THE RELATIONSHIP OF TENNIS-SPECIFIC MOTOR ABILITIES AND THE COMPETITION EFFICIENCY OF YOUNG FEMALE TENNIS PLAYERS

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Abstract:

A sample of 96 young female tennis players, aged 13 and 14 years, was included in the research aimed at establishing the influence of selected tennis-specific motor abilities on the competition efficiency of young tennis players. The selected tennis-specific motor variables were: muscular power of the arms and shoulders (MBP), muscular power of the legs (QJ), muscular strength of the trunk (SU60), acceleration (R20), shuttle run ability (R9x6), speed of alternate arm movements (TAP20), flexibility of the back (FBB), flexibility in the shoulders (TS), flexibility of hips (FH), agility (FAN), coordination (OC), hand-eye coordination (RTBR) and dynamic balance (TLB). In defining the criterion variable (competition efficiency), all the tournaments for female tennis players which had taken place in the period of the last competition season were taken into account. The results revealed a statistically significant connection between the group of selected tennis-specific motor variables and the criterion variable - competition efficiency (0.83). The regression analysis results show that the system of predictor variables explains 69% of the variance of the criterion variable. Among the selected variables there is a statistically significant connection between seven of them and the variance of the criterion variable. These variables measure the muscular power of arms and shoulders (MBP), acceleration (R20), flexibility in the shoulders (TS), flexibility of the back (FBB), flexibility of hips (FH), hand-eye coordination (RTBR) and dynamic balance (TLB).

Key words: *tennis, competition efficiency, tennis-specific motor tests*

DAS VERHÄLTNIS ZWISCHEN TENNIS-SPEZIFISCHEN BEWEGUNGSFÄHIGKEITEN UND KONKURRENZ-LEISTUNGSFÄHIGKEIT DER JUNGEN TENNISSPIELERINNEN

Zusammenfassung:

An dieser Forschung nahmen 96 junge Tennispielerinnen im Alter zwischen 13 und 14 Jahren teil, mit dem Ziel den Einfluss von vorgewählten tennis-spezifischen Bewegungsfähigkeiten auf die Konkurrenz-Leistungsfähigkeit zu beobachten.

Diese vorgewählten tennis-spezifischen motorischen Variablen waren: Muskelkraft von Armen und Schultern (MBP), Bein-Muskelkraft (QJ), Muskelkraft des Rumpfes (SU60), Beschleunigung (R20), Pendellauf-Fähigkeit (R9x6), Geschwindigkeit von alternierenden Bewegungen mit dem Arm (TAP20), Flexibilität des Rückens (FBB), Gelenkigkeit in den Schultern (TS), Gelenkigkeit der Hüften (FH), Gewandtkeit (FAN), Koordination (OC), Hand-Auge-Koordination (RTBR) und dynamisches Gleichgewicht (TLB).

Bei der Definition der Kriterium-Variable (Konkurrenz-Leistungsfähigkeit) wurden alle Turniere für Tennisspielerinnen berücksichtigt, die in der letzten Spielsaison stattfanden.

Die Resultate zeigten ein statistisch signifikantes Verhältnis zwischen der Gruppe der gewählten tennis-spezifischen Variablen und der Kriterium-Variable - Konkurrenz-Leistungsfähigkeit (0.83). Die Regressionsanalyse der Resultate zeigte, dass das System der Prediktor-Variablen 69% der Konkurrenz-Leistungsfähigkeit-Varianz erklärt.

Unter den gewählten Variablen besteht ein statistisch signifikantes Verhältnis zwischen sieben von diesen Variablen und der Kriterium-Variable-Varianz. Diese Variablen messen die Muskelkraft der Arme und Schultern (MBP), die Beschleunigung (R20), Gelenkigkeit in den Schultern (TS), Flexibilität des Rückens (FBB), Gelenkigkeit der Hüften (FH), die Hand-Auge-Koordination (RTBR) und dynamisches Gleichgewicht (TLB).

