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CORRELATION OF MORPHOLOGIC AND MOTOR VARIABLES WITH PERFORMANCE OF YOUNG FEMALE SPRINTERS ON 60 METERS

POVEZANOST MORFOLOŠKIH IN MOTORIČNIH SPREMENLJIVK Z USPEŠNOSTJO MLADIH ŠPRINTERK V TEKU NA 60 METROV

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Abstract

This study explains the role of morphological and motoric parameters in sprinting performance of young female sprinters in the 60 m run. Fifteen motoric and fourteen morphological parameters were used. The criterion was result of a 60 m run. The subject sample consisted of fifty-five girls, from 11 to 12 years of age.
With the method of expert modelling we evaluated performance in the space of motoric and morphological parameters. The correlation between the result of a 60 m run and potential successfulness was estimated with Pearson's correlation coefficient. The correlation is statistically significant at a level of 1% error.

Key words: sprint running, girls, motor skills, morphological characteristics, modelling

Izvleček

Naloga pojasnjuje povezanost morfoloških in motoričnih spremenljivk z uspešnostjo mladih šprinterk v teku na 60 m. V motoričnem prostoru smo zajeli baterijo petnajstih spremenljivk, v morfološkem prostoru pa smo zajeli baterijo štirinajstih spremenljivk. Kriterijsko spremenljivko je predstavljal rezultat v teku na 60 m. Obravnavani vzorec je bil sestavljen iz 55 deklic, ki so bile stare od 11 do 12 let.
Za dosego omenjenega cilja smo postavili reduciran potencialni model uspešnosti v motoričnem in morfološkem prostoru, ki smo ga ovrednotili z metodo ekspertnega modeliranja. S Pearsonovim korelacijskim koeficientom smo ugotovili povezanost med dejansko uspešnostjo (rezultatom teka na 60 m) in potencialno uspešnostjo. Povezanost je statistično značilna na nivoju 1% tveganja.

Ključne besede: šprinterski tek, deklice, motorične sposobnosti, morfološke značilnosti, modeliranje

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INTRODUCTION

Results in many of sport disciplines depend on the status and interdependence of the individual dimensions of the human psychosomatic status. The psychosomatic status is also influenced by internal and external factors. Dimensions have a special bondage and also interdependent influence on each other. Because of this bond and their interdependence their individual influence on the result is very unclear. Because of this we couldn't take all of them (all the factors that define the result) into consideration.

Factors that define successfulness in sprint are very complex and involved. We therefore used a simplified model and deal with it only from the most important viewpoints. The aim of this research was to find the association of morphologic and motor variables with performance of young female sprinters. Therefore we constructed the model of potential successfulness for young female sprinters in motor and morphologic space. In this model of potential successfulness we concluded from causes (motor and morphologic variables) to consequence (their 60m results).

REDUCED POTENTIAL MODEL OF SPRINTING SUCCESSFULNESS IN MORPHOLOGIC SPACE

Performance in sprint is also influenced by the morphologic characteristics of subjects. The assessed potential model of sprinting successfulness in morphologic space was based on the hierarchical structure of anthropometric dimensions, which was introduced in the research of Kurelić, Momirović, Stojanović, Šturm and Viskić-Štalec in 1975. Five latent dimensions were isolated with factorisation of 17 anthropometric variables in this research:

1. Longitudinal dimensions of the human body (body height, length of leg and length of arm).
2. Transversal dimensions of the human body (shoulder width, pelvic width, knee diameter and ankle diameter).
3. Circumferences of the human body (thigh circumference, shank circumference).
4. Factor of body fat (skin-folds).
5. Body mass.

There are no ideal anthropometric characteristics for sprinters, but we couldn't ignore some influence of these characteristics on sprinting performance. The macro and the micro level of anthropometric characteristics of sprinters are crucial for sprinting performance. The macro level of anthropometric characteristic is consisted of the following variables: body height, body mass, leg length, thigh and shank circumference, shoulder and pelvic width. On the other hand the structure and function of neuro-muscular system represent the micro level. In our model we assessed only the macro level of anthropometric characteristics, because the measurement procedure was then not so complicated.

The highest level of our model consist of body mass, external geometric dimensions and internal geometric dimensions (Table 1).

