INFLUENCE OF MOTOR SKILLS ON SPRINTER RUNNING PERFORMANCE

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ORIGINAL SCIENTIFIC ARTICLE

Summary: Motor skills have a significant impact on success in sprint running, as they enable optimal development of movement speed and efficiency. Research shows that there is a positive correlation between developed motor skills and better results in sprinting disciplines. The aim of this research is to determine statistically significant relationships between motor skills and individual criterion variables of sprinting speed in high school students aged 68 high school students in Novi Pazar, ages 15 and 16. Based on the results of the research, it was determined that the motor coordination tests with the stick (MKOR) and agility on the ground (MONT) have the highest correlation. These findings indicate that coordination and agility are interrelated components of motor skills, which together contribute significantly to the overall sports performance of high school students how specific training programs aimed at improving coordination and agility can affect sprint performance in high school students, considering that motor tests of coordination with the bat and agility on the ground showed the highest correlation with success in sprint running.

Keywords: athletics, students, correlation, performance

INTRODUCTION

The teaching of physical education in secondary schools is a key segment of the educational system, the aim of which is to promote a healthy lifestyle, physical development and improvement of the general health of students (Nikolić, 2019). Through various physical activities, students acquire the necessary knowledge and skills that contribute to their physical, emotional and social development. In the context of modern education, where a sedentary lifestyle is becoming more and more prevalent, the importance of teaching physical education becomes even greater (Pržulj et al., 2020). First of all, physical activity contributes to improving health, increasing muscle strength and endurance, and maintaining a healthy body weight. Regular physical activity also helps reduce stress, anxiety and depression, and improves cognitive function and academic achievement. In addition to health

benefits, physical education plays an important role in socializing students, developing team spirit, fair play and discipline (Gajić, 1986; Petrović, 2002).

The secondary school physical education curriculum covers a wide range of activities, including athletics, gymnastics, team sports, dance, recreational activities and exercises to develop flexibility and coordination. As part of these activities, students are introduced to the basics of physical health, proper exercise techniques and the importance of regular physical activity. Classes are organized to include theoretical and practical parts, enabling students to acquire both theoretical knowledge and practical skills (Jovanović et al., 1995; Gehri et al., 1998; Marković, 2016).

Athletics, as one of the oldest sports, has a long tradition and importance in the development of motor skills. Within athletics, sprinting disciplines represent the basis of speed and explosiveness, and are extremely important for the development of the overall physical form of athletes (Aksović et al., 2021). In high school students, sprinting disciplines not only contribute to physical health and fitness, but also to the development of a number of qualities such as discipline, persistence, team spirit and self-confidence (Dragaš, 2020). In order to improve the teaching process and pedagogical practice in general in secondary schools, research that establishes the relationship between the dimensions of psychosomatic status and specific motor abilities achieved by the program content of physical education is of scientific interest. From the analysis of relations between motor skills and specific motor skills of sprint running, confirmation of integral development is expected (Dejanović, 2002; Katanić, 2018; Aksović et al., 2021).

Some researchers (Bala, 1981; Arunović et al., 1992; Kragujević, 2005; Višnjić, 2006; Milanović, 2007) have repeatedly established a positive connection between motor skills and results in sprint athletic disciplines.

The aim of this research is to determine statistically significant relationships between motor abilities (as a predictor system) and individual criterion variables of sprinting speed (as a criterion system) in high school students aged 15 and 16 years.

The research hypothesis assumes the existence of statistically significant relationships between motor skills and results in running speed on short distances at 20, 50, 200 and 400 meters in subjects.

MATHERIALS AND METHODS

In the planned research, it is foreseen that, based on experimentally collected data, a transversal analysis of the results of motor skills and sprinting speed of the subjects will be performed. 68 high school students in Novi Pazar, aged 15 and 16 (± 6 months), participated in the experiment. All respondents carried out their activity in regular physical education classes and with three hours a week training process as selected athletes as part of additional classes.

