PREDICTIVE VALUES OF MORPHOLOGICAL CHARACTERISTICS IN RHYTHMIC GYMNASTICS

[1]Lejla Šebić-Zuhrić, [1]Muhamed Tabaković, [1]Ivan Hmjelovjec, [2]Almir Atiković
[1]Faculty of Sport and Physical Education, Sarajevo University, Bosnia and Herzegovina
[2]Faculty of Physical Education and Sport, Tuzla University, Bosnia and Herzegovina

Original scientific paper

Summary:
We examined the predictive values of morphological characteristics at the rhythmic gymnastics exercises performance at the sample consisting of unselected sample of 127 female pupils of first, second and third grades of high school. We used the set of the 22 variables, indicators of morphological characteristics and predictor system representatives, as well as the set of 10 basic rhythmic gymnastics elements as the indicators of criterion system. The examinees participated in a three-month rhythmic gymnastics training programme as a part of regular sport classes. The aim of the programme was to master the basic body elements: jumps, body balance, pirouettes and rhythmic gymnastics flexibility. After the three-month programme we examined the predictive values of the morphological characteristics at the 10 rhythmic gymnastics elements performance results which represent the basic movement structures of the free composition. Regression analysis showed a relatively high multiple correlation coefficients which confirms that the morphological characteristics have a high degree of predictive values in the rhythmic gymnastics elements performance results.

Key words: *rhythmic gymnastics, morphological characteristics, exercise performance*

INTRODUCTION

Research of morphological status as a predictor of a successful performance of esthetic movements in conventional type sports such as rhythmic gymnastics represent one of the important issues in kinesiology as they facilitate us in forming a morphological model of a top rhythmic gymnast based on scientific results.

Referee criteria in rhythmic gymnastics competitions aspire to promoting the ideal esthetic type of a top gymnast. The body type of the gymnasts has been adjusted to this requirement and they nowadays have long muscles and no subcutaneous fat tissue, they are tall and elegant (Branda 1994).

The studies made so far aiming at identifying morphological characteristics as a predictor of success in rhythmic gymnastics show prevailing views according to which a moderate and fat tissue below average is desirable in a gymnast (Douda et al., 1988; Miletić et al., 2004), as well as body weight and height below average (Case, Fleck, Koehler 1980; Alexander 1991; Branda 1994; Wolf-Cvitak 1993; Hume et al., 1993). The following table shows an overview of various researches of certain morphological features (body height, body weight and fat tissue percentage) on the sample of elite, average and beginner rhythmic gymnasts (Table 1.).

Some authors (Jastrjembskaia and Titov 1999) recommend ideal weight and height for beginner gymnasts at the age of 7 to 8 years as a part of the selection process (117 cm and less than 25 kg). The same authors state that rhythmic gymnasts have certain desirable body proportions, for example, the desirable hand length should be 11% of the body height, while the desirable leg length is 50% of the body height. Such authors have done research on gymnasts but, for the selection process and determination of desirable morphological characteristics that may prove to be significant in the process of adoption of specific motor skills in training, the important things is that such research should be conducted on beginners precisely. At the same time, this is the outstanding issue in rhythmic gymnastics as a discipline in which competition rules often change.
Beginner rhythmic gymnasts must overcome a large number of motor skills in exercise with and without props so as to be able to achieve the criteria imposed by the book of rules and be eligible for competitions.

Table 1: Average value of certain morphological characteristics of rhythmic gymnasts according to the results of research conducted so far on the sample of elite (E), average (P) and beginner (PO) rhythmic gymnasts

Research	Sample status	Average age (yrs)	Average height (cm)	Average weight(kg)	% fat tissue
Case, Fleck, Koehler (1980)	E	-	162	53,4	11,24
Gionet et al. (1986)	E	15	160	45	-
Alexander et al. (1987)	E	14	159	42,7	13,6
Alexander (1989)	E	15	164	49,6	13
Alexander (1991)	E	15	164	49,1	12,1
Alexander (1991)	P	13,7	164	48	12
Hume et al. (1993)	E	18	162	50	16,1
Hume et al. (1993)	P	13,6	156	47	17,4
Georgopoulos et al. (2002)	E	17,1	166	47	13,1
Klentrou and Plyley (2003)	P	14,5	160	43,4	14,3
Miletić et al.. (2004)	PO	7	130	26	-

