# THE IMPACT OF THE INITIAL STATUS OF MOTOR ABILITIES ON MASTERING MOTOR PROFICIENCY IN RHYTHMIC SPORTS GYMNASTICS

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**Abstract:**

The relations of some motor tests in the initial status to successfulness in rhythmic sports gymnastics (RSG) after a six - month learning process were investigated on the sample of 100 eleven - year - old pupils. The predictor system consisted of motor tests for evaluating coordination, realization of rhythmic structures, balance, flexibility, movement frequency, explosive and repetitive power. The criterion variables were represented by three rhythmic compositions, which are officially carried out at national championships for the category of girls in the required all-around RSG competitions. The most significant correlation to successful performance of RSG compositions was recorded with the tests of flexibility, strength and coordination in rhythm. The test of legs movement frequency (MBFTAZ) has an outstanding predictive value in the compositions with hand apparatus. The obtained pieces of information can be used in training sessions for developing such motor abilities that exhibit the greatest correlation to the performance, and, consequently, can show how to direct the training process in order to improve the final performance of the composition.

**Key words**: rhythmic sports gymnastics, motor tests, performance.

**Zusammenfassung:**

## DER EINFLUSS DES ANFANGSZUSTANDS VON MOTORISCHEN FÄHIGKEITEN AUF DAS ERWERBEN MOTORISCHER KENNTNISSE BEI DER RHYTHMISCHEN GYMNASTIK

Auf der Stichprobe von 100 elfjährigen Schülerinnen wurden die Zusammenhänge einiger motorischer Tests im Anfangszustand mit der Leistung bei der rhythmischen Gymnastik nach sechsmonatigen Trainingszeit untersucht. Die motorischen Tests zur Bewertung der Koordination, der Realisation rhythmischer Strukturen, des Gleichgewichts, der Flexibilität, der Bewegungsfrequenz, sowie der Explosivkraft und der repetitiven Kraft bildeten das Prädiktorsystem. Die Kriteriumvariablen umfassten drei im obligatorischen Mehrkampf an den Nationalmeisterschaften für Mädchen angewandte rhythmische Kompositionen.

Die wichtigsten Korrelationen mit der erfolgreichen Ausführung der rhytmisch-gymnastischen Kompositionen wurden in den Tests der Flexibilität, der Kraft und der Rhythmuskoordination verzeichnet. Der Test der Beinbewegungsfrequenz hat den speziellen Prädiktionswert für die Komposition mit Handgerät. Die erzielten Informationen können bei der Selektion sowie, noch wichtiger, im Trainingsprozess verwendet werden - zur Entwicklung derjenigen motorischen Fähigkeiten, die die meisten Korrelationen mit der Ausführung der Komposition gezeigt haben.

**Schlüsselwörter:** rhythmische Gymnastik, motorische Tests, Ausführung

## Introduction and issue

The development of rhythmic sports gymnastics (RSG) in the world today, and consequently in Croatia, has been in continuous progress and has undergone enormous changes which are also reflected in this year's (E. Abruzzini, RSG FIG) change of the rules of scoring in rhythmic sports gymnastics, hence any further development and progress of RSG definitely involves the use of scholarly research. It is only science that can give the correct answers to the ever-increasing and complex questions, and the responsibility, both expert and moral, of scholars is all the greater because the children who are to be actively involved in sport activities are younger and younger.

A group of authors in Croatia (RSG coaches and physical education teachers) has, during the past few years, created three rhythmic compositions which have been used in this investigation as criterion variables. The compositions are used extensively in national competitions of the youngest categories (the mandatory all-around competition). However,

we believe they would be applicable in the school population in order to improve, in the most productive way, the transformation of the anthropological characteristics of girls through the use of RSG operators in physical education classes. The homogeneity of the pupil population regarding age, sex, health status and material and organizational conditions, demands an adjustment of the contents and the forms of instruction according to the criteria imposed by the character of the population. Rhythmic sports gymnastics is aimed exclusively at the female population and is as such undoubtedly applicable in schools but also for recreational purposes after the classes are over.

An efficient orientation and a selection of rhythmic and sports gymnastics in schools and sports schools, is conditioned by the availability of scholarly information related to the impact of individual anthropological dimensions in rhythmic sports gymnastics instruction.

The establishment of factors responsible for performance in rhythmic sports gymnastics, most frequently investigated in Croatia by using a sample from the student population (Wolf-Cvitak, 1984, Wolf-Cvitak, 1995) or perspective young rhythmic gymnasts (Kocić, 1987; Furjan-Mandić, 1992) or by using scholarly information on the application of rhythmic sports gymnastics operators during physical education, has until now been far too inadequate.

Next, the investigations used to establish the performance factors in rhythmic sports gymnastics on heterogeneous population samples (Frenker R., Hitzel N., 1989; Hume P.A., Hopkins W. G., Robinson D. M., Robinson S. M., Hollings, S. C., 1993) when compared with the results of school children population may provide stable criteria for the efficient orientation of children and later, during the training process, for the effective selection of children.