The important morphologic characteristic is body mass. The association between body mass and the result in the short sprint is statistically significant (Harliček, 1972; Šturm, Pavlović, & Strel, 1976). Greater body mass represents a larger quantity of active muscle mass, which is a very important factor for sprinting performance. Many authors had also obtained a negative association between the body mass and sprinting performance in their research work (Ozolin, 1949, Volkov, Lapin, & Smirnov, 1972). Less body mass could enable a higher stride frequency and therefore a higher sprinting speed (Volkov et al., 1972).

The knot of the external dimension consists of the following dimensions: longitudinal and transversal dimensions and also the circumference of the human body (Table 1). Longitudinal dimensions consist of body height and leg length. If we defined sprinting speed as a product of stride frequency and stride length, sprinters with greater body height and length leg have an advantage over smaller ones. Longitudinal dimensions have a positive association with the result in short sprint of boys and girls (Strel, 1976; Harliček, 1972). In a physical sense, longer limbs also have a longer handle, which enables greater force production. We could conclude that extremes in body height and leg length (positive or negative) have a negative impact on sprinting performance.

Transversal dimensions consisted of the following variables: shoulder and pelvic width, then knee and ankle diameter (Table 1). Pelvic width has generally a negative impact on most motor abilities, but transversal dimensions of the bones are in a positive association with performance, which depends on the mechanism for regulation of intensity (Kurelić, Momirović, Stojanović, Šturm, & Viskić-Štalec, 1975). This mechanism is in charge of explosive and elastic power, which is very important in sprint running. Explosive power has greater impact on the sprint start, but elastic power has more influence on sprinting with maximal speed.

Relaxed upper arm circumference, thigh and shank circumferences define the dimension of circumference of the body. Those sprinters, who have a bigger upper arm, thigh and shank circumference, have also more active muscle mass. More muscle mass enables production of greater force. The association between the cross-sectional area of the muscle and force production has values between 0.5 and 0.7 (Mayhew, Ball, Ward, Hart, & Arnold, 1991).

The skin-fold of some body part represents the knot of internal geometric dimensions: stomach, triceps, thigh and shank skin-fold. Skin-folds represent body fat. Body fat (especially on active segments) has a negative impact on success in sprint running. Skin-fold has generally a negative impact on the result in sprint running of girls (Čoh, 1991).

REDUCED POTENTIAL MODEL OF SPRINTING SUCCESSFULNESS IN MOTORIC SPACE

Our potential model (Table 1) of sprint successfulness is based on a hierarchical structure of motor abilities (Kurelić et al., 1975), properties of sprint running and bio-psycho-social qualities of girl's 11 to 12 years of age. We used the following classification of motor abilities: speed, endurance, strength, co-ordination, flexibility, precision and balance. Variability of motor abilities depends on 4 latent mechanisms:

1. Mechanism for movement structuring
2. Mechanism for synergetic and tonus regulation
3. Mechanism for regulation of intensity of excitation
4. Mechanism for regulation of duration of excitation

These 4 mechanisms have two common latent dimensions:

1. Energy component of movement is in charge of the mechanism for regulation of intensity and of the mechanism for regulation of duration of excitation.
2. Informational component of movement is in charge of the mechanism for movement structuring and of the mechanism for synergetic and tonus regulation.

The first level of our model consisted of: basic motor abilities and special motor abilities. The second level of our model consisted of the two above-mentioned mechanisms: energy component of movement and informational component of movement. The third level of the tree consisted of the 4 above-mentioned mechanisms. The first one is mechanism for movement structuring, which is in charge of co-ordination. The second one is mechanism for synergetic and tonus regulation, which is in charge of flexibility and speed of alternate movements. The third one is mechanism for regulation of intensity of excitation, which is in charge of speed, explosive and elastic power. The fourth one is mechanism for regulation of duration of excitation. This one is in charge of repetitive strength and aerobic and anaerobic endurance.

Co-ordination is ability to perform movements with a complex motor structure (Agrež, 1979). In this space we chose the following two tests: polygon backwards and eight jumps – hurdles of different height. Co-ordination has a great influence on sprinting performance on macro and micro level. Macro level is represented with – of that are very important to include and exclude consecutively the proper motor unit and muscle group.

