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Some Anthropologic Factors of Performance in Rhythmic Gymnastics Novices

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A B S T R A C T

The aim of the study was to determine motor and morphological factors, and to assess their impact on specific motor skill performance in rhythmic gymnastics (RG). Experimental training process aimed at learning and improving basic movement structures of rhythmic gymnastics was performed for nine months in a sample of 50 female rhythmic gymnastics novices (mean age 7.1±0.3 years). Seven dimensions in total were isolated by factorial analysis of 13 motor, 11 morphological, and 20 specific rhythmic gymnastics tests. The factors of flexibility (Beta=0.26; p<0.05), explosive strength (Beta= 0.25; p<0.05) and adipose voluminosity (Beta=–0.42; p<0.001) explains 41% of the success in performing RG basic body elements – jumps, rotations, balance and flexibility (R=0.64), while the frequency of movement (Beta=0.44; p<0.001) and non-adipose voluminosity (Beta= 0.26; p<0.05) explains 26% of RG-specific manipulations with the apparatus – club, ribbon and ball wrist manipulation (R=0.52; p<0.01). According to study results, the RG--training process intended for rhythmic gymnastics novices should be programmed, with preset objectives for the development of flexibility and explosive strength, speed and peripheral joint strength and adipose tissue reduction.

Key words*: rhythmic gymnastics, basic movements, motor abilities, morphological characteristics, factor analysis, regression analysis*

Introduction

Basic motor abilities and skills have a crucial importance in the early phases of the motor learning process[1]. There are different theories on what should be taken in consideration on designing a motor program[2], however, task duration and structure definitely are crucial characteristics influencing the process.

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The efficiency of motor reactions is defined by the relations between motor information and level of abilities and properties that act interactively but differently in various stages of advancement. Thus, in the initial stage of a motor program performance cognitive functions and high-order motor factors are being involved. During structural improvement of the motor program, the impact of these factors gradually decreases, while low-order dimensions from various segments of the anthropologic space play an ever growing role in the acquired motor skill performance. Thus, optimal utilization of all anthropologic potentials of an individual is only possible in the automated stage of the acquired motor skill performance, the success of performance depending on the level of development of motor skills/characteristics.

Rhythmic gymnastics (RG) is characterized by an abundance of motor information. The information acquired in the early years of life, between 5 and 8 years of age, significantly contributes to success in this sport.

Several studies have described the physiologic characteristics of elite rhythmic gymnasts[3–5]. However, studies to analyze the learning process in RG are rare[6,7]. In experienced, skilled RG athletes (international and elite level), separate- element-performance is strongly influenced by strength, power and flexibility[4], and general RG-efficiency in RG is strongly influenced by coordination[8] and rhythmic coordination[9]. From the aspect of anthropometry, rhythmic gymnasts are characterized by a below-average percentage of subcutaneous fat and below-average body height and body weight[5]. The majority of the mentioned authors and studies, however, dealt with experienced, skilled athletes. Therefore, the need to determine the characteristic effect of particular motor abilities and skills as well as of morphological characteristics on the performance of specific skills of novice RG gymnasts is still an actual research issue. The mentioned issue has become even more intriguing in the last few years because of obvious trends in RG.

According to FIG's Code of Points[10], since recently – gymnasts must learn some new difficult motor skills (for example, mixed difficulties) and the youngest competitive categories of gymnasts now should perform their compositions with clubs and ribbon (the most difficult techniques). Thus, it is expectable that gymnasts start to learn and practice numerous difficult motor skills at a younger age. This particularly refers to the training of RG novices, which is characterized by an enormous amount of motor skills they are expected to attain. Novice gymnasts have to learn as many RG elements as possible at the beginning of systematic training. The level of expertise to which they are expected to master these skills is not very high at the beginning. A more accurate and skilful performance is the goal of training phases that are yet to come.

Therefore, RG novices could be a more appropriate sample for investigation and differential determination of the influence of particular anthropologic factors on performance in RG than experienced rhythmic gymnasts.

The establishment of correlations between motor abilities and morphological characteristics with performance of specific skills may be very helpful in the early stages of the RG training process as well as in the sport selection process.

It is already known that successful movement performance in some sports could be predicted by motor abilities and morphological characteristics of athletes[11–14]. The body built plays a significant role in performance of elite artistic[15,16] as well as elite rhythmic gymnasts[4,17], however, relevant scientific information on

rhythmic gymnast novices is particularly limited.

