skewness and Kurtosis. Distribution normality was determined by Kolmogorov-Smirnov test. After the somatotype was determined, and before further analysis of results, "partialization" was performed (according to Milas 2009, Gruić 2016), according to biological age (in relation with the period from menorrhea until the testing). Differences between models, according to age, program level and ranking, were determined by multivariate analysis of variance (MANOVA), and partial differences were determined by univariate analysis of variance (ANOVA). Statistical significance was tested with the error of 5% and controlled by application of Bonferroni correction.

3 RESULTS

Table 1: Analysis of normality of distribution of anthropometric variables of junior rhythmic gymnasts of Republic of Croatia.

Variables	max D	p
AMT	0,10	p > .20
AVT	0,07	p > .20
AITM	0,11	p > .20
ENDO.	0,18	p > .20
MEZO.	0,11	p > .20
EKTO.	0,18	p > .20

Max D-highest level of deviation, p-level of significance of K-S test, AMT – body mass, AVT – body height, AITM – body mass index, ENDO. – endomorph somatotype component, MEZO. – mesomorph somatotype component, EKTO. ectomorph somatotype component.

Results from Kolmogorov-Smirnov test conducted on data from anthropometric tests collected from junior rhythmic gymnasts of Republic of Croatia indicates that there is a normality of distribution of all analysed variables (table 1.), and that there are no statistically significant deviations from the normal theoretical distribution (p >.20); which is also confirmed through skewness values.

Table 2: Descriptive statistical parameters of anthropometric variables of junior rhythmic gymnasts of A, B and C programs of Republic of Croatia.

Variable	N	R	Min	Max	AS	SD	V	Skew.	Kurt.
AMT - A	15	26,2	34,5	60,7	46,88	8,87	78,60	-0,03	-1,28
AVT- A	15	27,4	146,4	173,8	161,01	8,67	75,14	-0,19	-1,10
AITM- A	15	7,91	15,13	23,04	17,92	1,95	3,82	1,07	2,32
ENDO -A	15	3,5	1	4,5	2,23	0,86	0,75	1,36	2,60
MEZO -A	15	2,9	1,5	4,4	2,81	0,88	0,77	0,20	-0,93
EKTO-A	15	4,5	1,5	6	4,43	0,96	0,92	-1,94	6,61
AMT – B	20	31,8	30,6	62,4	46,34	8,26	68,25	-0,10	-0,21
AVT- B	20	24,3	142	166,3	158,32	6,25	39,08	-1,07	0,94
AITM- B	20	9,85	13,69	23,54	18,36	2,24	5,04	0,12	0,59
ENDO -B	20	3,5	1,5	5	2,98	0,85	0,72	0,59	0,23
MEZO -B	20	4,5	1,6	6,1	3,41	0,86	0,74	1,26	4,97
EKTO-B	20	4,5	1,5	6	3,95	1,06	1,13	-0,11	0,59
AMT – C	20	27,38	34,9	62,28	50,90	7,51	56,35	-0,61	-0,57
AVT- C	20	17,8	150,8	168,6	161,51	5,24	27,41	-0,11	-0,85
AITM- C	20	8,02	15,35	23,37	19,45	2,40	5,78	-0,24	-1,12
ENDO –C	20	3,5	1,5	5	3,15	0,97	0,95	-0,09	-0,65
MEZO –C	20	3	1,9	4,9	3,27	0,88	0,77	0,27	-0,57
EKTO-C	20	4,5	1	5,5	3,53	1,40	1,96	-0,14	-1,00

N – number of subjects, R – range, Min. – minimal, Max. – maximal, AS – arithmetic mean, SD – standard deviation, V – variance, Skew. – Skewness, Kurt. – Kurtosis, AMT – body mass, AVT – body height, AITM – body mass index, ENDO. – endomorph somatotype component, MEZO. – mesomorph somatotype component, EKTO. ectomorph somatotype component.

Through descriptive analysis, it was determined that rhythmic gymnasts of A, B and C program were of equable height and mass, with the average height of 160 centimetres and with average body mass of 48 kilograms. Body mass index of approximately 18 kg/m^2 shows that rhythmic gymnasts are exceptionally lean, with a low percentage of subcutaneous fat tissue, which are characteristics of elite rhythmic gymnasts, which are expected to have a graceful body composition. Somatotype of rhythmic gymnasts of A program was 2,23-2,81-4,43 and indicates that rhythmic gymnasts of A program are of ectomorph constitution, which means that their muscles are elongated and "defined", there is a pronounced linearity of the body. Somatotype of rhythmic gymnasts of B program was 2,98-3,41–3,95 and indicates that rhythmic gymnasts of B program are of mesoectomorphic constitution, that is, basic component is ectomorphic, with addition of mesomorphic component. In trainees of C program, there is an equable distribution of all three body constitutions, with somatotype 3,15-3,27-3,53.