A review of studies, the aim of which is to identify the performance predictors in rhythmic sports gymnastics, shows the view that of all the motor abilities desirable for competitors in rhythmic sports gymnastics power is the most important (Wolf-Cvitak, 1984; Srhoj, 1989; Hume et al., 1993), followed by rhythmic coordination (Wolf-

Cvitak, 1984; Srhoj, 1989) and flexibility (Wolf-Cvitak, 1984; Srhoj, 1989; Frenker R., Hitzel N., 1989; Hume et al., 1993).

The problem is the analysis of relations between the motor abilities in the initial status and the performance of RSG exercises (without any implements, just with the ball and the rope) after a six-month training.

The main objective of the investigation is to establish the relations between the motor abilities in the initial status in girls aged 11 years and the performance of RSG compositions after a six-month training.

This objective can be further sub-divided into three segments:

1. to establish the relations between the motor abilities in the initial status and the performance of RSG compositions with no equipment after a six-month training;

2. to establish the relations between the motor abilities in the initial status and the performance of RSG compositions with the rope after a six-month training;

3. to establish the relations between the motor abilities in the initial status and the performance of RSG compositions with the ball after a six-month training.

## Methods

### Sample

The investigation was carried out in the primary schools "Plokite", "Marjan" and "Skalice" in Split on the sample of 100 fifth-grade girls, aged 11 years. The children regularly attended a two-hour a week experimental programme of rhythmic sports gymnastics over a six-month period. The only criterion regarding their eligibility was that the girls were clinically in good health without any aberrations and that they did not participate in any other extra-curricular activities.

The main advantage of a sample selected in such a way is the possibility of generalizing the results obtained, over the whole school population that the experimental programme is intended for.

### A sample of variables
### A sample of variables to assess motor abilities

In order to be able to assess the basic motor

dimensions, a selection of a battery of standard motor measuring instruments, as used by Gre-delj, Metikoš, Hošek, Momirović, 1975; Metikoš, Prot, Horvat, Kuleš, Hofman, 1982 was carried out.

A battery of 21 motor tests covering, to a certain extent, the space of latent movement and energy dimensions, sports whose application in rhythmic gymnastics is conceivable, was used in the investigation.

The following tests were used:

- to assess coordination: MAGKUS - side steps, MREPOL - polygon backwards, MAGONT - dexterity on the floor;

- to assess the performance of rhythmic structures: MKRBUB - non-rhythmic tapping, MKRPLH - tapping on horizontal boards, MKRBNR - hand and foot tapping;

- to assess balance: MBAU10 - standing on one leg longitudinally on the balance beam with the eyes open, MBAU1Z - standing on one leg longitudinally on the balance beam with the eyes closed, MBAP2Z - standing on both legs across the balance beam with the eyes closed;

- to assess flexibility: MFLISK - a twist, MFLRLK - straddle in a lying position, MFLPRP - straddle forward bend;

- to assess the movement frequency: MBFTAP - hand tapping, MBFTAN foot tapping, MBFTAZ - foot tapping against the wall;

- to assess explosive power: MFEBKL - throwing the medicine ball from the chest sitting on a chair, MFEBML - throwing the ball lying on one's back, MFESDM - long jump from a standstill;

- to assess the repetitive power: MRCMPT - sit-ups, MRCDNL - raising legs from a lying position, MRAZGP - undergrasp pull-ups on the bar.

**A sample of variables to assess the performance in rhythmic sports gymnastics**

Criterion variables are related to the results achieved by gymnasts while performing the three set rhythmic compositions.

The first variable is related to the rhythmic composition without hand apparatus (RKBR), the second variable to the rhythmic composition with the rope (RKV) and the third one to the composition with the ball (RKL).

The evaluation of success for all three compositions was performed by five judges using a scale from 1 to 5 which is the system of evaluation used in schools.

Judges (physical education teachers who specialized in rhythmic sports gymnastics) evaluated the subjects watching the videotape of each subject individually for each composition. The detailed description of exercises remains with the author.

**Description of the kinesiological treatment**
**Planning the experimental procedure**

The main goal of the experimental six-month kinesiological treatment of rhythmic sports gymnastics was to stimulate the positive transformation of anthropological characteristics in female pupils by employing operators from the rhythmic sports gymnastics domain. Another goal was to teach and improve the basic movement structures of rhythmic sports gymnastics without using the hand apparatus. The plan was to conduct a six-month experimental programme for the female fifth-graders from three primary schools in Split. No girl engaged in the programme had any knowledge of rhythmic sports gymnastics. Planning and programming, particularly difficult because of the enormous discrepancy in the biological development in eleven-year-old girls, calls for a completely individual approach. The diversity of pupils had to be taken into account, particularly in the selection of the movement structures to be employed in the programme.

**Programming of the experimental procedure**

*A. Selection and distribution of exercises*

The following modified programme of RSG school sports clubs was used:

1. Proper posture, gait, breathing. Spatial tracks: a circle, an ellipse, a figure of eight, a spiral.

2. Running, rhythmic realization of different musical notes by using the following movements: hand clapping, walking and hand clapping according to a set rhythm.