Flexibility is the ability to perform movement with a maximal amplitude (Agrež, 1979). We chose the following two tests: forward bend and touch on a bench and frontal leg flexibility in the prone position. We could say that maximal speed is a product of the stride length and frequency, so inadequate flexibility of hips could cause shorter stride length than is normal.

The space of speed consisted of two parts: simple reaction and speed of alternate movements (arm plate-tapping, left and right foot tapping). Simple reaction is very important at the beginning of the run. A crucial point of simple reaction is the time for the information, who has to pass from the sensor organ (ear) to the central nervous system (where the response is made) and then back through the efferent pathways to the effectors (muscles), which perform the push-off from the starting block. The speed of alternate movements also depends on the central nervous system, which includes or excludes proper muscle groups.

In the space of strength we used three tests for explosive and three tests for elastic power. For explosive power of the legs we used standing broad jump and vertical jump, whereas for explosive power of the arms we used heavy ball throwing. For elastic power we used standing and running triple jump and also eight jumps with hurdles of the same height. Explosive strength has a great influence on the start, whereas elastic strength has more influence on the performance in the continuation of the run, but at the end of the run repetitive strength is also a very important factor. In our model we used the following three tests: lateral hops, sit ups and pull-ups on a horizontal bar.

Aerobic endurance is also an important factor, which could have a great influence on performance in sprinting. So we used the 1200 m run for evaluation of this ability.

METHODS

The sample comprised of 55 girls from 11 to 12 years of age. In order to achieve the set goal, we constructed a reduced potential model of successfulness in motor and morphological space. In motor space we used a battery of 15 variables and in morphological

Table 1: Absolute decision rules and normalisers for younger girls.

