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Defining changes of physical efficiency in a group of female tennis players aged 9-10 in a one-year course of training

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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abstract

Background: The aim of the study was to define a change of physical effectiveness in a one-year training course and its relation with special effectiveness.

Material and methods: The research was conducted in a group of 30 female players at the age of 9 and 10 years who were training in clubs in the Podlaskie Voivodeship. The subjects were divided into two groups according to the age category. The level of motor abilities and special effectiveness was assessed twice during the one-year training course in March and November, 2013.

Results: In all trials we observed a statistically significant difference of mean results between the first and the second term of research in the group of girls aged 9 and 10. The correlation analysis of the results of attempts of motor abilities and the results of special efficiency assessed on the basis of the 100 ball Test showed that the statistically significant correlations exist.

Conclusions: The statistically significant correlations between results of the 20-meter run, the simple reaction test and the results of the test assessing special fitness efficiency – the 100 ball Test – suggest that speed has an important impact on special fitness in tennis.

Key words: tennis, female, physical efficiency, special efficiency.

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INTRODUCTION

Tennis is thought to be the most popular discipline of sport which develops dynamically in the world. Some researchers like Kovacs [1], Kovalchik [2], Kramer [3] emphasize that, apart from competitors' volitional features, somatic characteristics, and efficiency, motor abilities are among factors which determine a stable increase in the sports level in tennis. Systematic observations of the level of speed development, muscular strength, and endurance of coordinative skills within the development of a sport career of a tennis player at the stage of a basic training allow for scheduling the suitable training load taking into consideration the players' age and individual, psychological and physical predispositions. In the last few years the strength and speed of the game has grown significantly thanks to better and comprehensive training of tennis players. The pace of the game is becoming dynamic thanks to offensive and, indeed, aggressive style of the game. Generally estimating, the progress is associated with systematic growth of speed, accuracy and complexity of the parts of the game, which influence tactic formations [4–7] . In the schedule of a training course young players should be trained not only in technical knowledge and tactic of tennis but in physical efficiency as well. Effectiveness of the game in on a tennis court largely depends on a competitor's motor abilities and physically effectiveness [2, 3, 8]. Sozański [9], Kochanowicz [10], Raczek [11] have a similar opinion, and they claim that the extent of using technical-tactical abilities by sportsmen is proportional to the level of physical strength and the overall potential movement which is assigned to basic motor abilities like: speed, coordination, strength and endurance. The above opinions are similar to the research by Pac-Pomarnacki [12] who states that motor preparation has an influence upon effective rivalry. However, to be useful, it is necessary to prop up special efficiency. Therefore, using the best developed conditional as well as coordination qualities of a tennis player is possible thanks to a high level of mastering the technique. Despite a great number of scientific publications and wide knowledge in the area of the development, the problem of mutual relations between motor abilities and special effectiveness is still topical.

Therefore, the aim of the study was to define a change of physical effectiveness in the a one - year course of training and its relation with special effectiveness.

MATERIAL AND METHODS

Participants

The research was conducted in a group of 30 female players at the age of 9 and 10 who were training in clubs in the Podlaskie Voivodeship. The subjects were divided into two groups according to the aged category. The girls were at a different level of sport capability. The assessment of the level of motor abilities and special effectiveness was conducted twice during the one-year course of training in March and November, 2013.

In order to assess the level of motor skills, t attempts from the European Fitness Test (EUROFIT) were used, such as gripping a dynamometer, a 20-meter run, the Cooper Test [13, 14] and the test of simple and complex reaction [15]. Special effectiveness was examined by the 100 ball test (the rate recommended by the USTA) and Schefke and Zieliński [16].

The starting speed — the 20 m run

Description: the coach marks a distance of 20 m. The examined player is in the standing position and turning a step forward. The sports coach measures the time at the finish line holding his hand up. A competitor starts at the word of commend "steady, ready, go" and at a visual sign of his coach's hand down. It is necessary to cover the 20 m distance as fast as possible. The attempt is performed three times. The best time with 0.1 s accuracy out of the three attempts is registered (Fig. 1A).

Equipment: the tennis court, a stopwatch, a marker.

The test of simple reaction

The psychomotor speed reaction to simple light stimuli emitted at an imposed pace was examined by the Piórkowski device. The time of reaction is tightly associated with visual-motor coordination, attention focus, making a decision under time pressures and endurance to tiredness.

Description: The research involves the reaction of an examined competitor to appearing stimuli. The examined player reacts by pressing a button which is placed under each lighted sign. In the case of children, the pace was 60 stimuli per minute (Fig. 1B).

The test of complex reaction

The speed of complex reaction, which depends on the spatial sense of direction, psychomotor speed, visual-motor coordination, attention focus and speed and accuracy of perception and quickness of making decision, was examined by a cross device.

Description: During the test single points of light switch on in an irregular order. It is necessary to push the right button which is in the crossing between rows and columns where the lights turn on. The task was carried out twice: at an enforced pace and at the pace imposed at the signal of light (Fig. 1C).