Schlüsselwörter: *Tennis, Konkurrenz-Leistungsfähigkeit, tennis-specifische motorische Tests*

Introduction

Tennis is a dynamic sport played with a racket and a ball. Success in tennis is defined by several factors that can be divided into social (sport infrastructure, sport popularity, etc.), external (competitor, coach, parents, training conditions) and internal factors (potential capacity, realisation capacity and competition experience).

In this presented research, the competition efficiency of young female tennis players, aged 13 and 14 years, is explained on the basis of selected tennis-specific motor tests. The selected tests measure the muscular power of the arms and shoulders, muscular power of the legs, muscular power of the trunk, acceleration, shuttle run capacity, speed of alternate movements with the arm, flexibility of the back, flexibility in the shoulders, flexibility of hips, agility, coordination, hand-eye coordination and dynamic balance.

Muscular strength is defined as the ability of a muscle or a group of muscles to exert maximal force during contraction. Muscular power is a combination of strength and speed. The test measures how quickly muscular strength is applied.

In this issue field the following research studies have been consulted. Müller (1989) carried out 21 motor tests on 80 subjects, aged between 10 and 13 years. The criterion variable was the estimate of tennis quality. The highest correlation with the criterion variable was recorded in reaction tests, 20-metre run and Sargent jump.

Bunc, Dlouha, Höhm and Safarik (1990) have conducted research on 80 boys and girls aged 13 and 14 years with a test battery composed of eight tennis-specific motor tests and anthropometric measures. Based on comparison between the tests and competition efficiency in tennis they established that the speed of young tennis players was of high importance.

Filipčič (1993) compared competition efficiency with the results of basic motor and tennis-specific tests on 43 tennis players between 15 and 23 years of age. The results of the regression analysis showed a statistically significant connection between the system of predictor variables and the criterion variable. By applying the system of used predictor variables approximately 40% of the criterion variance can be explained.

Unierzyski (1994) used a sample of 217 boys and 163 girls to - among other things - establish the connection between the position on a national ranking list and seven motor tests. He succeeded in explaining 36.5% of competition efficiency with motor variables in 11-year old girls and 65.4% of criterion variable in 14-year old girls. He discovered the great significance of the first step acceleration in movement and of agility and strength in explaining competition efficiency.

Filipčič (1996) compared competition and potential efficiency with the regression analysis and expert modelling on 87 young tennis players, aged between 12 and 14 years. The regression analysis was initially performed separately on motor, morphological and physiological parts of the expert dendrogram. Using the morphological predictor variables 50% of the criterion variable was explained, using tennis-specific motor predictor variables 63% of the criterion variable was explained, and using the physiological predictor variables 53% of the criterion variable was explained. The regression analysis was furthermore performed on the highest level of the three dimensions that helped explain 66% of the criterion variable. Congruity of the results obtained through expert modelling and the regression analysis with the morphological dimensions turned out to be 0.40, with the motor dimensions 0.65 and with the physiological dimensions 0.58. On the highest level, i.e. the level of potential efficiency of young tennis players, the congruity of the results was 0.71. The congruity of the results obtained through expert modelling and regression analysis on the one hand and the criterion variable on the other hand turned out to be 0.53 considering the first method and 0.81 considering the second method.

Šerjak (2000) determined the connection between tennis-specific motor tests and competition efficiency on 51 female tennis players aged 11 to 14 years. The results of the regression analyses showed that there was a statistically significant connection between the system of tennis-specific motor variables and the criterion variable. Variables of muscular strength, speed of movement, flexibility and coordination had the highest prediction value.