	MARK WEIGHT	>=4.0 EXCELLENT	>=3.5 VERY GOOD	>=3.0 GOOD	>=2.0 SUITABLE
MARK	100.0				
MORPHOLOGY	20.0				
BODY MASS	1.0	43-47	38-52	32-58	27-64
EXTERNAL GEOMETRIC DIMENSIONS	12.0				
LONGITUDINAL DIMENSIONS	4.0				
BODY HEIGHT	2.0	156-160	162-164	145-170	139-176
LENGTH OF LEG	2.0	88-92	86-95	82-100	77-104
TRANSVERSAL DIMENSIONS	4.0				
SHOULDER WIDTH	1.0	33-34	31-36	29-38	26-40
PELVIC WIDTH	1.0	24-25	22-26	21-28	19-29
KNEE DIAMETER	1.0	8.4-8.6	7.9-8.8	7.5-9.3	7.0-9.7
ANKLE DIAMETER	1.0	6.5-6.7	6.2-6.9	5.7-7.3	5.4-7.6
CIRCUMFERENCES	4.0				
RELAXED UPPER ARM CIRCUMFERENCES	1.0	>=26	>=24.1	>=20.3	>=18.3
THIGH CIRCUMFERENCE	1.5	>=56.9	>=52.9	>=44.7	>=40.8
SHANK CIRCUMFERENCE	1.5	>=37.3	>=34.9	>=30.3	>=27.9
INTERNAL GEOMETRIC DIMENSIONS	7.0				
STOMACH SKIN FOLD	1.5	<=6	<=8	<=10	<=12
TRICEPS SKIN FOLD	1.5	<=6	<=9	<=11	<=13
THIGH SKIN FOLD	2.0	<=12	<=15	<=18	<=20
SHANK SKIN FOLD	2.0	<=7	<=11	<=14	<=15
MOTORICS	80.0				
BASIC MOTORICS	25.0				
INFORMATIONAL COMPONENT	13.0				
MECHANISM FOR MOVEMENT STRUCTURING	3.0				
COORDINATION	3.0				
POLYGON BACKWARDS	3.0	<=7.4	<=9.6	<=14.1	<=16.4
MECHANISM FOR SYNERGIC AND TONUS REGULATION	10.0				
FLEXIBILITY	2.0				
FORWARD BEND AND TOUCH ON A BENCH	2.0	50-54	45-56	40-62	34-68
SPEED OF ALTERNATE MOVEMENTS	8.0				
ARM TAPPING	2.0	>=52	>=47	>=37	>=31
RIGHT FOOT TAPPING	3.0	>=24	>=22	>=18	>=16
LEFT FOOT TAPING	3.0	>=24	>=22	>=18	>=16
ENERGY COMPONENT	12.0				
MECHANISM FOR REGULATION OF INTENSITY OF EXCITATION	8.0				
EXPLOSIVE POWER	8.0				
STANDING BROAD JUMP	8.0	>=232	>=214	>=177	>=159
MECHANISM FOR REGULATION OF DURATION OF EXCITATION	4.0				
REPETITIVE STRENGTH	4.0				
SIT UPS	2.0	>=63	>=56	>=42	>=34
PULL UPS ON HORIZONTAL BAR	2.0	>=20	>=15	>=5	>=2
SPECIFIC MOTOR ABILITIES	55.0				
INFORMATIONAL COMPONENT	8.0				
MECHANISM FOR MOVEMENT STRUCTURING	6.0				
COORDINATION	6.0				
EIGHT JUMPS-HURDLES OF DIFFERENT SIZE	6.0	<=3.5	<=3.9	<=4.6	<=5.2
MECHANISM FOR SYNERGIC AND TONUS REGULATION	2.0				
FLEXIBILITY	2.0				
FRONTAL LEG FLEXIBILITY IN PRONE	2.0	95-105	84-112	71-112	60-140
ENERGY COMPONENT	47.0				
MECHANISM FOR REGULATION OF INTENSITY OF EXCITATION	40.0				
EXPLOSIVE POWER	10.0				
VERTICAL JUMP	5.0	>=52	>=46	>=34	>=28
HEAVY BALL THROWING	5.0	>=8.7	>=7.7	>=5.5	>=4.4
ELASTIC POWER	26.0				
STANDING TRIPLE JUMP	10.0	>=656	>=616	>=537	>=499
RUNNING TRIPLE JUMP	10.0	>=811	>=763	>=667	>=619
EIGHT JUMP-HURDLES OF SAME HEIGHT	6.0	<=3.9	<=4.4	<=5.4	<=5.9
REACTION	4.0				
SIMPLE REACTION	4.0	<=5	<=10	<=21	<=26
MECHANISM FOR REGULATION OF INTENSITY OF EXCITATION	7.0				
REPETITIVE STRENGTH	3.0				
LATERAL HOPS	3.0	>=40	>=36	>=27	>=22
AEROBIC ENDURANCE	4.0				
1200 m RUN	4.0	<=274.2	<=309.1	<=378.9	<=413.9

space 14 variables. The criterion was the result of a 60m sprint. The reduced model of potential successfulness has a hierarchical structure (Table 1). On the lowest level we have the basic criteria (tests of the individual motor abilities and morphologic characteristics). These basic criteria are then aggregated into combined criteria (aggregated criteria, ex.: explosive power). At the highest level we have the trunk of the tree (assessment of suitableness for sprint). The basic criteria are named leaves of the tree and the aggregated criteria knots. For each leaf and each knot we set a weight, which represents the absolute proportion of that individual factor towards the final successfulness. The values of the tests were evaluated by defining numerical normalisers that divide the range of possible values into five classes (unsuitable [0.0–1.9], suitable [2.0–2.9], good [3.0–3.4], very good [3.5–3.9] and excellent [4.0–5.0]). On the basis of these values we can then compute the final predicted successfulness in sprint of each individual athlete. The model of potential successfulness was evaluated with the expert modelling method - computer programme SPEX (Leskošek, 1995). The mark at the highest level is therefore a combination of the marks of the individual subdimensions. The result is given with values on a five-point scale (unsuitable [0.0–1.9], suitable [2.0–2.9], good [3.0–3.4], very good [3.5–3.9] and excellent [4.0–5.0]). The correlation between the marks obtained with the reduced model of potential successfulness and the actual results in sprint was also checked with hierarchical regression analysis (method ENTER). The validity of the model was assessed with the Pearson correlation coefficient between the actual sprint result (60m run) and the computed potential successfulness (obtained with expert modelling). In this way we assessed the quality of our model.

