FACTA UNIVERSITATIS
Series: **Physical Education and Sport** Vol. 11, Nº 1, 2013, pp. 93 - 102

Original research article

MOTOR ABILITIES OF YOUNG FEMALE TENNIS PLAYERS OF THE NATIONAL TEAM OF SERBIA

UDC 796.342:512.547 (497.11)

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Abstract. *The basic aim of this research was to determine the differences in motor abilities of female tennis players of the national team of Serbia aged 12, 14 and 16. The research sample consisted of 15 female tennis players, five national team players for each age category. Overall 14 measures for the estimation of motor abilities were applied as follows: three for the estimation of speed, four for the estimation of power, two for the estimation of endurance and five for the estimation of agility/coordination. On the basis of the ANOVA, the obtained results determined statistically significant intergroup differences in the tests for the estimation of power (Sig. < .01) and in the tests for the estimation of speed and coordination (Sig. < .05). Better results in almost all tests were obtained by the tennis players of the oldest age category, except in the test for the estimation of the coordination, this being movement speed on the forehand side, where the best results were obtained by the female tennis players aged up to 12. After the administered Post Hoc Test for the estimation of intergroup differences the results have shown that female tennis players aged up to 16 were the best in the tests of power and speed, and the youngest national team players (up to 12) in the test of coordination. It can be concluded that growth (puberty) as well as the training process caused the presence of all intergroup differences in motor abilities of female tennis players of different age categories.*

Key words: *tennis, motor abilities, differences, national team players, Serbia.*

INTRODUCTION

A large number of tennis technique elements and a variety of shots require players to exhibit a high level of technical, tactical and motor abilities. Motor abilities denote man's ability to participate in solving the motor task and condition successful movements,

Received April 15, 2013 / Accepted March 23, 2013
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whether acquired through training or not (Malacko & Rađo, 2004). According to Bompa (2006), two factors determine the participation of motor abilities in the achievement of high athletic performance: the relationship of these abilities in a sport, which reflects the specificity of the given sport, and the development of each ability, according to the ratio of its frequency of use within the sport or discipline. The impact of motor abilities on the implementation of the technical and tactical elements in tennis is great.

In the last 20 years, tennis has evolved from a sport with long tennis points to dynamic tennis, which is based on the explosive movements, strength and speed of the players. Since a tennis game has no time limit, matches last from one to several hours (matches in five sets). This variability in the length of matches, as well as the specificity of the tennis game require from the players well-developed endurance capacity, both anaerobic for game performance and aerobic for faster recuperation during and after the game (Kovacs, 2006).

Lacourse & Young (1993) suggest that there are certain factors such as age and gender that affect the ranking of female players aged 11-14. They further point out that girls aged 11-12 who are more extrovert, more agile, with greater relative sitting body height and weight will also be more successfully ranked players. In the older age category of 13-14 years, the authors suggest that girls who perform the given task and are more prevalent (always compete in order to be better than others), and are more focused on task execution and have better timing anticipation will also be better ranked in the national and European lists in their competition category.

One of the key differences between men and women are exactly the size and strength of the upper body, and in many sports (tennis, handball, volleyball and so on) sports results depend on the physical abilities of the upper body (Zatsiorsky & Kraemer, 2006). In girls over the age of 14, muscle strength in the upper body does not increase naturally as it does in boys. Ignjatović et al (2011) point out that the girls after the age of 14 should train with different loads (medicine balls) in order to increase arm and upper body strength, especially in sports where success depends on the effectiveness of the upper limbs (handball, tennis).

Otherwise, the period from the age of 11 to 18 signifies the period of puberty which leads to rapid changes and the development of primary sexual characteristics. Between the ages of 11 and 14 girls experience an intense increase in height, which leads to the development of secondary sex characteristics that are manifested in changes in the development of skeletal muscles and subcutaneous adipose tissue, changes in voice, and so on. (Đurašković, 2009). At the same time, puberty has a profound influence on the expression of the natural abilities of women in sport. Female adolescents, actively engaged in the training process, normally developed or slightly more sexually matured, may be at an advantage due to the increase of power or force (Bertelloni, Ruggeri, & Baroncelli, 2006).

Tennis is a very demanding sport for the female body. It requires continuous preparation of the female players, customized to suit the relevant age characteristics and the expert guidance of all parts of the preparation process: physical, technical, tactical, and psychological (ITF, 1998). Female tennis players aged 12 to 14 are eligible to participate in national and European tournaments (ET), while juniors up to the age of 16 can participate in international ITF tournaments.