The participants included in the research were healthy and without any chronic diseases, heart problems, that is, without injuries of the locomotor apparatus that would affect the test results.

Measuring instruments for motor skills assessment (Predictors)

Repetitive power:

1. Lifting the trunk on the Swedish bench	MDTK
2. Mixed pull-ups	MMZG
3. Squats	MCUČ

Segmental speed:

4. Foot tapping	MTAN
5. Taping by hand	MTAP
6. Tapping your feet against the wall	MTAZ

Coordination:

7. Agility in the air	MOKV
8. Coordination with the bat	MKOP
9. Agility on the ground	MEST

Balance

10. Transverse standing on a low beam	MPSG
11. Standing on 1 leg along the balance bench	MSUK
12. Standing on 1 leg along a balance bench with closed eyes	ANT

The applied set of motor variables was taken from the research of Kurelić et al. (1975).

Measuring instruments for the evaluation of sprint running (Criterium)

1. Running at 20 m with a high start	TR20VS
2. Running at 50 m with a high start	TR50VS
3. Running at 200 m with a high start	TR200VS
4. Running at 400 m with a high start	TR400VS

The applied set of sprint speed tests was taken from the research of Kurelić, Momirović, Stojanović, Šturm and Viskić-Štalec in 1975.

The following statistical methods were used for data processing

Basic descriptive parameters:
Mean value, minimum value (Min), maximum value (Max), standard deviation (SD).

Intercorrelation:
The matrix of intercorrelations of the research variables was calculated;

Two procedures were used for the discriminativeness of measurements:
Skewness; Kurtosis

Canonical correlation analysis calculated:

- The magnitude of the canonical correlation (Can. R)-represents the maximum correlation between predictor and criterion variables,
- Canonical root (coefficient) of determination (Can. R2)–represents the % of common variability of the investigated space,
- Bartlett Lambda test (Shi-sqr)–represents the statistical significance of the canonical correlation coefficient,
- Degree of freedom (Df),
- Degree of significance (p)–represents the level of significance of the canonical factors,
- The column (Root) shows the structure of isolated canonical factors.

RESULTS WITH DISCUSSION

Basic statistical parameters

Table 1. Basic statistical parameters for assessing motor skills of subjects

Var.	N	Mean	Min.	Max.	Std. Dev	Skewn.	Kurtos.
MDTK	68	11.36	8.00	28.00	9.17	-0.058	0.310
MMZG	68	14.83	10.00	25.00	54.96	0.393	-0.465
MCUČ	68	12.57	7.00	16.00	0.28	0.049	-1.065
MTAN	68	28.42	22.00	33.00	4.16	-0.305	-0.037
MTAP	68	37.63	32.00	46.00	5.86	-0.115	0.239
MTAZ	68	21.84	16.00	26.00	1.44	-0.590	0.848
MOKV	68	14.92	10.70	18.38	6.49	-0.142	-0.710
MKOP	68	12.34	9.20	16.34	3.68	0.213	1,765
MEST	68	31.25	27.40	37.60	13.43	0.386	-0.178
MPSG	68	18.93	14.00	25.00	4.41	0.838	-0.635
MSUK	68	24.67	18.00	39.00	3.84	0.193	-0.899
ANT	68	32.26	27.00	42.00	2.02	0.939	2,733

Legend: arithmetic mean (Mean), minimum (Min), maximum (Max), standard deviation (Std. dev.), skewness (Skewn.), kurtosis (Kurtos.)

The results shown in Table 1 for the examinees within motor skills show that there are no significant deviations of the results from the normal distribution in any test. There are at least five standard deviations (St. Dev) in the ranges of minimum (Min.) and maximum (Max) results, which indicates significant dispersion and sensitivity of motor tests. Skewness values show that none of the measures have significant deviations from the normal distribution, as the values in no test exceed 1.00. The kurtosis results are below the normal distribution value of 2.75, which makes the distribution platykurtotic. These results of motor abilities are in accordance with similar research conducted in our country on this population of participants, which enables the application of multivariate methods of processing the results in this research. This makes it possible to generalize the results to the population from which the sample was derived.