RESULTS

On the basis of the constructed model (hierarchical structure of the model's dimensions, weights and normalisers) we obtained, on the highest level, the marks of potential successfulness for each girl. These are shown in Figure 1. The correlation between the model's assessment and the actual competitive result is shown in Figure 2 (-0.66, P<0.001).

Correlation between the criterion variable (the result of a 60 m run) and evaluation on each hierarchical level of our model are represented in Table 2. With our model we managed to explain 44% of the criterion variable's variability (Table 2).

DISCUSSION

We have therefore assessed the potential successfulness of young female sprinters on all the levels of our model with expert modelling. The statistical significance of the Pearson correlation coefficient pointed to a high correlation between the prediction of our model and the actual 60m result, attesting to the quality of the constructed model. The evaluation of the motor space had the highest value of the correlation coefficient with the actual 60 m result on the other hand the correlation of the morphological space with the actual sprinting performance was somewhat lower.

A more detailed inspection of the evaluation of the morphological space showed that the highest correlation with the criterion had the evaluation of external geometric dimensions. In the physical sense the sprinting speed is the product of the stride length and the stride frequency. Among other factors that influen-

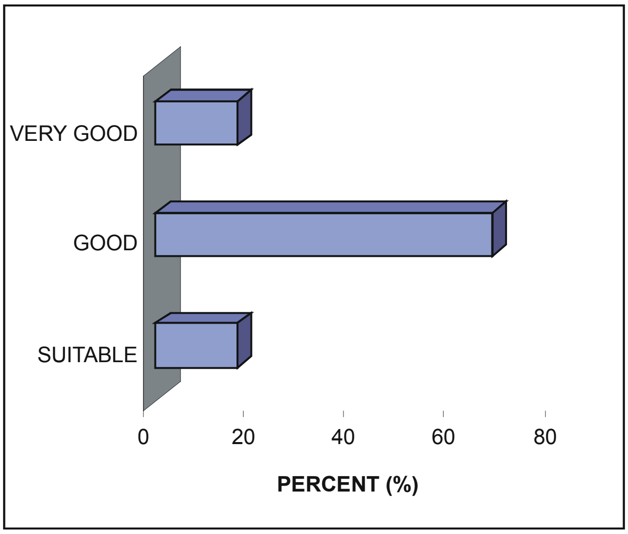

Figure 1: Structure of evaluation for a 60 m run

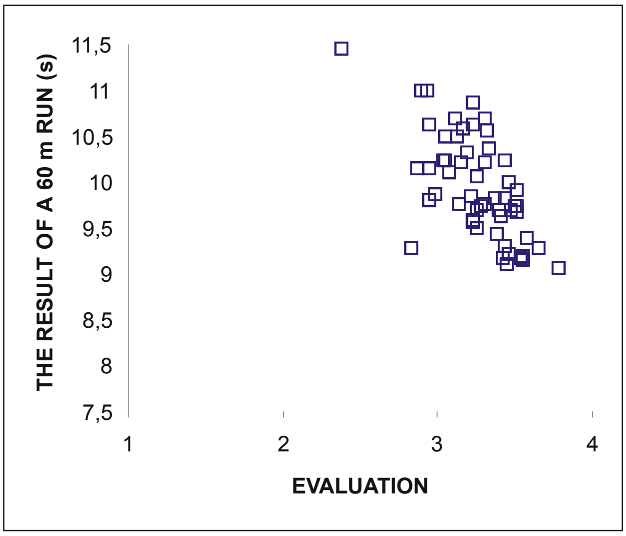

Figure 2: Association between the evaluation and the result of a 60 m run

Table 2: Results of correlation analysis between the actual performance and model of potential successfulness