Stare (2002) used the regression analysis to determine correlations between anthropometric and tennis-specific motor dimensions with the competition efficiency of tennis players. 75 young tennis players, aged between 12 and 14 years, participated in the research. The calculated values were statistically significant. Using anthropometric variables 32% of the criterion variable was explained, while tennis-specific motor predictor variables explained 41% of the criterion. Within the anthropometric variables, three variables were correlated to the criterion with statistic significance. Within the tennis-specific motor variables, stamina and speed of movement were statistically significant as well.

Methods

Subjects

The sample of subjects consisted of 96 active female tennis players in the age category of 13–14 years. The study covered only the players satisfying the following conditions:

- tennis players were ranked on the Slovene Tennis Association ranking list for U14 category;

- they participated in the process of regular training;
- they completed all the tests relevant to the research study.

Table 1. General characteristics of the subject sample

	Minimum	Maximum	Mean	Std. Deviation
Age (years)	12.00	14.81	13.5636	0.91215
Height (cm)	145.0	174.0	164.023	6.7771
Weight (kg)	32.0	68.0	53.727	8.6733

Procedures

The measurements were carried out at the Faculty of Sport in Ljubljana within regular annual measurements organised for members of the Slovenian national team. Apart from these candidates, the best female tennis players from different tennis clubs were invited to take part in the project. The measurements were carried out within one day. The tests of acceleration and speed of alternate movements with the arm were carried out immediately after the warm-up, while the tests of power of the trunk were carried out last.

Description of tennis-specific motor tests

Medicine ball put (MBP)

TASK: The subject stands behind a line (a right-hander with his/her left side towards the direction of the throw), holding the ball in his/her dominant hand, the left hand supporting the ball at its base. After a slight arch backward, the ball at thrown straight ahead with a move similar to a serve. The distance from the line to the point where the ball landed is measured.

Quarter jump (QJ)

TASK: The subject, from a sideways stance with his/her feet apart behind the line, takes four alternate jump steps, landing on both feet. The distance from the line to the last set of footprints (heel) is measured.

Oblique sit-ups in 60 s (SU60)

TASK: The subject lies down face up with the legs bent and the soles of the feet resting on the ground about 30 cm apart, hands behind the head, fingers interlocked. On the signal, the subject sits up, twisting the trunk and touching one elbow with the opposite knee, and then lies back flat again. The sit-up is repeated, the other elbow touching the other knee; the test is continued without interruption as many times as possible for a period of 60 seconds or as long as the subject can continue.

20-m run (R20)

TASK: The result is the time of the subject's running over a 20-m distance, starting from standing position at the start.

Hand-tapping 20 s (TAP20)

TASK: For twenty seconds the subject has to tap alternately two plates on the tapping board with his/her dominant hand, while holding the other hand in between the two plates. The result is the number of alternate double hits.

Fandrill (FAN)

TASK: The subject runs with a racket in his/her dominant hand, along a marked-out course of five directions of four metres. The subject must always step on the central marker and the other bases, or at least touch them with one foot. In addition, the racket must touch the ground in front of the player at each of the outside bases. Leg number three must always be run backward, while the other legs in any manner desired, as quickly as possible.

Turns on low beam (TLB)

TASK: The subject stands on a low beam and on command performs alternating turns of 180 degrees to the left and then to the right for 60 seconds. If the subject falls from the beam, he/she steps again on it and continues the task. The turn to one direction and back represents one repetition.

Twist with the stick (TS)

TASK: The subject stands and holds a stick forward with his/her arms extended. The left hand must be on the stick all the time while the right one can move. The subject moves the stick over his/her head so that the distance between the left and the right hand is as little as possible. The elbows of both arms must be extended. The result is the distance between the left and the right hand on the stick.

Forward bend on the bench (FBB)

TASK: The subject stands bare-footed on a bench. The legs are straight, feet are together and parallel. The toes touch the tape measure. The subject bends forward and pushes the board which slides down the tape measure. The final position must be maintained for at least 2 seconds.

Flexibility of hips (FH)

TASK: The subject stands beside the wall so his/her back touches the wall. The first foot is on a marked line, meanwhile with the second one he/she tries to make as long a step aside as possible.