Table 2. Basic statistical parameters for evaluating the subjects' sprint running

Var.	N	Mean	Min.	Max.	Std. Dev	Skewn.	Kurtos.
TR20VS	68	3.91	3.38	4.18	21.68	0.108	-1.311
TR50VS	68	8.01	7.23	8.37	23.51	-0.442	-1.039
TR200VS	68	36.99	32.76	40.51	28.88	0.454	1.084
TR400VS	68	1.26	1.14	1.38	4.74	-0.789	-0.756

Legend: arithmetic mean (Mean), minimum (Min), maximum (Max), standard deviation (Std. dev.), skewness (Skewn.), kurtosis (Kurtos.)

The results shown in Table 2 for the subjects in the field of sprint running show that there are no significant deviations of the results from the normal distribution in any test. There are at least five standard deviations (St. Dev) in the ranges of the minimum (Min) and maximum (Max) results, which indicates significant variability and sensitivity of the sprint tests. Skewness values show that none of the tests have significant deviations from the normal distribution, because the values of none of the tests exceed 1.00. Kurtosis scores are below the normal distribution value of 2.75, making the distribution platykurtotic. These results of sprint running are in accordance with similar research conducted in our country on this population of participants, which enables the application of multivariate methods of processing the results in this research. This enables the generalization of the results to the population from which the sample was derived.

Table 3. Intercorrelation matrix of motor skills

	MDTK	MDTK	MDTK	MDTK	MDTK	MDTK	MDTK	MDTK	MDTK	MDTK	MDTK	MDTK
MDTK	1.00											
MMZG	-0.31	1.00										
MCUČ	0.13	-0.17	1.00									
MTAN	0.12	-0.08	0.28	1.00								
MTAP	-0.01	0.18	0.08	0.11	1.00							
MTAZ	-0.21	0.25	0.08	0.13	-0.07	1.00						
MOKV	-0.17	0.17	0.18	-0.25	-0.10	0.02	1.00					
MKOP	-0.19	-0.15	-0.38	-0.02	-0.24	0.16	-0.08	1.00				
MEST	-0.12	0.39	-0.05	0.01	-0.24	0.01	-0.00	0.65	1.00			
MPSG	0.04	0.18	-0.34	0.09	-0.04	0.30	-0.33	0.15	-0.08	1.00		
MSUK	0.01	0.22	-0.24	0.02	-0.12	0.23	-0.27	0.13	-0.07	0.56	1.00	
ANT	0.11	0.00	0.05	-0.35	0.14	0.09	-0.08	0.09	-0.25	0.06	0.10	1.00

Table 3 shows the intercorrelation matrix of motor abilities. The motor tests of coordination with a stick (MKOP) and agility on the ground (MONT) have the highest correlation, which is 0.65.

Table 4.Intercorrelation matrix of sprint running

	TR20VS	TR50VS	TR200VS	TR400VS
TR20VS	1.11			
TR50VS	-0.51	1.06		
TR200VS	-0.39	-0.61	1.08	
TR400VS	0.44	0.49	0.39	1.07

Table 4 shows the intercorrelation matrix of sprint running. The 200m high start (TR200VS) and 50m high start (TR50VS) tests have the highest correlation with a value of -0.51.

Canonical correlation analysis

Canonical correlational analysis of motor skills and success in sprint running

The results of the canonical correlation analysis show (Table 5) that in the relations between the system of predictors, which make up the variables for the assessment of motor abilities and the criteria, which make up the variables for the assessment of sprint running, one statistically significant pair of canonical factors was obtained.

The canonical factor significantly explains the level of association of the set of predictor variables with the criterion (R=.69), as well as their common variance (R2=.52), which explains the influence of motor skills on success in sprint running with a coefficient of determination of 52%. The probability of error for rejecting the hypothesis of whether the function is significant or not was determined between the predictor and the criterion (P=.000) at the 99% level.