According to the characteristics of the period of growth and development of the players (puberty), and the impact of the training process on their abilities, the aim of this study was to determine whether there are differences in motor abilities between the age groups 12, 14 and 16 of the female national team members in tennis.

THE METHOD

The sample of participants

The research sample consisted of 15 female participants divided into three sub-samples. Every sub-sample was made up of the 5 participants who were the national team members of Serbia in their categories, i. e. the categories of 12, 14 and 16 years, respectively. Geographically, there were 11 female tennis players from Belgrade, while there was one from Lazarevac, Vršac, Subotica and Čačak. All the participants had been playing tennis for at least 5 years (having in mind that tennis playing experience can be from 9 to 10 years in the categories of 14 and 16 years) and that during the year, on average, they can participate in between 20 or 25 tournaments (state, European-Tennis Europe and international-International Tennis Federation, ITF). Table 1 shows the basic anthropometric parameters of the participants (body height and weight), as well as one of the parameters of the body structure - Body Mass Index (BMI).

Table 1. The basic anthropometric parameters and Body Mass Index of the participants

	Age		
	12 years	14 years	16 years
Body height (cm)	161,76	165,08	169,12
Body mass (kg)	50,76	52,40	63,36
BMI (kg/m^2)	19,35	19,21	22,19

The sample of measuring instruments

For the evaluation of motor abilities a set of 14 tests was used (ITF, 2003). The strength of the arms and shoulders, as well as of the upper body was evaluated by the following tests: push-ups (SKL), medicine ball overhead throw, medicine ball throw from the right side of the body, medicine ball throw from the left side of the body. Speed was evaluated by tests of the 20 meter sprint (S20m), 10 meter sprint (S10m), 5 meter sprint (S5m). Coordination and agility were evaluated by 5 tests: movement speed on the forehand side (KFOR), movement speed on the backhand side (KBEK), moving back speed (KUNA), test of agility Pland (PLAN), and the Hexagon test (HEKS). Endurance was evaluated by the shuttle run (SUTL) and the test of speed endurance (TBI).

Data processing

The collected data were processed using the statistics package for data processing SPSS 17.0 (SPSS Inc., Chicago, IL). The descriptive statistical parameters were calculated for every group. To determine intergroup differences the one factor univariate analysis of variance (ANOVA) was applied. For the additional determination of the differences among each group the LSD Post Hoc Test was used. The statistical significance was $p < .05$.

THE RESULTS

Table 2 shows the basic descriptive parameters of the motor abilities of the participants. The obtained results enable us to state that the female participants aged 16

achieved the best results in almost all the administered tests, except in the movement speed in forehand test. In the tests for strength assessment, female tennis players aged 16 exhibited much better results when compared to other two participant categories. In the medicine ball overhead throw test the participants achieved a result of 10,09m, while female tennis players aged up to 14 (7,59 m) and 12 (6,78 m) were significantly weaker. Also, better results were obtained in the other two tests for the hand and upper body strength assessment by the older players.

Female tennis players aged up to 14 achieved better results in almost all the administered tests when compared to their 12-year category. Only in the tests of coordination estimation, movement speed on the forehand side (2,11s vs. 2,04s) and movement speed on the backhand side (2,16s vs. 2,14s) were the 12 participants more successful.

The results show small aberrations from the standard values which point to the relative homogeneity of the sample.

Table 2. The descriptive parameters of motor abilities.

	12 Years (n=5)		14 Years (n=5)		16 Years (n=5)	
	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
Movement speed on the forehand side	2,04	0,13	2,11	0,20	2,32	0,06
Movement speed on the backhand side	2,14	0,14	2,16	0,16	2,28	0,13
Moving back speed	1,39	0,16	1,40	0,06	1,29	0,19
Agility test Planned	29,03	2,77	29,16	1,46	28,98	1,45
Hexagon	14,10	1,06	13,18	1,18	12,01	1,08
5m - Sprint	1,30	0,12	1,33	0,08	1,19	0,04
10m - Sprint	2,21	0,20	2,11	0,14	1,91	0,05
20m - Sprint	3,77	0,30	3,66	0,11	3,54	0,10
Speed endurance TBI	5,93	0,92	5,11	1,01	4,62	1,61
Medicine ball overhead throw	6,78	0,53	7,59	0,42	10,09	0,70
Medicine ball throw on the right side	7,41	0,54	9,62	0,38	11,09	0,68
Medicine ball throw on the left side	8,01	0,65	9,67	1,11	10,61	1,10
Push-ups	3,60	2,61	7,40	5,46	7,20	3,56
Shuttle run	5,71	1,31	6,79	0,57	7,21	0,94