9x6-m run (R9x6)

TASK: The subjects stands behind the first line and on the signal "Go!", starts running across the

first line (2.5 metres), continues the run to the second line (8.5 metres), where he/she stops (with both feet over the line) and runs in the opposite direction towards the first line. The six metre distance must be covered six times and he/she must finish the run over the third line (11 metres).

Obstacle course backwards (OC)

TASK: The subject crouches on all four limbs with his/her back turned to the obstacles. The subject's feet are behind the line. He/she must on the signal of the measurer move backwards, remaining on all four limbs, and cross the area between the two lines as fast as possible.

Rebounding the tennis ball with the racket (RTBR)

TASK: The subject holds the tennis racket in one and the tennis ball in the other hand. On the signal of the measurer the subject starts rebounding the tennis ball alternately once with the strings and once with the frame of the racket. If the ball drops off, the subject picks it up and continues with the task. The task is completed after 60 seconds.

In defining the criterion variable, all the tournaments for female tennis players aged up to 14 which had taken place in the period of the last competition season were taken into account. Since the players competed in a different number of tournaments, we selected the most suitable criterion variable (competition efficiency) which is the ratio between the number of points collected by an individual player in tournaments and the number of tournaments entered.

The number of collected points represented all the points received for ranking in a competition (depending on the competition rank; from 1st to 3rd rank); while the points received for winning depended on the opponent's ranking – bonus points. Points received collectively were divided by the number of tournaments entered and on this basis the coefficient of competition efficiency was calculated.

Data analysis

The basic statistical parameters of all the variables were computed in the first phase of the data analysis. In the second part classic multiple regression analysis was used to asses the relation between the tennis-specific motor variables and competition efficiency of the young female tennis players.

Results

Basic statistical parameters of the female tennis players are shown in Table 3.

The results of Kolmogorov-Smirnov test of distribution normality show that all the predictor variables and criterion variable (CE – competition efficiency) have a normal distribution.

Table 2. Predictor variables

Code	Name of test	Ability
MBP	medicine ball put (cm)	muscular power of arms and shoulders
QJ	quarter jump (cm)	muscular power of the legs
SU60	sit-ups in 60 s (freq.)	muscular power of the trunk
R20	20-m run (.1 s)	acceleration
R9x6	9x6-m run (.1 s)	shuttle run ability
TAP20	hand tapping in 20 s (freq.)	speed of alternate movements with the arm
FBB	forward bend on the bench (cm)	flexibility of the back
TS	twist with the stick (cm)	flexibility in the shoulders
FH	flexibility of hips (cm)	flexibility of hips
FAN	fandrill (.1 s)	agility
OC	obstacle course (.1 s)	coordination
RTBR	rebounding tennis ball with the racket (freq.)	hand-eye coordination
TLB	turns on low beam (freq.)	dynamic balance

Table 4 shows that the predictor system and the criterion variable are correlated with statistical significance. The coefficient of determination (R^2 = .686) shows that the predictor system of tennis-specific motor variables explains 69% of the variance of the criterion variable. The coefficient of multiple correlation (R = .828) shows that the relation of the system of predictor variables with the criterion variable is .83.

Among the selected variables, seven variables – *medicine ball put* (MBP), *9x6-m run* (R9x6), *forward bend on the bench* (FBB), *twist with the stick*