3. Beating the time, examples in the two-four time. Hops: Children's hops, hops with extended legs, hops with swerves and other combinations.

4. The realization of musical notes in the three-four time. Children's hops with stretched arm coordination. Hops: distant - high, forward and backward scissors, cat's leap.

5. Dancing steps: gallop, polka and waltz. A dance entitled 'let's kiss'.

6. Leg exercises: the emphasis is on the feet and knees. Stag leap. The realization of musical notes in the four-four time.

7. Motions in all planes and directions. Cossack leap. Dancing structures: dancing a reel.

8. Mastering semi-acrobatic elements: rolling forward and backward, over the shoulder bridges; forward and side split.

9. Arm exercises; figures of eight in all planes. Body and arm waves forward, backward and sideward.

10. Holds of balance, static and dynamic, on flat foot, on toes and in a half-squat. Waves in combination with balance. Repetitive beating of time with the realization of two-four, three-four and four-four time.

11. Teaching turn technique: open, closed, high, medium, low and spiral. Combination of turns with holds and different dance steps. Dance: Sicilian reel in a circle.

12. Mastering of an obligatory exercise without implements in primary schools set by the Croatian Association of Gymnasts (CAG).

13. Exercises with the ball. Ball holding, tossing the ball from one hand to the other in all planes while standing and while moving. Rolling the ball on the ground while running, skipping and dancing with simultaneous catching of the ball. Bouncing the ball onto the ground from a standstill, using the left and the right hand. Basic elements of ball handling: throwing and catching, bouncing and rolling (static and dynamic) - from a standstill and while walking, running, skipping, jumping, balancing and turning. Mastering the ball exercises is a part of the primary schools curriculum as set by the Croatian Association of Gymnasts.

14. Exercises with the rope. Hops over the rope with legs together, with one leg, both with an interhop and without it, by spinning the rope round, forward and backward. Circling the rope to the side and front plane, by holding the rope ends with the right and then the left hand, statically and dynamically. Throwing the rope from one hand to the other (by holding both ends with one hand) by swinging, statically and dynamically. Connect swinging and turning by throwing statically and dynamically.

The basic elements: jumps into the rope and different combinations of hops and jumping over the rope, statically and dynamically, changing the rope hold during the exercise.

Teaching the rope exercise is a part of the primary school curriculum as set by the Croatian Association of Gymnasts.

15. Improvement of the basic elements using the ball. Practising the other atypical elements of ball handling: rotations, throws and swings, and movements with balancing the ball on the palm of the hand. Statically and dynamically with different elements: walking, running, skipping, jumping, waving, throwing, balancing and turning. Handling the ball with the right and the left hand.

16. Improvement of the basic elements using the rope. Practising other atypical elements of rope handling: swinging, rotating, circling of the rope, movement in a figure of eight, throwing and catching the rope. Handling of the double-and quadruple-folded rope. Amplitude of movements related to rhythm - transition from slow to fast beats and vice versa. Handling the rope with the right and the left hand statically and dynamically.

17. Improvement of the basic elements WITHOUT using hand apparatus (swinging, rotation, waves, balancing, turning, hops and jumps). High difficulty requirements, connecting the elements into a whole.

18. Mastering more complex elements using the BALL.

19. Mastering more complex elements using the ROPE.

The recommendation is to use the implements in the second half of the lesson. The stated exercises were, during the six month training period, performed once or several times, depending on their complexity.

During the first part of the period the basic elements and obligatory exercises of rhythmic sports gymnastics without any equipment were practiced. In the second part the basic techniques related to handling the rope and the ball were mastered, as well as the obligatory exercises with the rope and the ball.

## B) Selection and the distribution of work madalities

The method most frequently employed was the synthetical one. However, when appropriate, the analytical one was also used. During the teaching of the compositions the combined and situational methods of practising were used, always keeping in mind the individual progress of the pupils. (For example, it took the less successful pupils longer to master the synthetical method; or, the more successful pupils were ready sooner for the situational work technology.)

## C) Selection and the distribution of work quantity

The right grading of the material load to be taught was the most difficult problem of the experimental procedure since two training sessions of 45 minutes a week were insufficient for an adequate transformation of the anthropological characteristics. Another difficulty was the need for the comprehensive teaching of new motor abilities involving a lot of information transference. The amount of load was increased in each training session designed in such a way as to teach the material based on the acquired motor skills, after the information which related to the previous session was repeated. In such a way the share of energy load was increased from one session to the other, proportionally to the increase of the motor skills. Some parts of the compositions were repeated in succession several times, and the mastered parts of the compositions increased from each consequent session thereby increasing the amount of work. In other words, the load increased continuously and the progressive discontinuity was achieved by including sessions where the information component was more pronounced.