This paper deals with a major problem: which combination of motor abilities and morphological characteristics describes best the performance in RG novices?

Another problem relevant for this investigation is to objectively identify and assess the quality of element execution as performed by RG novice gymnasts. Namely, the characteristic 'rough-form execution' of elements as required in the beginning of the teaching-learning process in RG does not make rigorous evaluation suitable. Yet, differences in the performance quality among evaluated gymnasts exist and must be estimated somehow. So, the performing quality of novice gymnasts has to be established on a basis quite different from the procedures and criteria prescribed by the FIG's Code of Points in RG[10] that are used to assess performance quality in experienced, skilled athletes.

The aim of the study was to determine the impact of motor abilities and morphological characteristic factors on the characteristic motor skill performance in all RG disciplines in a sample of female novice gymnasts. The authors presumed it might be very interesting and useful, especially from the aspect of motor teaching and learning practice, to determine the possible influence of certain basic motor abilities and morphological characteristic factors on the performance of certain elements in RG novices. The establishment of such correlations may be very helpful in the early stages of RG training process as well as in the sport selection process.

Subjects and Methods

Sample

The study sample included 50 female novice rhythmic gymnasts, mean age 7.1±0.3 years, all of them in good health condition and free from any obvious physical or mental aberrations. The girls were selected from a population of 337 age-matched volunteer participants in the school sport programs without any previous experience in RG. An attempt was made to recruit female pupils (from the population of 337 peers who joined sport-school programs voluntarily) that were above-average in flexibility and coordination dimensions.

The experiment design had two phases. In the first phase of the experiment, the motor and morphological tests were implemented (throughout the 1st month of practicing). After nine months of the standard RG training program for novices, implemented three times a week (4 hours *per* week), the performance was tested (throughout the 9th month of practicing).

Measurements

Three test batteries were used. The sample of variables used to assess motor abilities consisted of 13 motor standard tests as proposed by Katić *et al*[18–20]: tests assessing frequency of movement (HAND-TAPPING, FOOT-TAPPING, TAPPING AGAINST WALL – f/15 sec); power tests (STANDING JUMP – cm, 'SARGENT' – cm, MED-BALL-THROW – m), strength tests (BANCH STANDING – s, SIT-UPS – (f/ *per* min), SQUATS – (f/ *per* min), tests assessing flexibility (SIT-AND-REACH – cm, LEFT SPLIT/RIGHT SPLIT – degree); and coordination in rhythm test (HAND-DRUMMING, HAND-FOOT-DRUMMING – f/ *per* 20 s).

All tests to assess the frequency of movement, power, flexibility and coordination in rhythm subjects were performed three times and only best results were taken for analysis. The tests assessing strength were performing only once.

The sample of variables for assessment of morphological characteristics consisted

of 11 standard morphological tests[22] (suggested by Katić *et al*[21]: weight (kg); height (cm); biacromial diameter (cm); wrist length (cm); foot diameter (cm); abdomen circumference (cm), forearm circumference (cm), upper leg circumference (cm); triceps skinfold (mm); subscapular skinfold (mm); and abdomen skinfold (mm).

The sample of variables to assess performance of characteristic motor skills were employed in each RG discipline. The performance was tested after nine months of the standard RG training program for novices implemented three times a week. All participants were first videotaped to avoid any subjective evaluation[23]. Then five independent expert RG judges evaluated their performance on the Likert scale[24] (from poorest 1 to maximal 5) by watching the videotaped material.

The subjects performed all 20 elements (each RG element on time during the 9th month of practicing) three times, and only the best performance was evaluated. The authors tried to simplify the judging procedure; therefore, the standard RG judging score, which is more suitable for compositions than for evaluating single elements, was avoided. Judges were previously educated to evaluate specific rank of five motor assessment levels. Basically, they evaluate amplitudes and explicitly forms of all body elements, height of leaps/jumps, rotations of pivots, stability of balances as well as the basic pattern of equipment.

Fifty study subjects had to perform the following twenty rhythmic routines with all apparatus. Each element represents basic handling techniques for all apparatus (rope, ball, hoop, clubs and ribbon). They are mostly performed with A-difficulties (the easiest body techniques) according to the Code of Points of RG[10]:

ROPE: R-SCISS skips and scissors leap through the open rope held by both hands that rotates forward; R-THRO upright, leg in rear horizontally (arabesque), throwing and catching one and of the rope (echapper); R-COSS rotation of the rope in one hand and Cossack leap; R-EIGHT deep bend of back with straight knees, figure eight with rope.

