

# RELATIONS OF MOTOR ABILITY OF BALANCE AND SUCCESS OF PERFORMANCE OF GYMNASTICS ELEMENTS ON THE FLOOR EXERCISE

## RELACIJE MOTORIČKE SPOSOBNOSTI RAVNOTEŽE I USPJEHA IZVOĐENJA GIMNASTIČKIH ELEMENATA NA PARTERU

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### SUMMARY

*The purpose of this study is to investigate the relationship between motor ability for balance and the performance of selected gymnastic elements on the floor in students aged 7-8 years, to provide an overview of the current motor status of the respondents at this age, and to develop suggestions for possible changes in the curriculum at this age, and to develop suggestions for supplementing training methodology. Training of selected gymnastics elements was conducted on a sample of 42 subjects who had no previous experience in performing gymnastics elements during regular physical education classes, and the predictor variable was tested using four tests assessing motor balance ability. The tests assessing motor balance ability showed a statistically significant predictive value for the performance of all three gymnastics exercises. It is noticeable that the value of the prediction model increased the more complex an item was derived, indicating the complexity of the motor balance space and the high and stable level of the same in the subjects at the time of testing. Regarding the tests used, it can be noted that the test FLAM was significantly involved in the prediction of performance success in all three gymnastic elements, while the other two tests showed their predictive value in the execution of the hand stand. On the other hand, the study shows that the gymnastic elements used should be used in physical education classes to contribute to the promotion and development of all motor skills of students and as part of the preparation for the execution of more complex elements on the floor and apparatus in higher grades.*

**Key words:** gymnastic beginner, physical education, training

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## INTRODUCTION

Gymnastics is one of the esthetic sports in which it is extremely important to maintain various forms of balance during the execution of individual elements or exercises as a whole, which builds a complex relationship between levels and forms of balance in the execution of movement structures in gymnastics (Cohen, 2002). Živčić Marković and Krističević (2016) classify all sports in which acrobatic skills are performed on gymnastics equipment or with props, with several related branches: rhythmic gymnastics, acrobatics, trampoline, aerobics, including and gymnastics (Mezga, I., 2020). According to Vidović (2008), balance can be defined as the ability to maintain a stable body position in certain postures or positions (balance, hand stand, one-legged stance, etc.), during movement (running, walking, skating, skiing) and at the end of movement (landing after jumping, jumping on/off the apparatus, etc.). The literature identifies three types of balance: stable (body center of gravity is below the supporting surface), unstable (body center of gravity is above the supporting surface), indifferent (body center of gravity is at the supporting point), and static (ability to maintain a balanced position for as long as possible posture), dynamic (ability to maintain a balanced - stable position in movement - movement for as long as possible) and balancing objects; where all types of balance can be performed with open and closed eyes (Kurelić et al. 1975). Many children acquire the first knowledge of mastering the basic dynamic and static positions of the body during physical education in the first triad through basic gymnastic training (Novak, D., Kovač, M., Čuk, I. 2008, Živčić Marković 2007, 2010). The part of the gymnastics program that is applied from 1st to 4th grade is called beginner gymnastics and emphasizes that

children's development occurs through the development of coordination, balance, flexibility and strength (Hmjelovjec, I., Redžić, H., Hmjelovjec, D., 2004). The program of beginner gymnastics includes simpler gymnastic movements, individual elements and exercises that take place on various gymnastics equipment, with the aim of applying this content to improve the health of children and the development of basic motor skills that will be evident in everyday life (Živčić Marković, Krističević, 2016; Bijelić, S., Živčić Marković, K., Krističević, T., 2018). At this age, we are talking about the end of the sensitive period for the development of motor balance ability (Koprivica, V., 2002; Željaskov, C., 2004), and assuming that there is a level of developmental stabilization, it would be interesting to investigate the relationship between the motor status of girls aged 7-8 and the performance of certain gymnastic elements. Miletić Đ., Srhoj Lj. and Bonacin D. (1998) in their research determined the relationship between the predictor set of motor variables and success in performing elements and compositions in RG on a sample of subjects practicing rhythmic gymnastics, but no individual predictor value of balance as an independent factor was determined. Within the framework of a larger study, Delaš Kalinski (2009) found, among other results, the existence of a statistically significant influence of the predictor motor variables on the performance of gymnastic motor knowledge (shoulder stand, forward roll, etc.). In their research, Madić and associates (2011), on a sample of 120 girls (aged 11-12 years), through the results of a battery of 13 tests of basic motor abilities, evaluated the success of performing six gymnastic exercises. The obtained results indicated the predictor ability of motor abilities