Table 3. Basic statistical parameters of the female tennis players

	Min.	Max.	Mean	SD	K-S	Sig. K-S
MBP	430.00	810.00	578.039	76.9940	1.002	0.268
QJ	550.00	830.00	728.922	56.0385	0.623	0.833
SU60	30.00	68.00	47.059	7.8420	0.691	0.726
R20	3.50	4.36	3.857	0.1837	0.602	0.861
R9x6	13.40	19.50	16.155	1.1760	0.566	0.905
TAP20	30.00	50.00	41.980	4.2402	1.029	0.241
FBB	36.00	64.00	51.274	6.5851	0.948	0.330
TS	7.00	120.00	65.941	18.3133	0.593	0.873
FH	124.00	191.00	160.157	13.1869	0.925	0.360
FAN	11.90	20.70	15.633	2.2042	0.845	0.472
OC	7.50	17.30	10.729	1.9175	0.930	0.353
RTBR	6.00	61.00	37.9216	11.6839	0.518	0.952
TLB	6.80	11.30	9.2824	1.0950	0.780	0.576
CE	1.000	39.600	12.87727	10.75617	1.313	0.640

Legend:
Min. – minimal result, Max. – maximal result, Mean – arithmetic mean, SD – standard deviation, K-S – Kolmogorov-Smirnov test of distribution normality, Sig. K-S - probability of K-S ($p<0.05$)

Table 4. Regression analysis of the female tennis players

	R	R^2	F	Sig. F
	.828	.686	5.623	.000
	Correl	**Beta**	**T**	**Sig. T**
MBP	0.613	0.326	2.410	0.021
QJ	0.278	-0.219	-1.382	0.175
SU60	0.351	0.057	0.487	0.629
R20	-0.365	0.105	0.685	0.498
R9x6	-0.279	-0.414	-2.281	0.028
TAP20	0.383	0.234	1.612	0.115
FBB	0.525	0.435	3.804	0.001
TS	-0.166	-0.236	-2.089	0.044
FH	0.120	-0.431	-3.289	0.002
FAN	-0.195	-0.159	-0.728	0.471
OC	-0.224	-0.035	-0.292	0.772
RTBR	0.509	0.367	2.473	0.018
TLB	-0.148	0.550	2.706	0.010

Statistically significant correlations ($p<0.05$) are bolded.

Legend: R – coefficient of multiple correlation, R^2 – coefficient of determination, F – F test of H0: $R^2=0$, Sig. F – significance of F test, Beta – standardized beta coefficient, Correl – Pearson correlation coefficient, T – t value for H0: Beta=0, Sig T – two-tailed significance level of T

(TS), *flexibility of hips* (FH), *rebounding the tennis ball with the racket* (RTBR) and *turns on low beam* (TLB), had the largest partial projection and the beta coefficients were statistically significant. Pearson correlation coefficients with the predictor and the criterion variable were higher for the *medicine ball put* (MBP), *forward bend on the bench* (FBB) and *rebounding the tennis ball with the racket* (RTBR).

Discussion and conclusions

The results of the regression analysis (Table 4) showed that as many as 7 variables of the total of 13 were strongly statistically correlated with the criterion. This at first glance may seem surprising, but a detailed analysis of the results reveals a sensible interpretation of the results.

The area of muscular power and strength was covered by the tests *medicine ball put* (MBP), *quarter jump* (QJ) and *sit-ups in 60 s* (SU60). The *medicine ball put* (MBP) was used for measuring the muscular power of the arms and shoulders which was necessary for a good serve and smash. In the past a high correlation was established between the technical performance of the serve and the tests measuring muscular power of the arms and shoulders or throwing abilities measured using the cricket ball throw test and ball throw kneeling (Unierzyski, 1994). In the serve, where the entire body takes part, the arms and the shoulder girdle play a decisive role, especially in the last phase of the serve, i.e. before and at the time the ball is hit, when the hand and the racket need to move as fast as possible (Filipčič, 1993). The serve is becoming more and more important since on grassy surfaces tennis players win about 20% of all points in a match with the serve (Höhm, 1987). In view of the modern development trends of a tennis match, the importance of the serve and return is increasing, because on a clay court as much as 33% of points

are won immediately after both strokes, while on hard courts the relevant share is 42% (Schönborn, 1999).