BALL: B-STAG bottom leg tucked and rear leg horizontal (stag leap), throwing and catching the ball; B-SQUE upright, leg in rear horizontally (arabesque); bouncing the ball on the floor; B-EIGHT deep bend of back with straight knees, figure eight with ball; B-ROLL upright, long rolling on hands.

HOOP: H-ROTAT balance with body and leg horizontally, rotating the hoop in fist; H-COSS Cossack leap through the hoop; H-SPLIT upright, leg high up side assisted, rotating the hoop on the floor; H-ROLL single squatting arabesque, rolling the hoop on the floor.

CLUBS: C-CIRC balance with front leg, small vertical circles with clubs (from the wrist); C-STAG bottom leg tucked and rear leg horizontal (stag leap), big circle (from the shoulder) with clubs; C-THROW throwing and catching the club with rotation; C-MILLS 'mills' with clubs.

RIBBON: RB-SNAKE leg in rear horizontally (single arabesque); snakes with ribbon; RB-SPIR upright, leg high up side assisted, spirals with ribbon; RB-SPLIT split leap forward with legs stretched, large circles with ribbon; RB-EIGHT deep bend of back with straight knees, figure eight with ribbon.

Statistics

The methods used on data analysis included basic statistical parameters, standard factorial analysis, and correlation regression analysis. The basic variable parameters (mean ± SD), varimax factor complex, characteristic factor values (lambda) and percentage of the common

variance explained (variance %) for each group of manifested variables were calculated. The factors considered significant when explained variance (lambda) exceeded 1. In this way, latent variables in the morphological and motor space as well as latent variables in the area of RG motor skills were defined. Factor scores on defined latent variables were used in the following statistical procedures. The standard linear regression analysis was performed to determine relations between morphological and motor latent variables as predictors and individual latent variables of RG motor skills as criteria. The BETA partial regression coefficient, predictor to criterion correlation coefficient, i.e. multiple correlation (RO), and significance of regression coefficients and multiple correlation are presented.

Results and Discussion

The following group of motor variables were chosen so as to assess the basic motor abilities identified in previous studies to be relevant for success in RG[4,8]: psychomotor speed, rhythmic coordination, strength (explosive, repetitive and static), and flexibility.

Factorial analysis (Table 1) of the applied group of 13 motor variables yielded three factors, i.e. frequency of movements, explosive strength, and flexibility. The tests assessing the ability of performing rhythmic structures and tests assessing the frequency of movements showed highest projection on the first factor. In the study sample, facilitated performance of the frequency of movements necessitated muscular endurance, i.e. activity of the mechanism controlling the duration of energy mobilization (repetitive and static strength). The first isolated factor mostly integrated frequency of movements and repetitive strength of the trunk, and manifested as a general psychomotor speed factor dependent on subcortical regulatory mechanisms. The subcortical regulatory mechanisms allow for fast impulse flow through the central control subsystems and formation of simple, as a rule rhythmic motor structures. The variables assessing the hand and leg explosive strength showed highest projection on the second factor, thus it could be defined as an explosive strength factor. The third motor factor was defined by the variables assessing flexibility (hover back, hamstrings, and groin), thus being defined as the factor of flexibility.

A group of 11 morphological measures were chosen to assess the morphological status in study girls.

Factorial analysis of the group of morphological variables used (Table 2) isolated two morphological dimensions: adipose voluminosity and non-adipose voluminosity. The variables of subcutaneous adipose tissue and circumference, i.e. body volume, had extremely high projection on the first factor. The second factor was defined by the variables of skeleton dimensions and body mass and volume, representing basic characteristics of the morphological development in terms of ectomorphy and mesomorphy integration[26].