## Data processing

The characteristics of prediction and criterion variables were determined by using the usual descriptive procedures. The arithmetic means (XA), standard deviations (SD), semi-range where the actual values of arithmetic means varies 95% (DX), were computed, as well as the minimal (MIN) and maximal (MAX) result values. Normalcy of the distribution was tested by using the Kolmogorov and Smirnov procedure, and maximal differences between the actual and cumulative frequencies (D MAX) were computed. Then, the correlation matrix between parts of each test (R), mean correlation between test elements (RMS), representative coefficient of each element (MSA), the percentage of the total common variance (MAOCV), Crombach's coefficient of reliability ($\alpha$) and the homogeneity of the elements (HOM) were determined.

Discrete criterion variables were normalized for each judge. Then the evaluations of all judges for each criterion variable were reduced to the first important common matter of measurement.

In order to establish the relations between the predictor and criterion variables, three regression analyses were applied:

1. rhythmic compositions without hand apparatus (RKBR)

2. rhythmic compositions with the rope (RKVIJ)

3. rhythmic compositions with the ball (RKLOP)

All the necessary computer modification was done by Dobromir Bonacin.

## Results and discussion

The descriptive parameters and some metric test characteristics are shown in Table 1. The Kolmogorov-Smirnov test shows the normal distribution of all the variables except for the power test (MRAZGP) where the distribution deviates from normal. The coefficient of reliability and homogeneity, sensitivity and objectivity of the variables applied are satisfactory, hence the conclusion that the metric characteristics of the variables used are good, which is especially important in the case of the criterion variables, where all 5 judges had unified criteria of evaluating the motor skills.

The regression analysis related to the exercises without hand apparatus, by applying the predictor system consisting of twenty-one motor tests, provides information on the statistically significant impact (RO=.62) of motor tests on the performance of compositions without hand apparatus. The predictor system explains 38% of the variance.

The variable MBFTAZ (frequency of leg

*Table 1: Central and dispersive parameters and some metric characteristics of variables*

| No | variable | XA | SIG | MIN | MAX | DMAX | RMS | MSA | MAOCV | ALFA | HOM |
|----|----------|------|------|------|--------|------|------|------|--------|------|------|
| 1 | MREPOL | 14.54 | 3.07 | 9.64 | 23.86 | 0.08 | .84 | .83 | 82.00 | .95 | .97 |
| 2 | MAGONT | 32.43 | 6.55 | 18.21 | 51.86 | 0.11 | .84 | .86 | 80.00 | .95 | .98 |
| 3 | MAGKUS | 12.02 | 1.21 | 9.40 | 15.95 | 0.04 | .81 | .90 | 81.62 | .96 | .96 |
| 4 | MKRBUB | 9.15 | 2.36 | 4.03 | 14.56 | 0.04 | .74 | .80 | 71.70 | .92 | .94 |
| 5 | MKRPLH | 21.06 | 4.21 | 12.34 | 37.97 | 0.03 | .83 | .75 | 76.97 | .93 | .96 |
| 6 | MKRBNR | 5.98 | 2.50 | 0.67 | 11.02 | 0.04 | .76 | .74 | 68.05 | .90 | .95 |
| 7 | MBAU10 | 5.30 | 4.24 | 1.27 | 23.58 | 0.14 | .57 | .57 | 65.92 | .88 | .80 |
| 8 | MBAU1Z | 2.26 | 0.73 | 1.08 | 4.77 | 0.07 | .48 | .76 | 61.08 | .78 | .91 |
| 9 | MBAP2Z | 2.20 | 0.69 | 0.87 | 3.72 | 0.06 | .58 | .86 | 56.27 | .89 | .92 |
| 10 | MFLISK | 64.26 | 11.67 | 31.29 | 84.01 | 0.05 | .86 | .75 | 82.34 | .95 | .97 |
| 11 | MFLPRK | 109.01 | 14.68 | 71.67 | 138.34 | 0.06 | .92 | .78 | 89.49 | .97 | .98 |
| 12 | MFLPRR | 62.44 | 8.02 | 39.33 | 84.33 | 0.06 | .93 | .77 | 91.56 | .97 | .99 |
| 13 | MBFTAP | 23.74 | 1.84 | 18.66 | 29.99 | 0.04 | .79 | .76 | 70.22 | .91 | .96 |
| 14 | MBFTAN | 19.76 | 1.77 | 15.99 | 25.02 | 0.04 | .67 | .72 | 56.88 | .86 | .93 |
| 15 | MBFTAZ | 17.62 | 2.50 | 9.00 | 23.76 | 0.07 | .81 | .86 | 76.77 | .94 | .97 |
| 16 | MFEBML | 4.95 | 1.01 | 2.69 | 7.37 | 0.07 | .79 | .84 | 74.96 | .94 | .97 |
| 17 | MFEBKL | 4.29 | 0.60 | 2.76 | 5.84 | 0.07 | .76 | .73 | 67.93 | .90 | .95 |
| 18 | MFESDM | 140.72 | 23.75 | 75.49 | 186.50 | 0.06 | .90 | .87 | 87.98 | .97 | .99 |
| 19 | MRAZGP | 0.78 | 1.62 | 0.00 | 8.00 | 0.28 | | | | | |
| 20 | MRCDNL | 17.60 | 10.16 | 0.00 | 45.00 | 0.07 | | | | | |
| 21 | MRCMPT | 28.78 | 8.01 | 3.00 | 46.00 | 0.05 | | | | | |
| | RKBR | (*) | | | | | .88 | .91 | 85.89 | .97 | .99 |
| | RKVIJ | | | | | | .90 | .91 | 89.42 | .98 | .99 |
| | RKLOP | | | | | | .91 | .92 | 90.08 | .98 | .99 |