The comparison of the serve and the test *medicine ball put* (MBP) shows that the movements are in the active phase (just before the medicine ball is thrown and before the hit) very similar. Both motor actions include partial movements, which were based on biomechanical analyses recognised as relevant. These movements involve leg stretching in the knees, upper arm stretching forward and sideways in the elbow and hand stretching in the wrist. These three partial movements account for 35 to 55% of the final serve speed (Elliott, Marsh, & Blanksby, 1986). All three partial movements are recorded also in the test *medicine ball put* (MBP).

In the past, the serve was in female tennis typically considered to be of lesser importance than in males, but this has considerably changed lately. This means that the best female tennis players are capable of extremely fast serves (exceeding 200 km/h). In the age group which was the subject of this research the serve did not play such an important role as in the female category in general. It was, however, established that a good throw ability was strongly connected with the quality of the serve (Filipčič, 1996).

It has been established several times that the acceleration test (*20-m run*) is one of the tests with a high prediction value in explaining the competition efficiency of young tennis players (Bunc, Dlouha, Höhm, & Safarik, 1990; Müller, 1987; Filipčič, 1993, 1996; 1999, 2004; Unierzyski, 1994; Schönborn, Kraft, & Grosser, 2000; Šerjak, 2000; Stare, 2002). The above-mentioned findings - with the exception of Šerjak (2000) - apply to boys, which could be the reason why the high importance of the test 20-m run (R20) was not reaffirmed in this research.

Acceleration as well as start speed are abilities that play a special role in tennis. They have a decisive influence on the efficiency of tennis players' movements, since the start and the first few metres of the run determine the performance of a tennis player. Tennis involves many short sprints 5 to 11 meters long (Filipčič, 1996, 1999).

The *9x6-m run* (R9x6) is the test used for measuring a player's shuttle run ability. The variable *9x6-m run* (R9x6) had a high beta coefficient and was statistically connected with the criterion variable.

For the *9x6-m run* (R9x6) it can be established that it is to a certain extent similar to the movements in a tennis match since the female players during a single point make several short runs, changing direction. If we observe the game of 14-year old girls, we can see that the match is concentrated at the baseline of the court and there is much less action in the court and at the net. Therefore, the ability to move fast and change direction is crucial in points played at the baseline. It is obvious that in addition to acceleration the ability to change the direction of movement quickly is important in girls' tennis. This ability is part of the *shuttle run test* (R9x6).

Flexibility was measured by the tests *forward bend on the bench* (FBB), *twist with the stick* (TS) and *flexibility of hips* (FH). All three variables explained with statistical significance competition efficiency in tennis, which points to the great importance of flexibility in female tennis in this age group. Every variable represented a flexibility measurement covering a different body segment.

Forward bend on the bench (FBB) reflected the basic flexibility of a female tennis player. Adequate flexibility in the sagittal plane is necessary for many movements involved in tennis. The importance of optimal flexibility of the shoulder girdle, which is measured by *twist with the stick* (TS), was reflected in the serve and smash. Good flexibility enables a fast and relaxed loop in these two strokes. The importance of the *flexibility of hips* (FH) can be explained by the player's ability to hit the balls that she has more difficulty reaching and in doing so uses mainly an open stance. In boys Filipčič (1966) established that *flexibility of the hips* (FH) is very important to explain competition efficiency. Ultimately, we must not forget the positive impact of flexibility on other motor abilities (coordination, speed, strength, etc.).

The variable *rebounding the tennis ball with the racket* (RTBR) measured the ability of hand--eye coordination. The task was carried out with a racket and was very demanding. It involved a very specific activity, the importance of which was reflected in the precision of a tennis stroke. Undoubtedly, successful players had a well developed ability to perform quickly complex and untaught motor tasks with a racket and a ball.