The fundamental issue in this research is to establish whether there are morphological characteristics that can be desirable or limiting for the learning process itself, as well as for the process of adopting basic body elements by beginner rhythmic gymnasts.
The primary goal of this research is determination of predictive values of morphological characteristics on successful performance of elements without props in rhythmic gymnastics. In other words, it is necessary to determine the importance and relative impact of variables of morphological characteristics on a one-dimensional criterion defined as success in performing elements in rhythmic gymnastics in exercises without props. Exercises without props are important as this is the first exercise the girls face in the rhythmic gymnastics training process, and it represents the basis of the future success of a gymnast.

METHODS

The group of examinees in this research is defined as a population of high school female students aged 16 to 18. All examinees attended the „Druga gimnazija“ High School in Sarajevo. The group (sample) can be considered non-selective and beginner rhythmic gymnasts. The overall number of examinees in whom values of variables were registered and who were subjected to final processing and analysis is 127.
The students were involved in a three-month programme of rhythmic gymnastics training within regular sport classes. The aim of the programme was to master basic body elements: jumps, balance, pirouettes and mobility in rhythmic gymnastics.
After the completion of the three-month training programme, there followed the determination of predictive values of morphological characteristics on the success of realisation of ten rhythmic gymnastics elements that represent the basic movement structures of the free stance in exercises without props in rhythmic gymnastics.

The sample of predictor variable for the assessment of *morphological characteristics* in this research includes a group of twenty-two (22) measurement tests. The following variables were used for the assessment of longitudinal skeleton dimensionality: body height (AVISTJ), arm length (ADUZRU), hand length (ADUZSA), leg length (ADUZNO), foot length (ADUZST). The following variables were used for the assessment of *transversal skeleton dimensionality*: biacromial span (ABARAS), elbow diameter (ADJLAK), wrist diameter (ADJRUZ), bicrystal span (ABKRAS), knee diameter (ADJKOL), ankle diameter (ADJSKZ), hand diameter (ADJSAK). The following variables were used for the assessment *body volume and mass*: body mass (ATEZTJ), mean chest volume (ASROGK), upper arm volume (AONADL), upper leg volume (AONATK), lower leg volume (AOPOTK), waits volume (AOSTRU). The following variables were used for the assessment of *subcutaneous fat tissue*: back skin fold, upper arm skin fold (ANNADL), stomach skin fold (ANTRBU), lower leg fold (ANPOTK).

The sample of criterion variables for the assessment of success in performing the elements of rhythmic gymnastics without props in this research includes a group of ten rhythmic gymnastics elements in exercises without props: children's jumps, "arabesque" level , two-leg 720-degrees turn, body wave aside, swing infront of legs, cat jump, ring" balance, rolling on the ground, far-high jump and deer jump.

As a result of the use of the method of the first chief component from the stated system of variables in the factor analysis, the criterion variable containing the greatest amount of data obtained from the system has been labelled rhythmic gymnastics.
Regression analysis was applied for the purpose of determining the predictive values of morphological characteristics on the success in performing rhythmic gymnastics elements, i.e. determining the significance and relative impact of variables of morphological characteristics on the one-dimensional criterion – success in performing the elements of rhythmic gymnastics without props.

RESULTS AND DISCUSSION

Factor method of the first component of criterion variables system (elements of rhythmic gymnastics).

One more variable has been isolated from the criterion variables system (elements of rhythmic gymnastics). It contains the greatest amount of information related to that system and represents criterion variable Rhytmic Gymnastics. The condensation process of the set of applied variables was carried out and it resulted in obtaining variables with the highest variability in the matrix space Z.
The results of the factor method of the first principal component of the criterion variables system are presented in the tables 2 and 3.