The basic RG elements were chosen to assess the success of performing routine movements in RG for novices. Factorial analysis of the group of variables of routine movements in RG (Table 3) produced two dimensions: basic body elements (movements with large amplitudes) and specific manipulation with apparatus (movements with small wrist amplitudes). The first factor was equally defined by the variables containing regulated body weight basic elements[10] (jumps, balance, rotation and flexibility) irrespective of the apparatus used (rope, ball, hoop, clubs or ribbon). Thus, the basic elements of RG characterized by movements with large amplitudes predominated in all routines with high projections on the first factor. As a rule, the greater the movement am-

plitude, the higher the evaluation of performance. The second factor was defined by projections of the variables of the routine movements in RG, predominated by characteristic wrist manipulation with apparatus (ball, clubs and ribbon). These

TABLE 1
BASIC STATISTICS AND FACTOR ANALYSIS OF MOTOR VARIABLES ($\bar{x}$, MEAN; SD, STANDARD DEVIATION; V, CORRELATION BETWEEN VARIABLE AND ASSOCIATED FACTOR)

Variable	$\bar{x}$ ± SD	V1	V2	V3
Hand-tapping (f/15 sec)	18.34 ± 2.76	0.80	0.14	0.24
Foot-tapping (f/15 sec)	16.01 ± 2.01	0.85	0.11	0.24
Tapping against wall (f/15 sec)	15.52 ± 2.07	0.74	0.36	0.14
Standing jump (cm)	1.13 ± 0.13	0.40	0.72	0.04
Sargent (cm)	22.11 ± 4.13	0.25	0.77	0.13
Med-ball-throw (m)	2.58 ± 0.52	0.09	0.83	0.17
Bench standing (s)	9.60 ± 6.98	0.57	0.13	0.07
Sit-ups (f/min)	26.10 ± 8.01	0.61	0.45	0.29
Squats (f/min)	41.32 ± 9.54	0.55	0.46	0.36
Sit-and-reach (cm)	55.00 ± 7.54	0.12	0.22	0.90
rLeft split/right split (°)	86.38 ± 8.84	0.33	0.08	0.84
Hand drumming (f/20 sec)	5.71 ± 1.87	0.77	0.38	0.16
Hand-foot drumming (f/20 sec)	4.53 ± 1.97	0.85	0.22	0.12
Lambda		4.57	2.64	1.96
Variance %		35.15	20.31	15.08

TABLE 2
BASIC STATISTICS AND FACTOR ANALYSIS OF MORPHOLOGICAL VARIABLES ($\bar{x}$, MEAN; SD, STANDARD DEVIATION; V, CORRELATION BETWEEN VARIABLE AND ASSOCIATED FACTOR)

Variable	$\bar{x}$ ± SD	V1	V2
Weight (kg)	26.19±3.41	0.51	0.80
Height (cm)	130.41±5.61	0.11	0.77
Biacromial diameter (cm)	26.92±1.74	–0.01	0.68
Wrist length (cm)	14.49±1.00	0.05	0.80
Foot diameter (cm)	7.33±4.23	0.15	0.48
Abdomen circumference (cm)	55.11±4.25	0.71	0.54
Forearm circumference (cm)	19.22±1.63	0.61	0.63
Upper leg circumference (cm)	39.63±3.22	0.61	0.64
Triceps skinfold (mm)	9.63±2.61	0.91	0.15
Subscapular skinfold (mm)	7.19±2.61	0.93	–0.01
Abdomen skinfold (mm)	8.06±3.47	0.99	0.10
Lambda		4.11	3.71
Variance %		37.36	33.73

TABLE 3
BASIC STATISTICS AND FACTOR ANALYSIS OF MOTOR SKILL (ROUTINES IN RHYTHMIC GYMNASTICS) VARIABLES ($\bar{x}$, MEAN; SD, STANDARD DEVIATION; V, CORRELATION BETWEEN VARIABLE AND ASSOCIATED FACTOR)

Variable	$\bar{x}$ ± SD	V1	V2
(R) Scissors through open rope	2.83 ± 1.03	0.69	0.43
(R) Arabesque, throwing	2.42 ± 1.13	0.76	0.39
(R) Cossack leap, rotation	2.78 ± 1.11	0.84	0.25
(R) Bend of back, figure eight	3.03 ± 1.11	0.74	0.22
(B) Stag leap, throwing	2.58 ± 1.23	0.75	0.33
(B) Arabesque, bouncing	2.78 ± 1.04	0.85	0.10
(B) Bend of back, figure eight	2.37 ± 1.21	0.55	0.66
(B) Long rolling on hands	1.91 ± 0.99	0.54	0.72
(H) Balance horizontally, rotating (fist)	2.96 ± 1.11	0.71	0.40
(H) Cossack leap through the hoop	2.71 ± 1.09	0.49	0.57
(H) Balance up side, rotating (floor)	2.85 ± 1.12	0.77	0.36
(H) Squatting arabesque, rolling (floor)	2.24 ± 1.18	0.77	0.46
(C) Front balance, small circles	2.56 ± 1.13	0.71	0.48
(C) Stag leap, big circle	2.87 ± 0.97	0.56	0.62
(C) Throwing with rotation	2.20 ± 1.15	0.65	0.48
(C) *Mills*	1.55 ± 0.88	–0.06	0.82
(RB) Balance up side, *spirals*	2.18 ± 1.12	0.49	0.73
(RB) Single arabesque, *snakes*	2.11 ± 1.03	0.65	0.55
(RB) Split leap, large circles	2.62 ± 1.09	0.48	0.66
(RB) Bend of back, figure eight	2.92 ± 1.12	0.70	0.51
Lambda		8.75	5.39
Variance %		43.75	26.95