The last variable which explained competition efficiency in female tennis players with statistical significance was *turns on low beam* (TLB). It measured the ability of dynamic balance on a low beam. It can be concluded that dynamic balance is very important in tennis since tennis players perform more and more strokes in a position when they are not in contact with the surface. This is particularly true of the serve and smash, whereas in the case of other strokes (return, forehand, backhand, and volley) this depends on the situation.

At the end it can be established that the selection of variables included in the regression analysis was adequate, both in terms of the individual tennis-specific motor abilities covered and of explaining tennis success. It is above all important that some significant bases were developed for further research of girls' tennis and the importance of tennis-specific motor abilities in explaining the competition efficiency of female tennis players.

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POVEZANOST SPECIFIČNIH MOTORIČKIH SPOSOBNOSTI I NATJECATELJSKE UČINKOVITOSTI MLADIH TENISAČICA

Sažetak

Uvod

Svrha ovog istraživanja bila je utvrditi utjecaj za tenis specifičnih motoričkih sposobnosti na natjecateljsku učinkovitost mladih tenisačica.

Metode

Ispitanici. Uzorak je činilo 96 mladih slovenskih tenisačica u dobi od 13 i 14 godina koje su dobrovoljno sudjelovale u ovom istraživanju. Mlade tenisačice rangirane su prema rang listi za kategoriju tenisačica do 14 godina (U14) Slovenskog teniskog saveza, redovito su uključene u trenažni proces i sve su izmjerene testovima specifičnih motoričkih sposobnosti koje su važne za tenis.

Varijable. Uzorak selekcioniranih, za tenis važnih, specifičnih motoričkih varijabli obuhvaćao je: mišićnu snagu ruku i ramena (MBP – suvanje medicinke), mišićnu snagu nogu (QJ – četveroskok), mišićnu snagu trupa (SU60 – podizanje trupa iz ležanja na leđima u 60 s), ubrzanje (R20 – trčanje 20-m), sposobnost trčanja s promjenom smjera (*shuttle run*) (R9x6 – trčanje 9x6-m), brzinu alternativnih pokreta rukom (TAP20 - taping u 20 s), fleksibilnost leđa (FBB – pretklon na klupi), fleksibilnost ramena (TS – iskret palicom), fleksibilnost kukova (FH – fleksibilnost kukova), agilnost (FAN - *fandrill*), koordinaciju (OC - poligon), okulomotornu koordinaciju (RTBR – udaranje teniske loptice reketom) i dinamičku ravnotežu (TLB – okreti na niskoj gredi).

Za definiranje kriterijske varijable u obzir su uzeti svi turniri za žene koji su se odigrali u posljednjoj natjecateljskoj sezoni. Kako su se ispitanice natjecale u različitom broju mečeva, odabran je najprikladniji kriterij - natjecateljska učinkovitost izračunata kao omjer bodova koje je pojedina igračica prikupila na turnirima i broja turnira na kojima je sudjelovala.

Rezultati

Rezultati pokazuju statistički značajnu povezanost selektiranih varijabli motoričkih testova specifičnih za tenis i kriterijske varijable *natjecateljska efikasnost* (0,83). Rezultati regresijske analize pokazuju da odabrani sustav prediktora objašnjava 69% varijance kriterijske varijable.

Od odabranih prediktorskih varijabli sedam ih je statistički značajno povezano s kriterijem. To su mjere mišićne snage ruku i ramena (MBP – suvanje medicinke), ubrzanje (R20 – trčanje 20.m), fleksibilnost ramena (TS – iskret palicom), fleksibilnost leđa (FBB – pretklon na klupi), fleksibilnost kukova (FH – fleksibilnost kukova), okulomotorna koordinacija (RTBR – udaranje teniske loptice reketom) i dinamička ravnoteža (TLB – okreti na niskoj gredi).