test = 0.16

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(*) discrete variables before normalization

movement) has the highest correlation coefficient, then follows the test MRCDNL, and all the other tests for the evaluation of rhythmic structures, particularly MKRBUB structure. The highest proportion of criteria variance was explained by the variables MKRBUB (rhythm), MBFTAZ (frequency of leg movement) and MRCDNL (power). The impact of each predictor variable on the criterion one, vector Q (B) implies that only two out of 21 applied variables predict the efficiency in the performance of exercises without hand apparatus. They are MFLPRP (flexibility) and MRCDNL (power). The authors Fenker and Hitzel found that flexibility has a low but significant correlation with performance. Hume et al. point out that the flexibility and power of legs are the most important predictors in rhythmic sports gymnastics. Flexibility is the expected predictive factor, whereas "the power of legs" contributes to the performance by enabling

Table 2: Regression variables RKBR (exercises without hand apparatus)

| | R | R(Q) | P-R | B | P | sigmaB | Q(B) | F(B) |
|---|---|---|---|---|---|---|---|---|
| MREPOL | -.30 | 0.00 | -0.00 | -.01 | 0.38 | 0.14 | 0.92 | -0.48 |
| MAGONT | -0.17 | 0.07 | -0.07 | -0.07 | 1.30 | 0.10 | 0.50 | -0.28 |
| MAGKUS | -0.22 | 0.02 | -0.11 | -0.13 | 3.04 | 0.13 | 0.31 | -0.35 |
| MKRBUB | 0.30 | 0.00 | 0.20 | 0.25 | 7.64 | 0.13 | 0.06 | 0.48 |
| MKRPLH | 0.29 | 0.00 | 0.02 | 0.02 | 0.74 | 0.11 | 0.82 | 0.47 |
| MKRBNR | 0.24 | 0.01 | 0.01 | 0.01 | 0.36 | 0.10 | 0.88 | 0.39 |
| MBAU10 | 0.17 | 0.07 | 0.11 | 0.12 | 2.20 | 0.12 | 0.31 | 0.28 |
| MBAU1Z | -0.01 | 0.84 | -0.07 | -0.06 | 0.12 | 0.10 | 0.53 | -0.03 |
| MBAP2Z | 0.00 | 0.97 | -0.05 | -0.04 | -0.01 | 0.11 | 0.65 | 0.00 |
| MFLISK | -0.14 | 0.14 | -0.12 | -0.11 | 1.74 | 0.10 | 0.24 | -0.23 |
| MFLPRK | 0.05 | 0.62 | -0.09 | -0.08 | -0.44 | 0.10 | 0.58 | 0.08 |
| MFLPRR | 0.27 | 0.00 | 0.24 | 0.23 | 6.41 | 0.10 | 0.02 | 0.43 |
| MBFTAP | 0.05 | 0.59 | 0.00 | 0.00 | 0.03 | 0.10 | 0.94 | 0.08 |
| MBFTAN | 0.26 | 0.00 | 0.07 | 0.07 | 1.88 | 0.10 | 0.50 | 0.42 |
| MBFTAZ | 0.38 | 0.00 | 0.17 | 0.18 | 7.09 | 0.11 | 0.11 | 0.62 |
| MFEBML | 0.07 | 0.50 | -0.02 | -0.02 | -0.16 | 0.12 | 0.84 | 0.11 |
| MFEBKL | 0.05 | 0.57 | -0.05 | -0.06 | -0.38 | 0.13 | 0.63 | 0.09 |
| MFESDM | 0.21 | 0.02 | -0.13 | -0.17 | -3.79 | 0.14 | 0.23 | 0.35 |
| MRAZGP | 0.07 | 0.52 | -0.01 | -0.01 | -0.09 | 0.10 | 0.89 | 0.11 |
| MRCDNL | 0.32 | 0.00 | 0.22 | 0.22 | 7.29 | 0.11 | 0.04 | 0.52 |
| MRCMPT | 0.27 | 0.00 | 0.11 | 0.12 | 3.37 | 0.12 | 0.30 | 0.43 |

| DLT | S-DLT | RO | F | DF1 | DF2 | Q |
|---|---|---|---|---|---|---|
| 0.38 | 0.78 | 0.62 | 2.38 | 21 | 79 | 0.00 |

the performance of high and long jumps" which is a particularly important component of each of the rhythmic sports gymnastics exercises.