(R) = rope; (B) = ball; (H) = hoop; (C) = clubs; (RB) = ribbon

are regulated apparatus techniques that were less readily mastered by the girls, which predominated only in more complex RG disciplines (ball, clubs and ribbon). Such a motor learning that requires specific manipulation predominated by precise small wrist movements is considerably more difficult due to the specific weight of the apparatus and morphological characteristics of the 7-year-old girls. There is an overt disproportion between a 7-year-old girl's arm length and regular clubs length, between her height and ribbon length, and between her wrist width and regular training ball diameter. Thus, the variables defining the first factor in routine movements in RG were predominated by large amplitude movements which always involve large muscle groups, while the movements are performed with maximal combined flexibility of the hip, shoulder and back joints. The second factor defined the small amplitude movements of peripheral joints.

Multiple correlations in regression analyses (Table 4) between defined dimensions of the motor-morphological space and

TABLE 4
REGRESSION ANALYSIS OF MOTOR AND MORPHOLOGICAL LATENT SPACE AND ROUTINES IN RHYTHMIC GYMNASTICS

Latent dimension	Basic body element^{L}		Specific manipulation with apparatus^{S}	
	BETA		BETA	
Frequency of movements	0.19		0.44	***
Explosive strength	0.25	*	0.02	
Flexibility	0.26	*	0.07	
Adipose voluminosity	–0.42	***	0.13	
Non-adipose voluminosity	–0.06		0.26	*
RO	0.64	***	0.52	**

^{L} = movements with large amplitudes; ^{S} = movements with small wrist amplitudes;
BETA = regression coefficient; RO = multiple correlation; *p<0.05; **p<0.01; ***p<0.001

the space of routine movements in RG were high and significant, pointing to the high inter-relationship of the anthropologic status segments investigated and learning of the basic motor skills in RG.

The factor of flexibility had a significant predictive value (BETA coefficient) on performing basic body elements, i.e. large amplitude movements. Flexibility defines proper performance of the large amplitude movements, which are specifically scored in RG, and enhanced flexibility along with appropriate explosive strength is a precondition for proper performance of all basic body elements (jumps, balance, rotation and flexibility). The factor of movement frequency along with non-adipose voluminosity had a significant predictive value on performing small amplitude wrist movements. Thus, psychomotor speed in terms of movement frequency is a precondition for proper and coordinated apparatus manipulation. The results of the study pointed to the need of an appropriate approach in training, since successful motor learning of apparatus manipulation in female novices depends on the specific training of peripheral joint speed and strength.

Morphological characteristics are closely related to motor performance in children[16–18]. It has already been reported that a specific somatotype, characterized by under-average adipose tissue, is desirable in female rhythmic gymnasts[5]. In our study sample consisting of 7year-old girls the somatotype characteristic of competitors had not yet been defined, and is likely to occur following the process of persistent several-year training as well as a consequence of the gymnasts' growth and development. The factor of adipose voluminosity had a significant negative predictive value (BETA coefficient) on performing basic body elements, i.e. large amplitude movements. The higher percentage of adipose tissue exerted an unfavorable effect on the performance of basic body elements (jumps, rotation, balance and flexibility) already in novices, thus the girls with a pronounced endomorphic somatotype would be less successful in acquiring and performing specific body elements of RG during a training process of the same duration.