Rasprava i zaključak

Suvanje medicinke (MBP) korišteno je radi mjerenja mišićne snage ruku i ramena, što je nužno za dobar servis i smeč. U prethodnim istraživanjima utvrđena je povezanost između tehničke izvedbe servisa i testova koji mjere mišićnu snagu ruku i ramena, odnosno sposobnosti bacanja mjerene uz pomoć testova bacanja loptice za kriket i bacanja lopte iz klečanja. Ranije se servis kod žena tipično smatrao manje važnim nego kod muškaraca, što se promijenilo u posljednje vrijeme. Štoviše, utvrđeno je da je dobro razvijena sposobnost bacanja značajno povezana s kvalitetom servisa.

Višekratno se pokazalo da je test ubrzanja (trčanje 20-m) jedan od testova visoke prediktivne vrijednosti za objašnjavanje natjecateljske učinkovitosti mladih tenisača. Ubrzanje i startna brzina sposobnosti su koje igraju važnu ulogu u tenisu jer odlučujuće utječu na učinkovitost kretanja tenisača, dok start i brzina trčanja prvih nekoliko metara determiniraju tenisačevu izvedbu.

Trčanje 9x6m (*shuttle run;* R9x6) test je koji se koristi za mjerenje igračeve agilnost. Za trčanje 9x6-m (R9x6) može se reći da je u određenoj mjeri slično kretanju za vrijeme teniskog meča, budući da tenisačice za vrijeme poena izvode kratka trčanja, naglo i često mijenjajući smjer kretanja. Točnije, sposobnost brzog kretanja i promjene smjera suštinski je važno za igru na osnovnoj liniji.

Fleksibilnost se mjerila testovima pretklon na klupi (FBB), iskret palicom (TS) i fleksibilnost kukova (FH). Sve tri varijable statistički značajno pridonose objašnjavanju natjecateljske učinkovitosti u tenisu, što dovodi do zaključka o velikoj važnosti fleksibilnosti kod tenisačica ove dobne skupine. Svaka varijabla predstavlja mjeru fleksibilnosti različitih segmenata tijela. Pretklon na klupi (FBB) odražava bazičnu fleksibilnost tenisačice. Odgovarajuća fleksibilnost u sagitalnoj ravnini nužna je za izvedbu brojnih pokreta u tenisu. Važnost optimalne fleksibilnosti ramenog pojasa, mjerene iskretom palicom (TS), odražava se na servis i smeč. Dobra fleksibilnost omogućuje brze i opuštene petlje u izvedbi tih udaraca. Važnost fleksibilnosti kukova (FH) moguće je objasniti time da igračici omogućava da udari loptu usprkos poteškoćama pri hvatanju loptice te da se prilikom izvedbe udarca uglavnom koristi otvorenim stavom.

Varijabla udaranje teniske loptice reketom (RTBR) mjeri sposobnost okulomotorne koordinacije, tj. koordinacije između pokreta ruke i oka. Nedvojbeno je da uspješni igrači imaju dobro razvijenu ovu sposobnost brze izvedbe složenih i nenaučenih, nepoznatih motoričkih zadataka s reketom i lopticom.

Posljednja varijabla koja statistički značajno utječe na natjecateljsku učinkovitost tenisačica jesu okreti na niskoj gredi (TLB). To je mjera dinamičke ravnoteže. Moguće je zaključiti da je dinamička ravnoteža vrlo važna u tenisu, osobito stoga što tenisači izvode sve više udaraca iz pozicije u kojoj nisu u izravnom kontaktu s podlogom.

Zaključno je moguće reći da je selekcija prediktorskih varijabli uključenih u regresijsku analizu bila prikladna, kako s aspekta odabira pojedinih, za tenis specifičnih, motoričkih sposobnosti, tako i s aspekta objašnjavanja uspješnosti u tenisu. Izuzetno je važno da je ovo istraživanje dalo značajnu osnovu za buduća istraživanja tenisa na uzorku djevojčica ove dobi te da naglašava važnost specifičnih motoričkih sposobnosti u objašnjavanju natjecateljske učinkovitosti tenisačica.