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of strength, coordination, speed and agility to perform selected gymnastic elements on different apparatus. Petković, E. (2004) on a sample of 58 gymnasts aged 7-9 years applied a set of 10 predictor variables and 5 criterion variables to assess athletic success. Using two separate factors, the first responsible for a rapid solution of complex motor tasks and the second representing coordination in rhythm and the correct execution of hand movements in the lateral and frontal planes, it was possible to determine the overall success factor in the execution of short combinations individually on

the horizontal bar, on the beam, floor exercise, and on all apparatus combined. Similar results were obtained in the studies of Prassas, S., Kwon, Y.X., Sands, W.A. (2006), Di Cagno, et al, (2008), Miletić Đ., Srhoj Lj. and Bonacin D., 1998, Živčić Marković (2010), Sleeper, Kenyon, Elliott, & Cheng, (2016). The aim of this study is to investigate the relationship between the motor ability to balance and the performance of selected gymnastic elements on the floor exercise in students aged 7-8 years, in order to get an overview of the current motor state of the subjects.

## METHODS

The sample consisted of 42 respondents aged 7-8 years, with no previous experience in performing gymnastics elements, during the period when the training of selected gymnastics elements took place in regular physical education classes, all respondents were healthy and able to participate in class. The predictor variable was tested using four tests of motor balance ability that have the necessary measures (Metikoš, Prot, Hoffman, Pintar, and Oreb, 1989): standing on one leg crosswise on a balance beam with eyes open; standing on two legs lengthwise on a balance beam with eyes closed; standing on two legs lengthwise on a balance beam with eyes open and a flamingo test.

**Table 1.** Scale for assessing the quality of performing movement of acrobatics elements

score	description
0	Unsatisfying technique and amplitude
1	Satisfying technique, small amplitude
2	Satisfying technique, large amplitude
3	Good technique, small amplitude
4	Good technique, large amplitude
5	Very good technique, small amplitude
6	Very good technique, large amplitude
7	Great technique, small amplitude
8	Great technique, large amplitude
9	Excellent technique, small amplitude
10	Excellent technique, large amplitude

The criterion variable was formed by the assessed success in the performance of selected gymnastic elements: shoulder stand, head stand and hand stand, whose performance was evaluated by three licensed

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judges of the Gymnastics Federation of Republic of Srpska, with scores from 0 to 10 (Table 1). The scoring was done according to a predetermined set of values, given in tens of points for each exercise, according to the penalties established, leading to a final score of 10.00. The scoring was carried out in accordance with the FIG set of rules for scoring and activities of the judging panel "B" regarding the deduction of performance points, as well as scoring for compulsory exercises - GAY-GASMN set of rules (Petkovic E, 2004). In addition to basic descriptive statistical parameters for all variables, multiple regression analysis was performed to determine the presence of relationships. The results were processed using the SPSS 20 software package.

### **RESULTS AND DISCUSSION**

**Table 2.** *Intraclass correlation coefficients*

shoulder stand	0.991
head stand	0.986
hand stand	0.985

The values of the intraclass correlation coefficients used to determine the agreement of the different judges in the evaluation of the performance of the acrobatic elements are shown in Table 2. All the coefficients obtained were above 0.90, which confirms the very high objectivity of the measurement.