Multivariate analysis of variance (MANOVA) has shown that there are statistically significant differences between junior rhythmic gymnasts in measured morphologic characteristics according to biological age (p<0,001) and type of program (p<0,001), on a global level. According to achieved ranking on competition, statistical significance was not determined.

Table 3: Multivariate differences in morphologic characteristics of rhythmic gymnasts according to ranking, biological age and program level, acquired with MANOVA.

Variable	Wilks`Lambda	F	p
RANG	,82	.71	,73
BIOL.DOB	,50	3.32	,00
PROGRAM	,21	3.93	,00

Wilks`Lambda – value of Wilks`Lambda, F – approximal F – value, p- error, RANG – ranking achieved on competition, BIOL.DOB – biological age, PROGRAM - A, B or C program.

Through acquired partial differences of morphologic characteristics (table 4.) in relation to

achieved ranking on competition of junior rhythmic gymnasts of Republic of Croatia, it was determined that there are no total/global differences, and that statistically significant differences do not exist in any of the tests. ANOVA method did not display any statistically significant differences in observed anthropometric variables according to the program level, although, there was a general impact (Wilksλ=0,21; F=3,93, p=0,00) and with a certain reserve in conclusions of partial impact of body mass (AMT, F=2,55, p<0,09*). Statistically significant differences were determined in biological age, body mass (p<0,001), body height (p<0,001) and body mass index (p<0,001), which indicates to probable contributions of these factors that have an influence on increase of body mass and body height, changes in body composition, pubescence, etc…

Table 4: Partial differences of junior rhythmic gymnasts of Republic of Croatia in morphologic characteristics according to ranking, biological age and program level, acquired with ANOVA.

	Variables	F	p
RANG	AMT	2,01	0,16
	AVT	0,87	0,35
	AITM	1,55	0,22
BIOLAGE	AMT	41,87	0,00
	AVT	19,59	0,00
	AITM	27,25	0,00
PROGRAM	AMT	2,55	0,09*
	AVT	1,91	0,16
	AITM	2,06	0,14

4 DISCUSSION

Morphologic characteristics are one of more significant factors for success in rhythmic gymnastics (Di Cagno et al., 2008), next to psychological behaviour (Sedeaudet et al., 2014; Di Cagnoet et al., 2009), food (D´Alessandroet et al., 2007), age and maturity (Tringaliet et al.,2014.)

In former studies of Calderona et al (1986), Claessensa et al. (1991), Branda (1994), Purenović-Ivanović et al. (2016) body height of rhythmic gymnasts was approximately 150 (±5) centimetres, and body mass 40 (±3) kilograms, which are values

that are approximately 5 centimetres and 5 kilograms less than in Croatian rhythmic gymnasts. The same authors have stated that with an increase of results in observed variables, there is a tendency of decrease in the score of performance execution. Results of descriptive analysis of anthropometric variables displayed in this study were acquired from rhythmic gymnasts from all program levels (A, B and C), therefore, it is not out of the ordinary that the results in body mass and body height are somewhat higher in regard to results of elite gymnasts.

Somatotype of rhythmic gymnasts of A program (2,23- 2,81- 4,43) is in accordance with studies from other authors (Branda 1994, Claessens et al. 1991, Purenović-Ivanović, Popović 2014), and it can be concluded that the body type of rhythmic gymnasts "adapted" to the judging criteria on competitions. The gymnast will achieve a better "impression" on the judges if a standard where lean constitution benefits the aesthetical impression is satisfied, where somatotype of the gymnast is located in an ectomorph space. Besides the linearity of the body (lean and long muscles), gymnasts from B program exhibit a developed musculoskeletal system (2,98-3,41-3,95). In gymnasts from C program, there is an almost equal dispersion between all three types of body constitution, with somatotype 3,15-3,27-3,53. That is not unexpected, because C program is the lowest level, and there is no selection in that type of program, to make it possible for all interested children to participate in recreational exercising of rhythmic gymnastics, and to compete in competitions on school level.

5 CONCLUSION

Besides the conducted partializations of results according to biological age, it was determined that differences are large enough, and that the sources could be observed in secondary morphological characteristics, movement efficiency, subjective evaluations of scores of performance executions and other factors which are not encompassed in this study and, therefore, they limit the study. It can definitely be concluded that when participation in rhythmic gymnastics is not dependant on the result, then, it is a sport that can be practiced by children of all somatotypes. When there is an ambition for achieving results, then acquired results enable clear insight into and limited control over the somatotype through training, nutrition, selection, etc.

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