

CORRELATION BETWEEN MOTOR SKILLS AND PERFORMANCE EVALUATION OF BALL ROUTINE ELEMENTS IN RHYTHMIC GYMNASTICS

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Abstract

The primary aim of this research was to establish if there exists any correlation between motor skills and success in performing technical elements of the ball routine in rhythmic gymnastics. The research was conducted on 52 female sophomore students of the Faculty of Kinesiology at the University of Zagreb. The students were put through a series of 12 tests establishing their basic motor skills: coordination, flexibility, explosive strength and static strength. Their success in performing technical ball routine elements (6), which are defined and prescribed in the course plan and program, was assessed by five competent judges. Through regression analysis it was established that a cogent statistical significance between the observed motor skills and success in performing technical elements from the ball routine does not exist. From the set of predictor variables, only the test for assessing coordination MBKS3L (slalom with three balls) showed statistical significance in the prediction of success in performing the selected criterion element.

Key words: *students, coordination, flexibility, strength, regression*

Introduction

Rhythmic gymnastics is a conventional sport, which is characterized by the unity of the movement of the whole body complimented with the manipulation of apparatus in harmony with music that represents an integral part of all movements. (Wolf-Cvitak, 2004). The successful execution of individual competition compositions depends on the current Code of Points prescribed by the sport's governing body, the *Fédération Internationale de Gymnastique* (susceptible to changes in each Olympic cycle), judicial discretion, the gymnasts degree of preparedness and contemporary trends in the sport (Jastremskaia, N., Titov, Y., 1999). The gymnasts performance is evaluated by judges based on thoroughly established criteria, however, as there does not exist a precise measuring instrument, the final score depends on the judges subjective assessment, and therefore errors are possible. The execution of elements that are an integral part of the choreography depends on a number of different factors: the level of motor skills, which according to Wolf-Cvitak (1984) affects the performance of rhythmic gymnasts by up to 60%. As a precondition to virtuosity in handling the apparatus, with the simultaneous coordinated execution of physical elements. (Kolarec, 2012). Well developed motor skills allow for the adoption of the basic elements of rhythmic gymnastics, creating a broad base for learning technical skills: elements with and without apparatus (rope, ball, hoop, clubs and ribbon), which the quality of the performance of competitive compositions depends on (Jastrjemskaia, Titov, 1999). Besides motor skills the success of rhythmic gymnasts is affected by: cognitive abilities, conative characteristics and morphological characteristics, important for the execution of elements and choreography, and artistic impression (Vandorpe et al, 2011; Zuniga et al, 2011; Siatras et al, 2009).

Full-time female students of the Faculty of Kinesiology at the University of Zagreb take the rhythmic gymnastics course in their second year of study. The course syllabus includes the acquisition of general motor skills by adopting the basic physical elements of rhythmic gymnastics and manipulation techniques for each of the apparatus (rope, hoop, ball, clubs, AND ribbon). Given that each student, when enrolling into the university, must meet a certain level of motor abilities and motor skills, the assumption is that they will become proficient at initial level technical elements for each sport relatively quickly, and that the adoption of more complex movement structures will require of them greater commitment and more training, and that at this level their performance will differ more significantly. The objective of this study was to determine the relationship between the motor skills of students at the Faculty of Kinesiology and the successful execution of technical elements from the ball routine in rhythmic gymnastics.

Methods

The sample unit consists of 52 sophomore students of the Faculty of Kinesiology at the University of Zagreb, aged between 20-22 years, who attended the rhythmic gymnastics course for 2 semesters. The sample of predictor variables consisted of the results obtained by measuring motor abilities through 12 tests for assessment: *coordination* – MAGKUS (lateral steps), MAKTOZ (in air agility) and MBKS3L (slalom with three balls); *flexibility* – MFLPRK (sit and reach), MFLISK (overhead raise with stick) and MFLMOST (bridge); *explosive strength* – MFEbML (medicine ball throw from supine position), MFESDM (standing long-jump) and MFESVM (stationary standing vertical jump)

and *repetitive strength* – MSCUC1 (squats in 1 minute), MRCDIZ (back contractions) and MRCSJD1 (sit-ups in 1 minute) (Metikoš et al, 1989).

The criteria variables consisted of the average value of all ratings (5 experts) with which the success of their execution of technical elements with the ball were evaluated: toss, turn 360° and catching with one hand (LBH), forward somersault with throwing and catching the ball (LKOL); hip rotations with hands extended to both sides (LKOT); rhythmic striking with a waltz step (LUV); horizontal figure eights with feet shoulder width apart and wave (LV8), 2 jumps with throwing and catching (L2S). (Furjan-Mandic, 2000). The assessment of the mastery of each element with the ball is defined by clear protocols and pointing criteria that are unambiguously defined and aligned with the rules of judging in rhythmic gymnastics (*Code of points 2010*) for the purpose of objectivity, and were assigned on a scale of 1 (lowest) to 5 (highest rating), using exclusively whole numbers. Data was collected throughout the semester during lectures and classes, and the results were analyzed by the Statistics package program for Windows version 7, at the Faculty of Kinesiology at the University of Zagreb.