Table 3 shows the ANOVA between group results. The results show that there were determined statistically significant differences at the.01 level in the medicine ball overhead throw (Sig. = .000), medicine ball throw on the right side (Sig. = .000) and medicine ball throw on the left side (Sig. = .004). Statistically significant differences at the.05 level were determined in the movement speed in forehand (Sig. = .024), Hexagon (Sig. = .035) and 10m Sprint (Sig. = .020).

For the additional determination of the differences between each group the LSD Post Hoc Test (Table 4) was applied. Based on the obtained results one can conclude that there was a statistically significant difference in the medicine ball overhead throw test between the 12 and 14 year-old female tennis players (Sig. = .043), whereby better results were achieved by the 14 year-old female tennis players.

Table 3. ANOVA between groups.

	Sum of Squares	df	Mean Square	F	Sig.
Movement speed on the forehand side	,205	2	,103	5,139	,024
Movement speed on the backhand side	,057	2	,028	1,441	,275
Moving back speed	,038	2	,019	,894	,434
Agility test Planned	,085	2	,043	,011	,989
Hexagon	11,009	2	5,505	4,492	,035
5m - Sprint	,050	2	,025	3,506	,063
10m - Sprint	,234	2	,117	5,542	,020
20m - Sprint	,135	2	,067	1,855	,199
Speed endurance TBI	4,391	2	2,195	1,485	,265
Medicine ball overhead throw	29,782	2	14,891	46,727	,000
Medicine ball throw on the right side	34,234	2	17,117	56,979	,000
Medicine ball throw on the left side	17,304	2	8,652	9,069	,004
Push-ups	45,733	2	22,867	1,391	,286
Shuttle run	5,988	2	2,994	3,061	,084

Table 4. Post Hoc Tests.

Variables	Year	Mean Difference	Sig.
Movement speed on the forehand side	12 vs 14	-0,06	,488
	12 vs 16	-0,27	,010
	14 vs 16	-0,21	,037
Movement speed on the backhand side	12 vs 14	-0,02	,860
	12 vs 16	-0,14	,147
	14 vs 16	-0,12	,195
Moving back speed	12 vs 14	0,00	,983
	12 vs 16	0,11	,274
	14 vs 16	0,11	,265
Agility test Planned	12 vs 14	-0,13	,918
	12 vs 16	0,05	,971
	14 vs 16	0,18	,890
Hexagon	12 vs 14	0,93	,210
	12 vs 16	2,09	,011
	14 vs 16	1,17	,122
Sprint 5m	12 vs 14	-0,03	,637
	12 vs 16	0,11	,067
	14 vs 16	0,13	,028
Sprint 10m	12 vs 14	0,11	,263
	12 vs 16	0,30	,007
	14 vs 16	0,19	,056
Sprint 20m	12 vs 14	0,11	,388
	12 vs 16	0,23	,078
	14 vs 16	0,12	,324
Speed endurance TBI	12 vs 14	0,82	,308
	12 vs 16	1,31	,114
	14 vs 16	0,49	,533

Variables	Year	Mean Difference	Sig.
Medicine ball overhead throw	12 vs 14	-0,81	,043
	12 vs 16	-3,31	,000
	14 vs 16	-2,50	,000
Medicine ball throw on the right side	12 vs 14	-2,21	,000
	12 vs 16	-3,68	,000
	14 vs 16	-1,47	,001
Medicine ball throw on the left side	12 vs 14	-1,66	,020
	12 vs 16	-2,60	,001
	14 vs 16	-0,94	,154
Push-ups	12 vs 14	-3,80	,164
	12 vs 16	-3,60	,186
	14 vs 16	0,20	,939
Shuttle Run	12 vs 14	-1,08	,110
	12 vs 16	-1,50	,034
	14 vs 16	-0,42	,515

Between the 12 and 16 year-old female tennis players categories, statistically significant difference was obtained in four tests: movement speed in forehand (Sig. = .010), Hexagon (Sig. = .011), the medicine ball overhead throw (Sig. = .000) and the shuttle run test (Sig. = .034). In all the tests better results were achieved by the 16-year-old group.