Table 5. Canonical correlation analysis

	R	R2	Chi-sqr.	df	p
0	.69	.52	87.17	59	**.000**
1	.38	.14	29.45	32	.308
2	.32	.10	25.67	25	.369

*Legend:*canonical correlation coefficient (R), determination coefficient (R2), Chi-square test (Chi-sqr.), degree of freedom (df.), significance (p).

By looking at the structure of the canonical factors (Table 6), it can be concluded that the primary factors of motor abilities do not participate equally in the formation of the structure of the canonical factor, and this means that this canonical dimension is slightly different from the general factor. It can be concluded that a greater number of factors influence the efficient execution of sprint running variables, with the greatest influence in the deep bench press (MDTK -0.58) and mixed pull-ups (MMZG -0.47).

Table 6. Canonical factors of motor variables

VAR.	Root 1
MDTK	-0.58
MMZG	-0.47
MCUČ	0.44
MTAN	-0.37
MTAP	-0.44
MTAZ	0.25
MOKV	-0.37
MKOP	-0.44
MEST	0.21
MPSG	0.22
MSUK	-0.35
ANT	-0.44

Table 7.Canonical factors of criterion variables

VAR.	Root 1
TR20VS	0.44
TR50VS	0.57
TR200VS	-0.55
TR400VS	0.47

The canonical factors of sprint running (Table 7) indicate the existence of a one-dimensional space structure. The success factor of sprint running is best defined by running 50 meters with a high start (TR50VS 0.57).

Table 8. Cross-correlation analysis of motor variables and sprint running

	TR20VS	TR50VS	TR200VS	TR400VS
MDTK	-0.49	-0.43	0.41	0.52
MMZG	-0.45	0.48	-0.42	0.42
MCUČ	-0.06	-0.02	0.01	-0.03
MTAN	0.14	-0.07	0.10	-0.15
MTAP	0.02	-0.12	0.02	0.10
MTAZ	0.13	0.36	-0.39	-0.12
MOKV	-0.03	-0.02	-0.15	-0.04
MKOP	-0.12	-0.12	0.05	0.06
MEST	-0.24	0.22	0.32	0.32
MPSG	0.38	-0.35	0.14	0.14
MSUK	-0.27	0.24	0.35	0.35
ANT	0.28	-0.22	0.24	0.24

From the cross-correlation matrix of motor variables and variables of success in sprint running (Table 8), in the subjects, one can observe different levels of

correlation coefficients. The motor tests deep bending on the bench (MDTK) and mixed pull-ups (MMZG) in correlation with the tests of sprint running indicate the highest correlation of the observed sets.

DISCUSSION

In the planned research, it is foreseen that, based on the collected data, a transversal analysis of the results of the motor skills and sprinting speed of the subjects will be performed. 68 high school students in Novi Pazar, aged 15 and 16 years (± 6 months), participated in the experiment. Based on the results of the research, it was determined that motor tests of coordination with a stick (MKOR) and agility on the ground (MONT) have the highest correlation, with a correlation coefficient of 0.65. These findings indicate that coordination and agility are interconnected components of motor skills, which together contribute significantly to the overall sports performance of high school students. The stated results are confirmed by the authors (Klisarić, & Matić, 2021).

Coordination with the bat is a complex motor skill that requires precise coordination of hand and eye movements, as well as fine motor control. This test measures students' ability to control and manipulate an object (a bat) in space, which includes perception, movement planning and execution. A high level of coordination is necessary for many sports activities, where precision and control are key success factors (Malacko et al., 1990; Vučetić et al., 2011).

Agility on the ground means the ability to quickly change the direction of movement, maintain balance and control the body during dynamic activities. This test evaluates the reaction speed, explosiveness and agility of students (Bilić, 2002; Milčić et al., 2016). Agility is a key component in many sports, including football, basketball, handball and athletics, where quick changes of direction and pace of play are crucial. A correlation of 0.65 between bat coordination and ground agility indicates a significant association between these motor abilities. These results suggest that students who show a high level of coordination with the bat usually also have better agility on the ground, which is confirmed by the results of the study (Pavlović et al., 2014). This may be due to the fact that both skills require highly developed neuromuscular control, reaction speed and the ability to quickly adapt to changes in the environment.