	p	P	R
MARK	–0,66	0,000	0,43
– MORPHOLOGY	–0,45	0,001	0,20
– BODY MASS	–0,16		
– EXTERNAL GEOMETRIC DIMENSIONS	–0,25		
– LONGITUDINAL DIMENSIONS	–0,32	0,018	0,10
– BODY HEIGHT	–0,21		
└ LENGTH OF LEG	–0,35	0,008	0,12
– TRANSVERSAL DIMENSIONS	–0,04		
– SHOULDER WIDTH	–0,20		
– PELVIC WIDTH	–0,15		
– KNEE DIAMETER	–0,10		
└ ANKLE DIAMETER	0,05		
└ CIRCUMFERENCES	–0,07		
– RELAXED UPPER ARM CIRCUMFERENCES	–0,01		
– THIGH CIRCUMFERENCE	–0,06		
└ SHANK CIRCUMFERENCE	–0,11		
└ INTERNAL GEOMETRIC DIMENSIONS	–0,27	0,047	0,07
– STOMACH SKIN FOLD	–0,27		
– TRICEPS SKIN FOLD	–0,13		
– THIGH SKIN FOLD	–0,02		
└ SHANK SKIN FOLD	–0,41	0,004	0,16
└ MOTORICS	–0,66	0,000	0,44
– BASIC MOTORICS	–0,55	0,000	0,30
– INFORMATIONAL COMPONENT	–0,24		
– MECHANISM FOR MOVEMENT STRUCTURING	–0,38	0,004	0,14
– COORDINATION	–0,38	0,004	0,14
– POLYGON BACKWARDS	–0,38	0,004	0,14
└ MECHANISM FOR SYNERGIC AND TONUS REGULATION	–0,14		
– FLEXIBILITY	–0,08		
– FORWARD BEND AND TOUCH ON A BENCH	–0,08		
└ SPEED OF ALTERNATE MOVEMENTS	–0,12		
– ARM TAPPING	–0,27		
– RIGHT FOOT TAPPING	–0,05		
└ LEFT FOOT TAPING	–0,06		
└ ENERGY COMPONENT	–0,66	0,000	0,43
– MECHANISM FOR REGULATION OF INTENSITY OF EXCITATION	–0,61	0,000	0,37
└ EXPLOSIVE POWER	–0,61	0,000	0,37
└ STANDING BROAD JUMP	–0,61	0,000	0,37
└ MECHANISM FOR REGULATION OF DURATION OF EXCITATION	–0,51	0,000	0,26
└ REPETITIVE STRENGTH	–0,51	0,000	0,26
– SIT UPS	–0,33	0,014	0,11
└ PULL UPS ON HORIZONTAL BAR	–0,44	0,001	0,19
– SPECIFIC MOTOR ABILITIES	–0,67	0,000	0,45
– INFORMATIONAL COMPONENT	–0,28	0,041	0,08
– MECHANISM FOR MOVEMENT STRUCTURING	–0,28	0,042	0,08
└ COORDINATION	–0,28	0,042	0,08
└ EIGHT JUMPS-HURDLES OF DIFFERENT SIZE	–0,28		
└ MECHANISM FOR SYNERGIC AND TONUS REGULATION	–0,07		
└ FLEXIBILITY	–0,07		
└ FRONTAL LEG FLEXIBILITY IN PRONE	–0,07		
└ ENERGY COMPONENT	–0,70	0,000	0,49
– MECHANISM FOR REGULATION OF INTENSITY OF EXCITATION	–0,70	0,000	0,50
– EXPLOSIVE POWER	–0,56	0,000	0,31
– VERTICAL JUMP	–0,60	0,000	0,36
└ HEAVY BALL THROWING	–0,19		
– ELASTIC POWER	–0,73	0,000	0,53
– STANDING TRIPLE JUMP	–0,61	0,000	0,37
– RUNNING TRIPLE JUMP	–0,67	0,000	0,45
└ EIGHT JUMP-HURDLES OF SAME HEIGHT	–0,14		
└ REACTION	–0,14		
└ SIMPLE REACTION	–0,14		
└ MECHANISM FOR REGULATION OF INTENSITY OF EXCITATION	–0,23		
– REPETITIVE STRENGTH	–0,31	0,020	0,10
└ LATERAL HOPS	–0,31	0,020	0,10
└ AEROBIC ENDURANCE	–0,13		
└ 1200 m RUN	–0,13		

Legend: p–Pearson correlation coefficient R–determination coefficient (% of explained criterion variance), P–statistical significance of Pearson correlation coefficient ce the stride length is also the leg length (Hay, 1985), which had the highest correlation with actual sprinting performance. Many authors reported a positive influence of body height and leg length on performance in sprint running (Kurelić et al., 1975; Čoh, & Šturm, 1986; Gombač, 1967). Body height has a positive influence on those variables of jumping where the initial inertia has been followed by movement in the same direction (Kurelić et al., 1975).