For all variables in the predictor group basic statistical parameters were defined, normality of distribution was determined, and the correlations of predictor variables were calculated. While determining the objectivity of the judge’s marks descriptive parameters were calculated and the objectivity of the judges assessments were reviewed by a reliability analysis using the *Reliability analysis-scale Alpha*, and correlations in the judge’s marks for each individual element was established. Relations between the predictor and each individual criterion variables were determined through the application of *forward stepwise regression analysis*.

Results and discussion

Table 1. Matrix of descriptive parameters for predictor variables

	N	MV	SD	MIN	MAX	Skew	Kurt
MAGKUS	52	9,47	0,53	8,24	10,33	-0,41	-0,36
MAKTOZ	52	4,26	0,45	3,28	5,15	-0,08	-0,32
MBKS3L	52	25,70	3,35	19,29	33,37	-0,14	-0,49
MFLPRK	52	54,28	6,43	38,33	66,00	-0,53	-0,14
MFLISK	52	69,12	13,06	23,67	93,33	-0,64	1,57
MFLMOST	52	85,20	15,75	29,00	127,67	-0,55	2,72
MFEBML	52	7,97	1,25	5,37	11,27	0,37	-0,01
MFESDM	52	191,24	18,11	151,67	241,00	-0,17	0,20
MFESVM	52	47,07	5,70	37,33	58,33	0,36	-0,71
MSCUC1	52	52,31	6,12	38,00	68,00	0,02	0,28
DINZAKL-I	52	23,65	8,15	10,00	49,00	1,08	1,84
MRCSJD 1	52	35,81	4,98	23,00	46,00	-0,29	0,01

N – number of test subjects, MV – mean value, SD – standard deviation, MIN – minimum value, MAX – maximum value, Skew - asymmetry coefficient, Kurt - coefficient of curvature

The negative asymmetric distribution of the observed results indicates better results in most of the variables, which is most likely conditional to: positive selection, engagement and commitments to other practical subjects at university, and the fact that most of them were involved in a systematic training process. Positive asymmetry was observed in the back contractions test (DINZAKL), as a result of lower repetitive strength in the back, and in the medicine ball throw from supine position test (MFEBML), weaker explosive strength of the arms and shoulders, stationary standing vertical jump (MFESVM), weaker plyometric explosive strength and squats in 1 minute (MSCUC1), weaker repetitive leg strength.

From the correlation matrix it is clear that the majority of the correlations between variables to assess motor abilities are low, but statistically significant. A significant parallel between motor variables with a correlation of -0.47 and common variability of 22.09% is visible between assessment tests: explosive power MFESVM (stationary standing vertical jump) and coordination MBKS3L (slalom with three balls). Significant correlations were obtained between the variables to assess the same latent dimensions, the same mechanisms for the regulation of movement, between tests to assess vertical jump explosive power: stationary standing vertical jump (MFESVM) and standing long jump (MFESDM) = 0.52, and 27.04% common variance, and between tests to assess flexibility: bridge (MFLMOST) and overhead raise with stick (MFLISK) = 0.49 and 24.01% of common variance. Although the judges determined and elaborated evaluation criteria in advance, and were selected on the basis of knowledge and experience, objectivity is checked through reliability coefficients, and the correlation coefficient. (Miletić et al, 2004). Assessing or scoring the technical elements with the ball covered six elements from the group of: throwing and catching, deflecting, rolling (on the body or the ground) and the various movements with the apparatus such as: swinging, balancing, circling, figure eights and lobbing, in connection with physical elements. The average values of the judges scores ranged from 1.50 to 5.00, with mutual correlation coefficients ranging from 0.86 to 0.96, and an average correlation between the units of 0.92 (AVR). The resulting high value Cronbach reliability coefficient ($\alpha = 0.98$), indicated consistency in judicial assessment. This high level of objectivity, is the result of the competence (knowledge) and training (experience) of the judges (Dizdar, 2006), as well as of the clearly defined evaluation criteria. The results of the *Forward stepwise regression analysis* between the group of predictor variables (motor skills) and success criteria (total score) in the performance of elements with the ball did not establish a statistically significant association ($p < 0.27$), except in the predictor sit-ups in 1 min (MRCSJD1) with an error factor of 0.05 ($p < 0.03$). This association was unexpected because the assessed technical elements with the ball predominantly require agility in manipulating the apparatus.