The first principal component with the value 6,023 (Total), which is (Cumulative %) 91,229 % of the total variance explained of rhythmic gymnastics variables, was extracted on the basis of the solved characteristic equation of the correlation matrix (Table 2.), that is, by factoring correlation matrix of the applied variables of rhythmic gymnastics elements.

Table 2: Matrix of characteristic roots and total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6,023	60,234	60,234	6,023	60,234	60,234
2	1,638	16,376	76,610			
3	1,024	10,237	86,846			
4	,438	4,383	91,229			
5	,336	3,358	94,588			
6	,228	2,277	96,865			
7	,143	1,434	98,299			
8	,099	,989	99,288			
9	,044	,439	99,727			
10	,027	,273	100,000			

Extraction Method: Principal Component Analysis.

Table 3: Matrix of the isolated first principal component

Varijable	Component 1
SPDJP	,837
RAVAG	,674
OK2NZ	,823
PVZAK	,775
PVZAM	,529
SPMAC	,891
RAPRS	,725
PVKOT	,804
SPDAL	,763
SPJEL	,874

Extraction Method: Principal Component Analysis a 1 components extracted

The analysis of the matrix of the isolated first principal component (Table 3.), in which the coefficients of first matrix component are demonstrated, (correlations of vectors of manifest variables with isolated first component) show that all ten applied rhythmic gymnastics elements have equable and very high correlations with the first principal component. The first principal

component is highly saturated with all estimated rhythmic gymnastics elements and hypothetically represents a general success in rhythmic gymnastics.

The regression analysis of criterion variables (RHYTHMIC GYMNASTICS) in the manifest space of morphological variables (Table 4.) provides information on the impact of applied morphological variables on the success in performing the treated criterion variable.
The predictor system of variables explains (R Sguare = 29 %) the joint variability with the criterion, while the correlation of the overall predictor system of variables with the criterion, i.e. the coefficient of multiple correlation is (RO = .54), which represents a relatively high value, while the correlation is significant at the level (Sig . = .01)
The remaining 71 % in explaining the joint variability can be attributed to other characteristics and examinees' abilities that have not been covered by this research (motor, functional, conative and cognitive characteristics...).

Table 4: The regression analysis of the criterion variable Rhythmic Gymnastics in the manifest space of motor variables

RO	R Square	Adjusted R Square		Std. Error of the Estimate	
,542	,294	,144		,92507017	
	Sum of Squares	df	Mean Square	F	Sig.
Regression	37,001	22	1,682	1,965	,012
Residual	88,999	104	,856		
Total	126,000	126			

Key: RO – multiple correlation coefficient, R Square – criterion variable determination coefficient, Std. Error of the Estimate, Sum of Squares Regression – valid variance, Sum of Squares Residual – outstanding variance, Sum of Squares Total – total variance, df – degrees of freedom, F – the test used for determining the significance of the multiple correlation coefficient, Sig.- the level of multiple correlation significance.

By analysing the impact of particular – partial (Beta) regression coefficients (Table 5.), it can be seen that two variables from the predictor system of morphological characteristics have the statistically significant impact on the criterion variable (RHYTHMIC GYMNASTICS), as follows: body weight (ATEZTJ) and lower leg skin fold (ANPOTK), both of which are significant at the level of (Sig = or < .05).
The research has confirmed that body mass and subcutaneous fat tissue have a highly negative impact on successful learning and mastering the basic body elements in beginner rhythmic gymnasts.
Research results also show that the girls with a greater body mass and a higher percentage of subcutaneous fat tissue will master the basic elements in rhythmic gymnastics exercises without props with more difficulty and in a much more slowly manner.

The Wolf-Cvitak research (1993) showed that the possibility of a more successful performance of jumps in rhythmic gymnastics is evident in middle height girls with narrow hips and relatively small body weight, while the efficiency of performance of elements in balanced positions is negatively affected by morphological variables such as longitudinal and transversal dimensionality and body mass and volume.

Similar results were obtained in the Miletić research (1999), confirming that overly body volume and fat tissue make it difficult to perform complex structures and generally affect the overall impression, including the final mark in rhythmic gymnastics.