Statistical significant correlation with the sprinting performance had also the evaluation of the internal geometric dimensions, which consisted of skin-folds on the lower level of our model. Skin-folds represent fatty tissue in the organism. Numerous studies have showed a negative role of skin-folds on different sections of a sprinting distance (Šturm, 1992; Čoh, & Kugovnik, 1990). A study by Kurelić et al. (1975) also speaks of fatty tissue as ballast mass, preventing better results in sprints and jumps. In a study by Čoh and Kugovnik (1990), the stomach skin-fold has the greatest negative predictive power for sprinting velocity (according to the value of the beta coefficient) between 5m and 10m. Also the thigh skin-fold has the greatest negative predictive power for sprinting between 10 and 15 and 20 and 60 m (Čoh, & Kugovnik, 1990).

The correlation between the evaluation of motor space and the 60m result is higher then previous. From the basic and specific motor subspaces, the energy component has higher correlation coefficient with the sprinting performance than the informational component.

In basic motorics, the evaluation of explosive power, repetitive power and co-ordination statistically significantly correlate with the performance in sprinting. Explosive power is especially important in the crouch start and the first part of the sprint, where it is important to achieve the greatest possible locomotor velocity in the shortest possible time. Starting acceleration, immediately after the start, when the sprinter's velocity is still low, is most defined by the starting power, which represents a combination of explosive and absolute power (Verhošanskij, 1979).

The reason for significant correlation between the result of a 60 m run and the evaluation of repetitive power probably lies in fact that chosen tests are under the influence of two mechanisms. The first one is mechanism for regulation of intensity of excitation and the second one is the mechanism of duration of excitation (Čoh, 1991). Every repetitive movement includes also explosive power, especially at the start of the movements. Crucial component for starting speed and also for maximal speed is especially explosive power.

Co-ordination is also crucial motor ability for sprinting. It is important on macro and micro level. Good intra- and inter-muscular co-ordination reflects in timely inclusion and exclusion of proper motor units and muscles or muscular groups during running with maximal speed.

In addition to co-ordination, evaluation of elastic and explosive power and also evaluation of repetitive strength significantly correlate with performance in specific motoric space. The running and standing triple jump are significant predictors in elastic power space, representing a test of push-off power, where the push-off is performed with one leg and is therefore very similar in its structure to sprint. Namely, sprint can be also considered a series of horizontal jumps from one leg to another. At push-off the jumper develops great force with a specific combination of eccentric-concentric contraction. The push-off action consists of three phases: in the first there is a relaxation of the extensors of the push-off leg, in the second this relaxation ends and a transition into the third phase is made, where the extensors of the ankle, knee and hip joints overcome the force of gravity with concentric contraction (Šturm, Stefanovska, Zakrajšek, & Novak, 1983). The efficiency of push-off depends therefore on three components: elastic, explosive and the speed of their integration (Šturm et al., 1983). The push-off in sprinting is composed in a similar way: in the first phase (braking phase) there is an eccentric contraction of the extending muscles, in the second phase a concentric contraction of the extending muscles follows. However, the important thing is a rapid transition from one phase to the next.

Also the eight jumps over the hurdles of different size significantly correlate with sprinting performance in specific motor space. The eight jumps test contains the following two components: co-ordination and elastic component. This test represents a demand for quick realisation of take-off power. The time of take-off is a very important factor of this test. The short times of take-off enable utilisation of the elastic potential of a muscle. The short times of take-of and proper intra- and inter-muscular co-ordination are very important factors of frequency of running.

In the space of explosive power the vertical jump has the highest correlation with criterion. The vertical jump explains the major part of variability of the result in the first five meters of the run (Čoh, & Kugovnik, 1990). The vertical jump has a similar structural and qualitative demands as the standing broad jump.

In our model we therefore encompassed some of the abilities and characteristics (and their hierarchical structure) that are decisive for performance in running 60 meters. In this way we could evaluate all the considered dimensions that affect performance for each individual athlete. In this way we have the possibility of identifying the strengths and weaknesses of each girl with the model. The above-mentioned data might be a guideline for initial selection and for planning, monitoring and analysing the training process.

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