Table 2. Correlation matrix of predictor variables; p=0,05

	MAGKUS	MAKTOZ	MBKS3L	MFLPRK	MFLISK	MFLMOST	MFEBML	MFESDM	MFESVM	MSCUC1	DINZAKL-I	MRCSD1
MAGKUS	1,00	0,24	0,26	0,01	-0,20	-0,26	-0,10	-0,34	-0,24	-0,23	0,05	-0,10
MAKTOZ	0,24	1,00	0,40	0,03	-0,05	-0,03	-0,05	-0,20	-0,32	-0,11	0,14	-0,27
MBKS3L	0,26	0,40	1,00	-0,16	-0,02	0,02	0,04	-0,23	-0,47	-0,22	0,04	-0,06
MFLPRK	0,01	0,03	-0,16	1,00	-0,35	-0,40	0,21	0,11	0,22	0,04	-0,11	0,10
MFLISK	-0,20	-0,05	-0,02	-0,35	1,00	0,49	-0,22	0,12	-0,05	-0,18	-0,15	-0,03
MFLMOST	-0,26	-0,03	0,02	-0,40	0,49	1,00	-0,15	0,05	-0,11	0,02	0,15	-0,22
MFEBML	-0,10	-0,05	0,04	0,21	-0,22	-0,15	1,00	0,29	0,33	0,02	-0,27	-0,06
MFESDM	-0,34	-0,20	-0,23	0,11	0,12	0,05	0,29	1,00	0,52	0,03	-0,05	0,26
MFESVM	-0,24	-0,32	-0,47	0,22	-0,05	-0,11	0,33	0,52	1,00	-0,01	-0,07	0,07
MSCUC1	-0,23	-0,11	-0,22	0,04	-0,18	0,02	0,02	0,03	-0,01	1,00	0,19	0,09

Table 3. Descriptive parameters and reliability analysis of judges scores for the elements with the ball

	N	MV	Min	Max	SD	Skew	Kurt	Itm-Totl	Alpha if
ASL 1	52	3,43	2,17	4,83	0,67	0,21	-0,80	0,96	0,97
ASL 2	52	3,36	2,17	4,83	0,63	0,28	-0,44	0,94	0,98
ASL 3	52	3,64	2,50	5,00	0,65	0,07	-0,67	0,98	0,97
ASL 4	52	2,92	2,00	4,17	0,59	0,36	-0,77	0,92	0,98
ASL 5	52	2,59	1,50	4,00	0,59	0,40	-0,31	0,93	0,98
AVR	0,92								

N – number of test subjects, MV – mean value, MIN – minimum value, MAX – maximum value, SD – standard deviation, Skewness – asymmetry coefficient, Kurtosis – coefficient of curvature, Itm-Totl – correlation of individual units with a simple linear combination of all the other units, Alpha if – test reliability coefficient, ASL 1 – ASL 5 – average value of score for technical elements with ball first - fifth judge, AVR – average correlation between judges scores.

Table 4. Regression analysis of predictor variables and the criterion variable of the total score for elements with the ball

R= 0,53 R ² = 0,28 F(12,39)= 1,28 p<0,27 SEP: 0,58						
	b	SEP	Beta	SEP	t(39)	p
Intercept			4,26	3,30	1,29	0,20
MAGKUS	-0,19	0,16	-0,22	0,18	-1,20	0,24
MAKTOZ	0,00	0,16	0,00	0,22	0,02	0,98
MBKS3L	0,27	0,17	0,05	0,03	1,53	0,13
MFLPRK	0,23	0,16	0,02	0,01	1,48	0,15
MFLISK	-0,06	0,18	0,00	0,01	-0,32	0,75
MFLMOST	-0,16	0,18	-0,01	0,01	-0,89	0,38
MFEBML	-0,11	0,16	-0,05	0,08	-0,66	0,51
MFESDM	0,20	0,18	0,01	0,01	1,15	0,26
MFESVM	-0,18	0,19	-0,02	0,02	-0,95	0,35
MSCUC1	0,10	0,15	0,01	0,01	0,64	0,52
DINZAKL-I	0,20	0,16	0,01	0,01	1,23	0,23
MRCSD1	-0,36	0,16	-0,04	0,02	-2,24	0,03

R – multiple correlation coefficient, R² – determination coefficient of multiple correlation, F – coefficient of multiple correlation with the degrees of freedom, p – level of significance of multiple correlation coefficients, SEP. – standard error of prediction, b – regression coefficient, Beta – standardized (partial) regression coefficient, t – degrees of freedom when testing the significance of regression coefficients, p – level of significance of the regression coefficient

Through the Forward stepwise regression analysis, it was established that a statistically significant correlation (R=0.46) exists between the predictor variables and the criterion variables in the successful execution of elements with the ball, with a 21% mutual variance in error levels 0.05 (p<0.04).