The relatively high multiple correlation, the percentage of joint variability of the predictor system of variables with the criterion and a rather modest number of valid partial regression coefficients obtained within the presented regression analysis indicates that the prediction – the prognosis of the impact of predictors on the criterion variable can be better done with the assistance of the entire system of predictor variables of morphological characteristics.

Table 5: Individual - partial results of the regression analysis of the predictor system of morphological variables on the criterion variable Rhythmic Gymnastics

Variables	Unstandardised Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
AVISTJ	-,042	,042	-,275	-1,013	,314
ADUZRU	-,025	,052	-,084	-,475	,636
ADUZSA	,020	,080	,027	,252	,801
ADUZNO	-,036	,047	-,180	-,759	,450
ADUZST	-,088	,086	-,121	-1,023	,309
ABARAS	-,039	,068	-,063	-,573	,568
ADJLAK	,547	,376	,176	1,454	,149
ADJRUZ	,106	,413	,027	,256	,798
ABKRAS	,026	,060	,056	,433	,666
ADJKOL	-,045	,281	-,022	-,161	,872
ADJSKZ	,036	,331	,015	,110	,913
ADJSAK	,308	,282	,121	1,093	,277
ATEZTJ	,107	,056	-,815	1,918	,044
ASROGK	-,030	,035	-,155	-,857	,393
AONADL	,001	,004	,023	,247	,805
AONATK	-,031	,055	-,128	-,554	,581
AOPOTK	-,039	,071	-,094	-,551	,583
AOSTRU	,002	,002	,101	1,102	,273
ANLEDJ	-,098	,054	-,245	-1,830	,070
ANNADL	-,032	,048	-,092	-,652	,516
ANTRBU	-,054	,044	-,181	-1,243	,217
ANPOTK	-,102	,039	-,319	-2,621	,010

Key: Std. Error – standardised regression coefficient error,
Beta – partial regression coefficient, t – each predictor variable's contribution,
Sig.- the level of partial regression coefficients significance.

CONCLUSIONS

The discussion on the anthropometric factors, in addition to a good command of the morphological type of elite gymnasts, must be based on the characteristics of beginners, the monitoring of the level of motor information and the relations with other segments of the anthropological status during growth and development.The research has confirmed that body mass and subcutaneous fat tissue have a highly negative impact on successful learning and mastering the basic body elements in beginner rhythmic gymnasts. Availability of scientific information on the impact of morphological characteristics on the ability of learning, adopting and performing motor skills in rhythmic gymnastics can significantly improve the process of orientation and selection in rhythmic gymnastics schools.

REFERENCES

1. Aleksander, M. J. (1991). *Physiological characteristics of top ranked rhythmic gymnasts over tree years*. Journal of human movements studies, 21, 99-127.
2. Aleksander, M. J., S. R. Boreskie, S. Law (1987). *Hart rate response and time motion analysis of rhythmic sportive gymnasts*. Journal of human movements studies, 13 (9): 473-489.
3. Branda, A. (1994). *Efects of development of rhyrhmic sportive gymnastics on physical habitus of rhythmic gimnasts*. 10th Commonwealth & International Scientific Congress; Victoria, British Columbia, Canada.
4. Case, S., S. Fleck, P. Koehler (1980). *Physiological and performance characteristics of the 1979 USA RG team. International Gymnast*, 22(4), TS 10-11.
5. Douda, H., S. Tokmakidis, N. Tsigilis (1998). *The effect of training during growth on rhytmic sports gymnasts development*. In Sargeant A. J., Siddons H. (Eds.); Third ECSS Proceedings Book (p.p. 267). Manchester, UK.
6. Fédération Internationale de Gymnastique (2001). *Code of Points in Rhythmic Gymnastics*. Abruzzini, E. (Ed.). FIG.
7. Georgopoulos, N., K. Markou, A. Theodoropoulou, D. Benardot, M. Leglise, A. Vagenakis (2002). *Growth retardation in artistic compared with rhythmic elite female gymnasts*. J Clin Endocrinol Metab, 87(7):3169-73.