In a specific tennis movement test (movement speed in forehand), the best results were achieved by the youngest category of up to 12-years.

Between group results of the 14 and 16 year-old participants show that there were differences in the movement speed in forehand (Sig. = .037), 5m Sprint (Sig. = .028), medicine ball overhead throw (Sig. = .000) and medicine ball throw on the right side (Sig. = .000) tests. In all the results the older female tennis players were more successful, except in the movement speed in forehand test, where younger age female tennis players achieved better results.

DISCUSSION

Comparing our research results of the basic descriptive statistical parameters with the reference values of the ITF (2003), it can be concluded that the national team female tennis players of all categories have achieved weaker results in most motor tests. The participants in our study achieved better results only in the tests for the specific tennis movement estimation (movement speed in forehand and movement speed in backhand), then anaerobic endurance (TBI) and hand and upper body strength (medicine ball overhead throw, medicine ball throw on the right side, and medicine ball throw on the left side). All three categories of participants achieved remarkably weaker results compared to the reference values on the test for the aerobic endurance estimation (Shuttle run test). The reasons for such bad results in aerobic endurance could be found in the insufficient selection basis, which in turn conditions the selection of the female tennis players according to their national team of Serbian competitions.

The ANOVA results show that there are statistically significant differences in six tests (Table 3). A statistically significant difference was determined in the tests for the estima-

tion of coordination, strength and speed. The best results in the tests for the estimation of strength and speed were achieved by 16 year-old female tennis players, while in coordination (movement speed in forehand) the best results were achieved by up to 12 year-old female tennis players. Such results of the oldest group of participants could be explained by the negative influence of puberty, because in this phase of growth and development of the female tennis players their coordination abilities are weaker (Đurašković, 2009). Some authors have determined differences in motor abilities of the male and female tennis players of different age groups, but there are many studies investigating and confirming the significant correlation of coordination (Tsetseli, Malliou, Zelou, Michalopoulou, & Kambas, 2010), strength (Filipčić & Filipčić, 2005; Filipčić, Pisk, & Filipčić, 2010), speed (Filipčić & Filipčić, 2004) and other motor abilities with success in tennis. Also, with the growth and development there comes a development of the motor abilities through other types of activities (Milojević & Stanković, 2010).

Coordination is a dominant ability for the realization of technical movements in tennis. Female tennis players with well-developed coordination ability who can perform swift, complex motor tasks with the racquet and ball are much more successful. In the tests Hexagon and Movement speed in forehand used to estimate this motor ability, statistically significant differences were determined in six (Table 3). Comparing the results of the intergroup differences of the participants (Table 4), it can be said that there is a difference between female tennis players aged 12 and 16, that is, 14 and 16 in the movement speed in forehand side test where better results were achieved by both younger groups of female tennis players (12 and 14 years). This could be explained by better a movement technique of the younger players during returning to the middle of the court. The proper technique for the beginning of the forehand movement causes a more efficient and quicker first and second step, and this in turn causes a swifter ball approach (Tudor, Šunić & Tomić, 2013). Another reason to justify weaker results of the older participant categories can be the greater rate of nourishment (Table 1) when compared to the participants aged 12 and 14, because it is well known that body mass acts as the disturbing factor in movement speed. Better results in the Hexagon determined a difference between the female tennis players aged 12 and 16, where better results were achieved by the members of the national team of the oldest category.

Some studies (Tsetseli et al., 2010) have found significant influences of the coordination program (with a special emphasis on the reaction ability and kinesthesis) on the serve technique in male tennis players aged 9-13. Some previous studies recommend training of coordination with the aim of developing skills and performances in racquet sports (Kambas, Falouros, Aggelousis, Gourgoulis, & Taxildaris, 2003). On the basis of the mentioned research the obtained results of our research point out that older participants who can boast of longer playing experience also have better coordination abilities.