Table 5. Forward stepwise method of regression analysis between the predictor and criterion variable for elements with the ball

R= 0,46 R ² = 0,21 F(5,46)= 2,52 p<0,04 SEP: 0,56						
	b	SEP	Beta	SEP	t(46)	p
Intercept			3,11	1,73	1,80	0,08
MBKS3L	0,29	0,14	0,05	0,02	2,10	0,04
MFLPRK	0,28	0,13	0,03	0,01	2,09	0,04
MRCSD1	-0,28	0,13	-0,03	0,02	-2,05	0,05
DINZAKL-I	0,22	0,13	0,02	0,01	1,66	0,10
MAGKUS	-0,17	0,14	-0,20	0,16	-1,28	0,21

A significant partial contribution was established for predictor variables: slalom with three balls (MBKS3L) (p<0.04), sit and reach (MFLPRK) (p<0.04), and sit-ups in 1 minute (MRCSD1) (p<0.05). The ball is the first apparatus that students taking the rhythmic gymnastics course are introduced to, for this reason a selection of more demanding elements was made because they spent more time in contact with this apparatus.

Therefore, the adoption of technical elements with the ball, manipulating the apparatus and control over its movement in space in coordination with the body, does not represent a limiting factor for the students. On the contrary, the knowledge acquired in the program of study prior to the rhythmic gymnastics course, represents a clear benefit for their successful mastery.

Conclusion

The main objective of this study was to investigate the relationship between motor skills and successful performance in rhythmic gymnastics. The sample consisted of 52 female test subjects between the ages of 20-22, full-time students enrolled in their sophomore year at the Faculty of Kinesiology at the University of Zagreb. The group of predictor variables consisted of a total of 12 tests of 3 each to assess basic motor skills: coordination, flexibility, explosive and static strength. The criterion set of variables consisted of ratings by 5 competent judges that evaluated the subjects success in mastering the 6 elements with the ball. The relationship between the predictor variables (motor skills) and criteria (score in elements with

the ball) were determined by applying the Forward stepwise regression analysis. The results showed that out of a set of predictor variables, only the slalom with three balls test (MBKS3L), designed to assess coordination, stands apart as statistically significant with regard to the successful execution of elements with the ball. The execution of this test requires of the test subjects a simultaneous coordinated performance, manipulating their hands and feet, while executing a slalom with 3 balls around pylons, which is most similar to the performance of the technical elements with the ball. The acquired results point to the inadequacy of the selected tests, considering the complexity of rhythmic gymnastics as a sport. It is therefore necessary, for scientific purposes, to engage in further research that would encompass motor areas through the application of specific tests to assess balance, rhythm, precision, static strength. Thereby empirically and scientifically established motor skills that contribute to the successful execution of the technical elements of rhythmic gymnastics. This form of higher content assessment would certainly contribute to a better selection of content and methodological procedures in the implementation of teaching the subject of rhythmic gymnastics.

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KORELACIJE IZMEĐU MOTORIČKIH VJEŠTINA I USPJEŠNOSTI IZVOĐENJA ELEMENATA S LOPTOM U RITMIČKOJ GIMNASTICI

Sažetak

Osnovni cilj ovog istraživanja bio je utvrditi postoje li relacije između motoričkih sposobnosti i uspješnosti u izvođenju tehničkih elemenata s loptom u ritmičkoj gimnastici. Istraživanje je provedeno na uzorku od 52 studentice druge godine studija Kineziološkog fakulteta Sveučilišta u Zagrebu. Studentice su izmjerene s ukupno 12 testova za procjenu bazičnih motoričkih sposobnosti: koordinacije, fleksibilnosti, eksplozivne snage i statičke snage. Uspješnost u izvođenju tehničkih elemenata s loptom (6), koji su definirani i predviđeni planom i programom kolegija, procjenjivalo je pet kompetentnih sutkinja. Regresijskom analizom se utvrdilo da ne postoji veća statistička značajnost između promatranih motoričkih sposobnosti i uspjeha pri izvođenju tehničkih elemenata s loptom. Iz skupa prediktorskih varijabli, samo je test za procjenu koordinacije MBKS3L (slalom s tri lopte) pokazao statističku značajnost u predikciji uspjeha u izvođenju odabranog kriterijskog elementa.

Ključne riječi: studentice, koordinacija, fleksibilnost, snaga, regresija

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