The exercise without hand apparatus, regarding the number of difficult elements and intensity, is estimated to be the most difficult for the school population, hence the predictive value of the power test is understandable, whereas the flexibility test as a factor of predicting performance in performing the exercises without equipment was predictable. The significant correlation with the tests for evaluating the performance of rhythmic structures supports the artistic value of exercises composed of choreography and musical accompaniment.

The relationship between the system of motor variables used with the performance of the exercises with the rope is RO=.64, which explains the common variability between the predictor and criterion variable, which is around 41%. The analysis of the coefficient correlation shows that the test MBFTAZ (frequency of leg movement), then all the tests for evaluating the performance of rhythmic structures (particularly MKRPLH), and the flexibility (MFLPRP) and power test (MRCMPT) have a significant correlation with its criterion. When discussing the impact of each predictor on the criterion (P) the test MBFTAZ with the highest value (as much as

*Table 3: Regression variables RKVIJ (exercises with the rope)*

|        | R     | R(Q)  | P-R   | B     | P     | sigmaB | Q(B)  | F(B)  |
|--------|-------|-------|-------|-------|-------|--------|-------|-------|
| MREPOL | -0.32 | 0.00  | -0.04 | -0.06 | 2.02  | 0.14   | 0.67  | -0.51 |
| MAGONT | -0.12 | 0.20  | 0.04  | 0.04  | -0.51 | 0.10   | 0.69  | -0.19 |
| MAGKUS | -0.31 | 0.00  | -0.10 | -0.11 | 3.77  | 0.13   | 0.62  | -0.48 |
| MKRBUB | 0.28  | 0.00  | 0.12  | 0.14  | 4.16  | 0.13   | 0.28  | 0.44  |
| MKRPLH | 0.34  | 0.00  | 0.12  | 0.13  | 4.59  | 0.11   | 0.25  | 0.53  |
| MKRBNR | 0.24  | 0.01  | 0.00  | 0.00  | 0.12  | 0.10   | 0.95  | 0.37  |
| MBAU10 | 0.16  | 0.09  | -0.02 | -0.02 | -0.48 | 0.11   | 0.79  | 0.25  |
| MBAU1Z | -0.00 | 0.98  | -0.08 | -0.07 | 0.00  | 0.10   | 0.53  | -0.00 |
| MBAP2Z | 0.06  | 0.55  | 0.08  | 0.08  | 0.51  | 0.10   | 0.56  | 0.09  |
| MFLISK | -0.06 | 0.52  | -0.09 | -0.08 | 0.55  | 0.10   | 0.59  | -0.10 |
| MFLPRK | 0.09  | 0.63  | -0.07 | -0.06 | -0.62 | 0.10   | 0.52  | 0.14  |
| MFLPRR | 0.27  | 0.00  | 0.16  | 0.15  | 4.32  | 0.10   | 0.12  | 0.42  |
| MBFTAP | 0.10  | 0.29  | -0.00 | -0.00 | -0.01 | 0.10   | 0.98  | 0.16  |
| MBFTAN | 0.23  | 0.01  | 0.03  | 0.03  | 0.83  | 0.10   | 0.72  | 0.36  |
| MBFTAZ | 0.49  | 0.00  | 0.32  | 0.33  | 16.54 | 0.11   | 0.00  | 0.76  |
| MFEBML | 0.11  | 0.27  | -0.04 | -0.05 | -0.57 | 0.12   | 0.67  | 0.17  |
| MFEBKL | 0.16  | 0.09  | 0.11  | 0.13  | 2.18  | 0.13   | 0.67  | 0.25  |
| MFESDM | 0.24  | 0.01  | -0.05 | -0.07 | -1.75 | 0.14   | 0.61  | 0.37  |
| MRAZGP | 0.16  | 0.09  | 0.12  | 0.11  | 1.97  | 0.10   | 0.24  | 0.25  |
| MRCDNL | 0.15  | 0.12  | 0.03  | 0.03  | 0.48  | 0.10   | 0.76  | 0.23  |
| MRCMPT | 0.32  | 0.00  | 0.10  | 0.10  | 3.55  | 0.11   | 0.63  | 0.50  |

| DLT  | S-DLT | RO   | F    | DF1 | DF2 | Q    |
|------|-------|------|------|-----|-----|------|
| 0.41 | 0.76  | 0.64 | 2.68 | 21  | 79  | 0.00 |

16.54) must again be pointed out, follow the tests MKRBUB and MKRPLH (rhythm), and the flexibility test (MFLPRR). The analysis of the impact of individual motor variables shows that the variable MBFTAZ (BETA =.32) has statistically the most significant impact. The test MBFTAZ is the predictive factor in the exercise with the rope since handling the rope involving a whole series of jumps and skips implies the frequency of leg movements.

Other motor tests could have a higher correlation with the exercise provided that the intensity of exercises be increased and thus more appropriate and purposeful for the school population.