8. Hmjelovjec, I. (1989). Relacije između antropometrijskih i psihomotornih karakteristika sa uspjehom u realizaciji kretnih kvaliteta sportske gimnastike studenata. Doktorska disertacija, Sarajevo: Fakultet za fizičku kulturu.
9. Hume, P. A., W. G. Hopkins, D. M. Robinson, S. M. Robinson, S. C. Hollings (1993). Predictors of attainment in rhytmic sportive gimnastics. The Journal of Sports Medicine and Physical Fitness, 33 (4):367 - 377.
10. Jastrjembskaia N., Y. Titov (1999). Rhythmic Gymnastics. Human Kinetics, USA
11. Klentrou, P., M. Plyley (2003). Onset of puberty, menstrual frequency, and body fat in elite rhythmic gymnasts compared with normal controls. Br J Sports Med, 37: 490 - 494.
12. Miletić Đ., N. Viskić - Štalec (2002). Clubs in rhythmic gymnastics – differences between 7-year old girls. In: Milanović D., F. Prot (Eds.), International Scientific Conference «Kinesiology – new perspectives» Proceedings Book, Book (p.p.624-627), Faculty of Kinesiology, Opatija.
13. Miletić, Đ., Ž. Kragić, R. Bašić (2004). Ocjenjivanje osnovnih elemenata loptom u ritmičkoj gimnastici. U: Findak V. (Ur.), Zbornik radova 13. ljetne škole kineziologa republike Hrvatske (str:364-368), Rovinj.
14. Miletić, Đ., R. Katić, B. Maleš (2004). Some Anthropologic Factors of Performance in Rhythmic Gymnastics Novices. Coll. Antropol. 28(2):727-737.
15. Tabaković, M. (2003). Relacije morfoloških karakteristika, motoričkih sposobnosti i uspjeha u izvođenju elemenata sportske gimnastike na parteru i preskoku. Doktorska disertacija, Sarajevo: Fakultet za fizičku kulturu.
16. Wolf - Cvitak, J. (1993). Odnosi između morfoloških i motoričkih karakteristika i osnovnih elemenata tehnike u ritmičko - športskoj gimnastici. (disertacija). Zagreb: Fakultet za fizičku kulturu.

PREDIKTIVNE VRIJEDNOSTI MORFOLOŠKIH KARAKTERISTIKA U RITMIČKOJ GIMNASTICI

Izvorni naučni rad

Sažetak:
Utvrđivanje prediktivnih vrijednosti morfoloških karakteristika na uspješnost izvođenja vježbe bez rekvizita u rimičkoj gimnastici provedeno je na neselekcionisanom uzorku od 127 učenica I, II i III razreda "Druge gimnazije" u Sarajevu. U istraživanju korišten je skup od 22 varijable za procjenu morfoloških karakteristika koje ujedno predstavljaju prediktorski sistem, i skup od 10 osnovnih elemenata bez rekvizita u ritmičkoj gimnastici koje predstavljaju kriterijski sistem. Učenice su bile uključene u tromjesečni program treninga ritmičke gimnastike u okviru redovne nastave izbornog predmeta – sport. Cilj programa je bio savladavanje osnovnih tjelesnih elemenata: skokova, ravnoteža, pirueta i pokretljivosti u ritmičkoj gimnastici. Nakon tromjesečnog programa obuke, izvršeno je utvrđivanje prediktivne vrijednosti morfoloških karakteristika na uspješnost u realizacji deset elemenata ritmičke gimnastike, koji predstavljaju bazične kretne strukture slobodnog sastava u vježbanju bez rekvizita u ritmičkoj gimnastici. Primjenom regresione analize dobijen je relativno visok koeficijent multiple korelacije, koji potvrđuje da morfološke karakteristike imaju visok stepen prediktivnih vrijednosti u pogledu ostvarivanja uspijeha u ritmičkoj gimnastici.

Ključne riječi: ritmička gimnastika, morfološke karakteristike, vježba bez rekvizita

Correspondence to:

Lejla Šebić-Zuhrić, Ph.D.
Sarajevo University
Faculty of Sport and Physical Education
Patriotske lige 41
71 000 Sarajevo
Phone: 061 215-415
E-mail: lsebic@fasto.unsa.ba