**Table 3.** *Central parameters of balance tests and gymnastic elements*

	Min.	Max.	AM	SD
hand stand	.00	10.00	3.293	2.681
shoulder stand	.33	10.00	5.761	3.505
head stand	.00	10.00	3.928	3.235
MBAP	.12	2.71	1.126	.587
FLAM	.63	3.84	1.875	.653
MBAU	.00	4.87	1.526	.979
MBAUZ	.00	1.86	.975	.434

Legend: Min.-minimum, Max.-maximum, AM- arithmetic mean, SD - standard deviation

Table 3 shows the values of the arithmetic mean for the balance tests and the evaluation of the performance of each gymnastics element, with the obtained results indicating the highest values for the execution of shoulder stand and for the test FLAM.

**Table 4.** *Results of the Kolmogorov-Smirnov test*

	Stat. val.	Sig.
MBAP	0.112	.200
FLAM	0.089	.200
MBAU	0.122	.200
MBAUZ	0.098	.200

Legend: Stat. val. - statistical value, Sig. - statistical significance

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The data on the normal distribution of the obtained results, verified by statistical processing with the KS test, are presented in Table 4. The values obtained for the variables used are at the lower limit of the normal distribution, so it is possible to proceed with the statistical analysis.

**Table 5.** Results of regression analysis for all criterion variables

	R	R <sup>2</sup>	F	Sig.
shoulder stand	.628	.394	6.022	<b>.001</b>
head stand	.699	.489	8.860	<b>.000</b>
hand stand	.688	.474	8.319	<b>.000</b>

Legend: R- the share of variance in the dependent variable, R<sup>2</sup>- coefficient of determination, Sig. - statistical significance

Table 5 shows the results of the regression analysis for the performance of all three gymnastic elements. The obtained value of the coefficient of determination for the value of the results of the execution of the shoulder stand is .394, which means that a total of 39.4% of the variance is explained by the predictive model used. This is followed by the values of the coefficient of determination for the value of the results of head stand (.489) and the value of the results for the variable of hand stand (.474), indicating that a total of 48.9% and 47.4% of the variance of these gymnastic elements. The results obtained in the prediction of the model used showed statistical significance in the performance of all three gymnastic elements at the level of  $p = .001$ .

**Table 6.** Selected significant predictor coefficients for all criterion variables

criterion variables	predictor variable	Stand. B. Coef.	Sig.
shoulder stand	FLAM	<b>.458</b>	<b>.003</b>
headstand	FLAM	<b>.514</b>	<b>.000</b>
hand stand	MBAP	<b>.255</b>	<b>.046</b>
hand stand	MBAUZ	<b>.435</b>	<b>.003</b>
hand stand	FLAM	<b>.314</b>	<b>.025</b>

Legend: Stand.B coef. - standardized Beta coefficient, Sig. - statistical significance

The presented values of beta coefficients (Table 6) show that the highest BETA coefficient in predicting headstand outcomes based on FLAM test scores (.514), with a statistically significant contribution (.000). Similarly, in the performance of posture with support on the leaves, where a statistically significant prediction result (.003) was obtained with the value of beta coefficient .458. The values of BETA coefficient for the performance of hand stand showed the highest value in the MBAUZ test (.435), followed by the values for the FLAM (.314) and MBAP (.255) tests, with all three variables making a statistically significant contribution in the regression model (.003, .025, .046).