The common variability of predictor variables and the composition with the ball amounts to 58%. As many as seven variables contribute to the variability of the predictor system. Again, the variable MBFTAZ has the highest correlation (.53), and all the coordination tests, tests assessing rhythm, flexibility and power also have significant correlation. The highest criterion variance proportion is explained by the variables MBFTAZ (as much as 16.90), then MKRBUB (rhythm) and MFLPRR (flexibility). The test MBFTAZ (B=.31) again shows the most

*Table 4: Regression variables RKLOP (exercises with the ball)*

|  | R | R(Q) | P-R | B | P | sigmaB | Q(B) | F(B) |
|---|---|---|---|---|---|---|---|---|
| MREPOL | -0.42 | 0.00 | -0.14 | -0.15 | 6.76 | 0.12 | 0.19 | -0.56 |
| MAGONT | -0.25 | 0.01 | -0.15 | -0.11 | 3.05 | 0.08 | 0.16 | -0.33 |
| MAGKUS | -0.30 | 0.00 | -0.17 | -0.17 | 5.30 | 0.11 | 0.11 | -0.39 |
| MKRBUB | 0.34 | 0.00 | 0.22 | 0.23 | 8.10 | 0.11 | 0.03 | 0.45 |
| MKRPLH | 0.38 | 0.00 | 0.03 | 0.03 | 1.15 | 0.09 | 0.75 | 0.50 |
| MKRBNR | 0.28 | 0.00 | 0.09 | 0.07 | 2.25 | 0.08 | 0.61 | 0.37 |
| MBAU10 | 0.14 | 0.14 | -0.09 | -0.08 | -1.15 | 0.09 | 0.57 | 0.18 |
| MBAU1Z | 0.10 | 0.30 | 0.12 | 0.09 | 0.99 | 0.08 | 0.26 | 0.13 |
| MBAP2Z | 0.04 | 0.64 | 0.14 | 0.11 | 0.54 | 0.09 | 0.20 | 0.06 |
| MFLISK | -0.08 | 0.62 | -0.14 | -0.10 | 0.95 | 0.08 | 0.20 | -0.11 |
| MFLPRK | 0.08 | 0.59 | -0.23 | -0.19 | -1.62 | 0.08 | 0.03 | 0.11 |
| MFLPRR | 0.32 | 0.00 | 0.27 | 0.22 | 7.27 | 0.08 | 0.01 | 0.43 |
| MBFTAP | 0.24 | 0.01 | 0.23 | 0.18 | 4.52 | 0.08 | 0.03 | 0.31 |
| MBFTAN | 0.23 | 0.01 | -0.02 | -0.02 | -0.48 | 0.08 | 0.80 | 0.30 |
| MBFTAZ | o.53 | 0.00 | 0.35 | 0.31 | 16.90 | 0.09 | 0.00 | 0.69 |
| MFEBML | 0.00 | 0.94 | -0.31 | -0.30 | -0.20 | 0.10 | 0.00 | 0.00 |
| MFEBKL | 0.17 | 0.08 | 0.25 | 0.26 | 4.49 | 0.11 | 0.02 | 0.22 |
| MFESDM | 0.25 | 0.00 | -0.07 | -0.08 | -2.06 | 0.11 | 0.51 | 0.33 |
| MRAZGP | 0.02 | 0.79 | -0.09 | -0.07 | -0.17 | 0.08 | 0.57 | 0.03 |
| MRCDNL | 0.19 | 0.05 | 0.13 | 0.10 | 2.08 | 0.09 | 0.24 | 0.25 |
| MRCMPT | 0.23 | 0.01 | -0.01 | -0.01 | -0.32 | 0.09 | 0.88 | 0.31 |

| DLT | S-DLT | RO | F | DF1 | DF2 | Q |
|---|---|---|---|---|---|---|
| 0.58 | 0.64 | 0.76 | 5.27 | 21 | 79 | 0.00 |

significant statistical predictive value, then follows the test of explosive hand power (MFEBML and MFEBKL), MKRBUB (rhythm), MFLPRR (flexibility) and MBFTAP.

The predictor system in the exercise with the ball explains more than one half of the variability supporting the inclusion of this exercise into the school curriculum, since it might be expected that it will contribute to a positive transformation of strictly aimed motor skills (particularly regarding the development of the strength of hands, the frequency of leg and arm movements, leg and

trunk flexibility and rhythmic movements).

The analysis of the three regression analyses shows that one the predictors related to the exercises with hand apparatus explain and predict more fully the criteria than the exercises without hand apparatus do. All the analyses demonstrate predictor multi-linearity which is revealed in a relative impact of each predictor in explaining the impact on individual rhythmic compositions (P) since a considerably greater number of motor tests than implied by the vector Q(B) significantly explain the criteria.

Thus, the impact of a wide motor space on

the criteria supports the richness and complexity of the dynamic system of movements in the rhythmic sports gymnastics, with the complexity of exercises with hand apparatus, the exercises with the ball being more pronounced. The beauty of movements of adequate amplitudes has a comprehensive motor origin.