Based on the results of the canonical correlation analysis, it can be concluded that a greater number of factors influence the efficient execution of the variables of sprint running, with the most pronounced influence in the deep bench press (MDFK -0.58) and mixed pull-ups (MMZG -0.47). These results indicate specific physical abilities that are of key importance for the successful performance of sprint disciplines. These results agree with the authors' research (Džibrić et al., 2016) the authors analyzed the results of a running test in students in order to determine how motor readiness can affect speed and efficiency in running short distances.

Deep bench press (MDFK) shows the greatest influence on the efficiency of sprint running with a coefficient of -0.58. This result suggests that the flexibility and mobility of the hindquarters and lower back play a key role in sprinting performance. Flexibility allows sprinters to maintain optimal running biomechanics, which is essential for achieving maximum speed and efficiency of movement.

Insufficient flexibility can lead to limited range of motion, increased risk of injury and reduced overall performance (Toppeta, 2013). Therefore, exercises that improve flexibility, such as deep lunges, should be an integral part of a sprinter's training program.

Mixed pull-ups (MMZG) also have a significant influence on the efficiency of sprint running, with a coefficient of -0.47. This exercise emphasizes the importance of upper body strength and core stability. The strength of the upper body is important for maintaining proper posture and efficient arm swing during running, which contributes to better balance and coordination (Čanaki et al., 2006). Central stability allows sprinters to maintain a stable torso, which reduces energy loss and improves force transfer from the upper to the lower body. Incorporating back, shoulder and core strengthening exercises can significantly improve a sprinter's performance.

In addition to upper body flexibility and strength, there are a number of other factors that affect sprinting performance. These include lower extremity strength, explosive power, coordination, running technique and anaerobic endurance. Each of these components contributes to different aspects of sprinting, such as initial acceleration, maximum speed, and the ability to maintain that speed throughout the race.

Based on these findings, and the results of the study they conducted (Stević, & Idrizović, 2013), it is recommended that coaches and athletes pay special attention to exercises that improve the flexibility and strength of the upper body. Incorporating deep bench presses and compound pull-ups into a regular training program can significantly contribute to better sprinting performance. In addition, it is important to continuously monitor the progress of athletes and adjust the training program according to individual needs and goals (Babin, 2001).

The results of the canonical correlation analysis on the sample of subjects showed that at the multivariate level there is a strong linear relationship between motor skills and running speed (p= .000). The proposed hypothesis - (There are statistically significant relationships between motor abilities and the results in the speed of running short distances at 20, 50, 200 and 400 meters in subjects) is fully accepted.

CONCLUSION

The results of this research have important implications for the planning and implementation of training programs in secondary schools. Focusing on the development of coordination and agility can contribute to the comprehensive improvement of students' motor skills, which is useful for their participation in various sports and recreational activities. Training programs that include coordination exercises with equipment (such as bat drills) and agility drills (such as agility drills) can be very effective in improving these key skills.

Given that different factors affect sprinting performance, an integrated approach to training that combines different types of exercises is recommended. For example, a training program should include exercises for flexibility, strength, explosiveness, technique and anaerobic endurance. Such a holistic approach allows

sprinters to develop all the necessary performance components and achieve optimal results.

Based on the high degree of correlation, it is recommended to include combined exercises that simultaneously target the development of coordination and agility. For example, exercises that combine object manipulation and rapid changes of direction can significantly improve these abilities. Specific exercises may include:

- Drills with cones and balls: Setting up a series of cones through which the students must drive the ball with the help of a stick or hand, changing the direction of movement.
- Exercises with agility ladders: Running through ladders with different movement patterns, with the addition of tasks with balls or other props.
- Combined games and challenges: Games that involve catching, throwing and avoiding obstacles, which simultaneously develop coordination and agility.

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