Neuromuscular strength of the legs, hands and shoulders, all exert influence on the tennis players' performances in the functional and preventive sense (from the injuries). This is confirmed by several studies (Müller, 1989; Šerjak, 2000; Filipčić & Filipčić, 2005) which have determined a positive and statistically significant correlation between neuromuscular strength and tennis moves, jumps and swift first steps after the "Split step". Also, a significant correlation between the medicine ball throw test and success in tennis in participants aged 13-14 was determined by Filipčić & Filipčić (2005). The results obtained in our research have shown that there are significant intergroup differences in strength and also the fact that the greatest strength is displayed by female tennis play-

ers aged 16. This can be ascribed to the period of puberty, because with the growth and development strength also grows (Đurašković, 2009; Beachile & Earle, 2008). Another factor that can influence such results is the length of the sporting career that is, playing experience (Bompa, 2006; Beachile & Earle, 2008).

Success in tennis depends on the ability to quickly cover short distances and the start speed, acceleration, reaction speed and the speed of the repeated movements. Some authors (Stare 2002; Filipčić, Pisk & Filipčić, 2010) conclude that the starting speed as well as the acceleration (5m sprint and 20m sprint) significantly contributes to the competition success in tennis. Our research determines statistically significant differences in running speed (10m Sprint) between the participant groups of 14 and 16, that is, 12 and 16 (Table 3 and Table 4), where better results in both cases were achieved by the oldest participants. Between the female tennis players aged 14 and 16 there is a statistically significant difference in the 5m Sprint test, and better results were achieved by the older participants. Given the fact that game of tennis is characterized by short distance movements and sprints, correct and timely movement enable the performance of the basic tennis shots. Speed is the ability which is mostly genetically determined (.95), so that training can affect it slightly (Malacko & Rađo, 2004). Better speed predispositions and longer tennis playing can be considered the influential factors causing the achievement of better results of the oldest category of the female tennis players in our research.

Well defined and developed aerobic endurance enables female tennis players to achieve high playing levels during the match, as well as to earn points after long exchanges of shots. Aerobic endurance in our research was also estimated by the test of the shuttle run. A statistically significant difference was determined between the groups of female tennis players aged 12 and 16 (Table 4), where better results were achieved by the participants of the oldest age category. The intensity of the game in this age is of a lower level so that the aerobic processes can contribute significantly to the success of the female tennis players (Filipčić & Hazar, 2011).

CONCLUSION

On the basis of the obtained results one can conclude that the oldest age category of the female tennis national team players of Serbia (up to 16 years) achieved the best results when compared to the categories aged 12 and 14 in terms of strength and speed in some tests of coordination. This can be explained by the structure of the training process because in this period the development of motor abilities is pronounced.

Female tennis players of the youngest age category (12 years) achieved statistically best results in the test of coordination, which were applied to estimate specific tennis movement - movement speed in forehand. In this age period, the training process emphasizes mostly speed and coordination and learning of the tennis technique so that these results can be explained in these terms. Bearing in mind that female tennis players of this age are at the beginning of puberty period our research results were expected.

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MOTORIČKE SPOSOBNOSTI MLADIH REPREZENTATIVKI SRBIJE U TENISU

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Osnovni cilj istraživanja bio je da se utvrde razlike u motoričkim sposobnostima teniserki reprezentacije Srbije uzrasta 12, 14 i 16 godina. Uzorak je obuhvatio ukupno 15 teniserki, po pet reprezentativki za svaku uzrasnu kategoriju. Primenjeno je ukupno 14 mera za procenu motoričkih sposobnosti i to: tri za procenu brzine, četiri za procenu snage, dve za procenu izdržljivosti i pet za procenu agilnosti/koordinacije. Na osnovu rezultata dobijenih ANOVA-om utvrđene su statistički značajne međugrupne razlike u testovima za procenu snage (Sig. < .01) i u testovima za procenu brzine i koordinacije (Sig. < .05). Bolje rezultate u skoro svim testovima postigle su teniserke najstarije uzrasne kategorije, osim u testu za procenu koordinacije i to Brzina kretanja na forhend stranu gde su najbolje bile teniserke uzrasta do 12 godina. Nakon primene Post Hoc Test za utvrđivanje međugrupnih razlika, rezultati su pokazali da su teniserke uzrasta do 16 godina bile najbolje u testovima snage i brzine, a najmlađe reprezentativke (do 12 godina) u testu koordinacije. Može se zaključiti da rast (period puberteta) kao i trenažni proces utiču na postojanje svih međugrupnih razlika u motoričkim sposobnostima teniserki različitih uzrasnih kategorija.

Ključne reči: *tenis, motoričke sposobnosti, razlike, reprezentativke, Srbija.*