In spite of expectations the balance tests employed in the investigation do not show a significant statistical correlation with any of the rhythmic compositions, not even in the values of relative predictor impact when explaining the impact on the criteria (the exception is the test MBAU10 when exercising without hand apparatus). It is rather unexpected, since the balance positions are an integral part of the criterion variables used. The coefficient of reliability in balance tests is the lowest, yet the tests are deemed to be reliable, and the reason for no statistical correlation should be searched for in the insufficiency of balance positions as an integral part of the compositions, because their inadequate participation does not reflect on the judges' evaluation and consequently are not correlated with the predictors.

Contrary to the balance tests, all the tests related to the evaluation of rhythmic structures show a high positive correlation in all three compositions, and the coordination in rhythm is pointed out as a very significant prerequisite for the performance in rhythmic sports gymnastics.

The research conducted with the school population confirms the predictive value of flexibility, power and coordination tests in certain RSG events. The results obtained can be used for the purpose of selection, and more importantly, they can be used during the training process in order to develop those motor skills which show the highest correlation with performance and hence can be a very useful indicator in helping to orientate the training process towards a better composition performance.

The test of the frequency of leg movements MBFTAZ and the flexibility test MFLPRR play a significant role in this research (Bogić, 1995 also pointed it out), and it would be best to employ these tests in all initial and final testings when the elements of RSG are used as the operators of the transformation of motor skills.

## 4. Conclusion

The research regarding the relationship between motor skills in the initial phase and the performance of rhythmic compositions (without hand apparatus, with the rope, with the ball) after a six-month training period was conducted, using a sample of 100 eleven-year - old girls from three primary schools "Plokite", Skalice" and "Marjan" in Split.

The sample of predictor variables consisted of 21 motor tests selected to evaluate the basic motor skills according to the structural model (Gredelj, Metikoš et al, 1975). Three rhythmic compositions, used in the national competitions in obligatory all-around competitions in RSG, were used as criterion variables.

The results of regression analyses show statistically significant correlation in all the three criteria. The test MBFTAZ (frequency of leg movements) has the highest result prognostic value in exercises with hand apparatus, and the test MFLPRR (flexibility) and the test MRCDLN (power) in exercises without hand apparatus. Futher, in exercises with the ball the predictor system explains as much as 58% of variability with 7 variables, and exercises with the ball are recommended in schools and in other training processes where the elements of rhythmic sports gymnastics are used as the operators of transformation of motor skills.

Future research of anthropological space is necessary to explain the remaining still unexplained criterion variances.

# References

1. Abruzzini, E. (1997). *Bodovni pravilnik ritmičko-sportske gimnastike*. Međunarodni gimnastički savez.

2. Bogić, D. (1995). *Utjecaj treninga ritmičko-sportske gimnastike na neke funkcionalne, morfološke i motoričke karakteristike*. (Master's thesis) Zagreb: Fakultet za fizičku kulturu Sveučilišta u Zagrebu.

3. Frenker, R. and N. Hitzel (1989). Predicting attainment in rhythmic sport gymnastics: a three - year longitudinal study. In: *Proceedings of the First International Olympic Committee Congress on Sports Medicine*. Colorado Springs: IOC, 31.

4. Furjan-Mandić, G. and J. Wolf- Cvitak (1992). Povezanost situacijskih motoričkih sposobnosti i koordinacije u ritmičko-sportskoj gimnastici. *Kineziologija*, 24 (1-2):27-29.

5. Gredelj, M., D. Metikoš, A. Hošek and K. Momirović (1975). Model hijerarhijske strukture motoričkih sposobnosti. Rezultati dobijeni primjenom jednog neoklasičnog postupka za procjenu latentnih dimenzija. *Kineziologija*, 5 (1-2):7-82.

6. Hume, P.A., W.G. Hopkins, D.M. Robinson, S.M. Robinsoni, S.C. Hollings (1993). Predictors of attainment in rhytmic sportive gimnastics. *Journal of Sports Medicine and Physical Fitness*, 33(4):367-377.

7. Kocić, J. (1987). Značaj morfoloških karakteristika i motoričkih sposobnosti za selekciju djece u ritmičko-sportskoj gimnastici. *Fizička kultura*, 41:47 - 52.

8. Metikoš, D., F. Prot, V. Horvat, B. Kuleš and E. Hofman (1982). Bazične motoričke sposobnosti ispitanika natprosječnog motoričkog statusa. *Kineziologija*, 5: 16 - 62.

9. Srhoj, LJ. (1989). *Relacije između nekih antropometrijskih, motoričkih i funkcionalnih manifestnih i latentnih dimenzija učenica i uspjeha u ritmičko-sportskoj gimnastici*. ( doctoral thesis) Skopje: Fakultet za fizičku kulturu.

10. Wolf-Cvitak, J. (1984). *Relacije između morfoloških i primarnih motoričkih dimenzija za uspješnost u ritmičko-sportskoj gimnastici kod selekcioniranog uzorka*. (Master's thesis). Zagreb: Fakultet za fizičku kulturu.

11. Wolf-Cvitak, J. (1995) Relacije motoričkih sposobnosti i okreta u ritmičko-sportskoj gimnastici. *Kineziologija*, 27 (2):56-60.