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## DISCUSSION

Bala and Katic (1989) concluded that the anthropological characteristics that form the basis for the practice of various sports are improved in respondents who participate in athletic gymnastics, the activities of the educational process (Milanović, 1997). The subject of this research was an anthropological feature from the group of motor ability - balance, which depends on the maturation of the functions of the vestibular, kinesthetic, tactile and visual analyzer (Massion, 1998). The elements of sport gymnastics most commonly performed on the floor and used as a means of training beginners, which were analyzed in this research (shoulder stand, headstand and hand stand), are performed in a static position. Considering the above facts, the research was conducted under the assumption that there is a relationship between the quality of their performance and static balance. The results obtained showed that the respondents scored the highest marks when performing the gymnastic element shoulder stand (5.761). Before discussing the results obtained, it is necessary to refer to the scale used to evaluate the performance of gymnastic elements, from which it could be concluded that it was not entirely appropriate for the age of novice gymnasts who are not competitors and the scale is intended for the evaluation of competitors. In this context, the retraining of professional judges should also be considered. In addition, according to the research findings, it can be assumed that a greater number of training hours are required, which suggests that the introduction of a greater number of physical education classes should be considered, in which gymnastic content is taught to a greater extent, as this can improve the growth and development of children. Since balance is a motor ability with a high coefficient

of innateness and it is necessary for its development to repeat actions frequently (Breslauer, Hublin, Zegnal Koretić, 2014), it can be assumed that one of the reasons for the obtained scores is an insufficient number of attempts, i.e. insufficient training time. Since good balance requires a well-integrated nervous system with adequate afferent input, mobile joints and healthy muscles, and the quality of movement depends on the quality of postural tone, which ensures the balance of the body and its segments during movement, this suggests that disruption of any of these factors reduces the ability to maintain balance (Kosinac, 2009, 2011). From this point of view, the quality of postural tone of the subjects could be one of the reasons for poorer performance in gymnastic elements, but also in balance tests, as well as the level of other motor skills essential for the execution of gymnastic elements, which were not the subject of this research (Radanovic, D., Stajer, V., Popovic, B., & Madic, D., 2013; Madić, D., Popović, B., Tumin, D., Obradović, J. & Radanović, D., 2011; Petković E., 2004, Sleeper, MD, Kenyon, LK Elliott, JM & Cheng, MS, 2016). The second part of the explanation could be found in the biological maturity of the subjects, which had a positive effect on their motor-morphological status at the time of training and testing (Đorđić et al., 2006). Considering one of the more common classifications of motor knowledge, made according to the following criteria: according to the precision and type of musculature; according to the type of organization; according to the possibility of prediction in the environment; according to the proportion of cognitive elements (Schmidt and Wrisberg, 2000; Coker, 2009), an overview of the achieved scores of gymnastic element performance can be given.

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According to the first criterion, it can be said that the subjects achieved a relatively satisfactory movement precision using a positive ratio of smaller and larger muscle groups, indicating a higher motor maturity of the subjects. Various authors have addressed the issue of chronological and biological age at the younger school age and found that girls at this age have already entered the phase of stabilization of the relationship between morphological changes and changes in accompanying motor skills, which allow for better movement control and execution of elements (Madić, D., Popović, B., Tumin, D., Obradović, J. & Radanović, D., 2011; Radanovic, D., Stajer, V., Popovic, B., & Madic, D., 2013). When considering the criterion of organization of motor knowledge, the respondents showed a higher level of discrete knowledge characterized by the precision of execution from the beginning to the end of the action, but also a more responsible approach to the execution of the test elements in terms of

serial organization of knowledge. Since the serial organization of knowledge characterizes sports and activities with a more pronounced esthetic component, such as dance, rhythmic and athletic gymnastics, it is understandable that the respondents have a greater propensity for it, and it was found that performing these activities leads to positive morphological and motor changes influence the derivation of given elements (Steinberg et al, 2008; Uzunović, Kostić and Živković, 2010; Cvetkovic, M., Popovic, B., Stupar, D., Spasic, A., Orlic, D., & Andrasic, S., 2014). The predictable environment in which complete planning of movements was possible was characterized by the execution of the elements used, and it can be said that closed motor knowledge prevailed in this criterion. The criterion that probably had its importance besides the motor segment is the one that spoke about the proportion of cognitive elements, where the respondents used a balanced proportion of cognitive and motor knowledge in the execution of gymnastic elements on the floor (Delaš Kalinski, 2009).