The defined factors of anthropologic status of girls have a varying impact on learning new motor knowledge and skills, depending on whether large amplitude movements characterized by large muscle group activation and marked flexibility of the hip, back and shoulder joints, or

small amplitude wrist movements (specifically, apparatus manipulation) are performed. Accordingly, successful motor learning and performance of basic motor skills in RG (balance, jumps, rotation and flexibility) will primarily depend on the development of flexibility, and to a lesser extent of explosive strength, along with under-average adipose tissue, whereas successful apparatus (clubs, ribbon and ball) manipulation will depend on the frequency of movements, along with a moderate ectomesomorphic somatotype in girls. Based on the results obtained, it is suggested to program the RG novice training with special reference to the development of specific speed and strength of peripheral joints (along with flexibility and explosive strength), the former being a precondition for skilful apparatus manipulation. Furthermore, training stimuli should help in developing functional abilities in order to reduce, in combination with appropriate dietary habits, the proportion of subcutaneous adipose tissue[18–20].

Conclusion

The morphological and motor status of 7- to 8-year-old girls was clearly defined by the results obtained in the present study. The motor status was found to be defined by three factors underlain by the mechanisms responsible for motor functioning. The mechanism of speed regulation was found to be responsible for the first factor, frequency of movements; the mechanism of force regulation for the second factor, explosive strength; and the mechanism of muscle tonus regulation for the third factor, flexibility. The work of these regulators is being integrated by the general motor mechanism, in a manner appropriate for the performance of a particular movement motor structure[17–19].

The morphological status is predominantly defined by two components: the one is body volume based on adipose tissue generation, i.e. adipose voluminosity, and the other is responsible for the development of the skeleton and muscular tissue, i.e. non-adipose voluminosity[26–28].

Although motor skills in RG are defined by only two factors (basic motor RG skills performed by the whole body activity with large movement amplitudes, and specific motor RG skills related to apparatus manipulation, i.e. small amplitude movements), their structure is complex. Thus, motor RG skills, i.e. routines predominated by large or small amplitude movements, or those incorporating both types of movements, can be differentiated. The abilities to be activated on performing a particular element – RG routine also depend on the extent to which the performance of a routine is dependent on the performance of a previous routine in a certain movement structure, especially when the whole body movement and apparatus manipulation have to be simultaneously performed.

The results of regression analyses pointed to determination of the defined latent variables of the morphological and motor space as predictors, and of the latent variables of motor RG skills as criteria, i.e. how the performance of motor RG skills is determined by the morphological characteristics and basic motor abilities. For any RG movement to be efficient, it has to be nice and harmonious, which means that it should be properly graded and leveled in terms of strength, speed, amplitude and muscle tonus. On performing RG exercises, various movements have to be integrated into a harmonious unity. Therefore, appropriate flexibility in terms of joint mobility and proper muscle tonus regulation are preconditions for successful RG in girls, as it is a basis to facilitate the whole body explosive strength performance as well as the speed in terms of movement frequency.

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UTJECAJ NEKIH ANTROPOLOŠKIH ČIMBENIKA NA IZVOĐENJE U RITMIČKOJ GIMNASTICI KOD POČETNICA

SAŽETAK

Cilj istraživanja bio je utvrditi motoričke i morfološke faktore te istražiti njihov utjecaj na izvođenje specifičnih motoričkih znanja u ritmičkoj gimnastici (RG). Na uzorku od 50 djevojčica (srednje dobi 7.1±0.3 godina), početnica gimnastičarki, primijenjen je eksperimentalni trenažni proces u trajanju od devet mjeseci, s osnovnim ciljem usva-

janja i uvježbavanja osnovnih kretnih struktura u RG. Faktorskim analizama 13 motoričkih, 11 morfoloških te 20 specifičnih RG testova izolirano je ukupno sedam dimenzija. Faktor fleksibilnosti (Beta=0.26; $p<0.05$), ekspolzivne snage (Beta=0.25; $p<0.05$) i adipozne voluminoznosti (Beta=–0.42; $p<0.001$) objašnjava 41% uspješnog izvođenja osnovnih elemenata tijelom (skokova, okreta, ravnoteža i gibljivosti) u RG ($R=0.64$), dok brzina frekvencije pokreta (Beta=0.44; $p<0.001$) i ne-adipozne voluminoznosti (Beta=0.26; $p<0.05$) objašnjava 26% uspješnog izvođenja specifičnog baratanja sa spravama (baratanje čunjevima, trakom i loptom iz zgloba šake) ($R=0.52$; $p<0.01$). Trenažni proces za početnice u RG, prema rezultatima ovog istraživanja, mora se programirati, s istaknutim ciljevima razvoja fleksibilnosti i eksplozivne snage, te razvoja brzine i snage perifernih zglobova i smanjenja postotka masnog tkiva.