### CONCLUSION

The tests assessing the motor ability of balance showed a statistically significant predictive value for the performance of all three gymnastic elements. It is noticeable that the value of the prediction model increased the more complex element was derived, indicating the complexity of the motor balance space and the high and stable level of the same in the subjects at the time of the test. Regarding the tests used, it can be noted that the test FLAM was significantly involved in predicting performance success in all three gymnastic elements, while the other two tests showed their predictive value in the execution of the hand stand. In this sense, it raises the question of the use of balance tests

whose performance is based on vertical performance, while the gymnastic elements were performed in steep positions with different support surfaces. In this sense, we can speak of the need to apply more specific tests of motor ability to balance in the study of gymnastic knowledge. On the other hand, the level of scores obtained in the performance of gymnastic elements indicates the need to increase the amount of gymnastic training through the number of hours or a longer duration of training for a certain age. One of the assumptions is that better methodical treatment is necessary to ensure optimal progress in the development of balance in all its manifestations. The gymnastic

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elements used are an example of basic balance positions in a beginner gymnast, which the respondents successfully mastered to a greater extent, showing that they are ready to adopt more complex motor skills from gymnastics. The limitations of strictly applying the current curriculum can be mitigated by individualizing the work of individuals or individual sections, which in turn requires good periodization and quality diagnostics, which should be addressed when working with this age. In this way, better

conditions could be created (larger sample, more predictive tests, longer training time, more criterion elements in gymnastics, etc.) to determine the predictor value of motor balance ability and draw a generalized conclusion. On the other hand, the study shows that the gymnastic elements used should be used in physical education classes to contribute to the promotion and development of all motor skills of students and as part of the preparation for the execution of more complex elements at the ground floor and higher grades.

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## SAŽETAK

Cilj ovog istraživanja je ispitivanje relacija motoričke sposobnosti ravnoteže sa izvođenjem izabраниh gimnastičkih elemenata na parteru, kod učenica uzrasta 7-8 godina, kako bi se dao osvrt na trenutno motoričko stanje ispitanika tog uzrasta, konstruisanje prijedloga eventualne izmjene u nastavnom planu rada u tom uzrastu kao i konstruisanje prijedloga dopunjavanja metodike obuke. Na uzorku od 42 ispitanice, bez prethodnog iskustva u izvođenju gimnastičkih elemenata, sprovedena je obuka izabраниh gimnastičkih elemenata na redovnoj nastavi fizičkog vaspitanja, pri čemu je prediktorska varijabla testirana pomoću četiri testa za procjenu motoričke sposobnosti ravnoteža. Korišteni set testova za procjenu motoričke sposobnosti ravnoteža pokazao je statistički značajnu prediktivnu vrijednost za izvođenje sva tri gimnastička elementa. Uočljivo je da je vrijednost prediktivnog modela rasla što je izvođen složeniji element ukazujući na složenost motoričkog prostora ravnoteže te na visok i stabilan nivo iste kod ispitanica u vreme testiranja. Govoreći o korištenim testovima može se konstatovati da je test FLAM učestvovao značajno u predikciji uspjehnosti izvođenja kod sva tri gimnastička elementa dok su preostala dva testa pokazala svoju prediktivnu vrijednost kod izvođenja stava o šakama. Sa druge strane iz istraživanja je evidentno da korišteni gimnastički elementi trebaju biti upotrebljavani na časovima fizičkog vaspitanja kako bi se doprinijelo podsticanju i daljnjem razvoju svih motoričkih sposobnosti učenika te kao dio pripreme za izvođenje složenijih elemenata na parteru i na spravama u višim razredima.

**Ključne riječi :** gimnastička početnica, fizičko vaspitanje, obuka

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