Runnning endurance — the Cooper test

Description: The examined player performed a warm-up with average intensity before the attempt . The individual or mass start is from the start line at the word of command "ready, steady, go" . A participant is in constant run around the tennis court for 12 minutes. Marching is also possible. A sports coach counts the laps. The covered distance is given in meters with 10 meter accuracy (Fig. 1D).

Equipment: tennis court, 6 bollards, stopwatch.

Dynamometric strength of a hand — gripping a dynamometer

Description: An examined tennis player is in a standing position and a little straddling; she grips a dynamometer in her dominant hand. The dynamometer is fitted closely to fingers of a player's hand; her shoulder is pulled down along her upper body so that a player's hand cannot touch her body. It is obligatory to clench the handle of a dynamometer constantly for at least 2 seconds with maximum strength. The better result is registered with 1 kg accuracy (Fig. 1E).

Equipment: dynamometer.

THE 100 BALL TEST

This is a test evaluating the ability of steering a tennis ball through basic hitting (forehand and backhand from the court depth and volley from forehand and backhand in half court and service). A tennis player performs 100 shots in 12 series and 80 shots (forehand and backhand from the court depth and volley). This is performed from the coach's pass, while the services are performed by players in order to practise the accuracy of hitting.

Description: A tennis player stands just behind the finish line of the court, in the centre between sidelines, in the position of looking forward to hit the ball from forehand. The coach is on the other side of the court at a distance of about 3-4 m from the net. An appointed line judge assessing the accuracy of hitting a ball and its power is on the back line on the side of a coach. The coach starts passing balls with a tennis racket, according to an order of attempts, beginning with forehand. After finishing the first series of 10 balls the coach informs – not taking a break – about the change of an area of directing shots. After two series there is a break which is used for gathering tennis balls. After performing 4 first series, a contestant from the depth court takes a place in the centre court just behind the service line and starts the first series of shots from volley. After performing 4 series from volley, a tennis player comes to the main line of the court in order to perform 4 series and 5 serves each (Fig. 1 F).

Assessment of the test: each shot is scored doubled, one point for accuracy (2 points in the basic control area, 1 point for a ball in the adjunctive control area, 0 points – out ball, or in the net) and for the strength of hitting (2 points for a ball whose second bounce will be outside line which is at the distance 33 and 38 cm from the back-line of the tennis court, 1 point for the second rebound of the ball in the area between this line and the court line and 0 points if a ball makes the second rebound before the backline of the tennis court). The total scores for accuracy and strength of 100 shots gives the final result of the test – a tennis player can score a maximum of 400 points.

Order of attempts:
- 1st series – 10 shots from forehand crosscourt,
- 2nd series – 10 shots from backhand down the line,
- 3rd series – 10 shots from backhand crosscourt,
- 4th series – 10 shots from backhand down the line,
- 5th series – 10 shots from volley forehand crosscourt,
- 6th series – 10 shots from volley forehand down the line,
- 7th series - 10 shots from volley backhand crosscourt,
- 8th series – 10 shots from volley backhand down the line,
- 9th series – 5 serves in the inner area of the right serve box,
- 10th series – 5 serves in the outside area of the right serve box,
- 11th series – 5 serves in the inner area of the left serve box,
- 12th series – 5 serves in the out area of the left serve box.

Equipment: tennis court, 20 tennis balls, racket.

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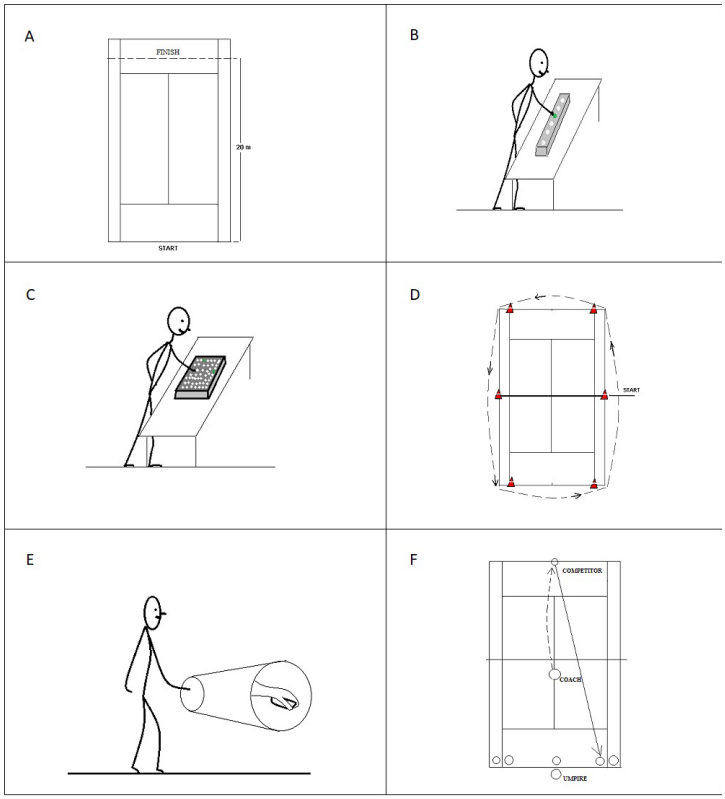

Fig. 1. A. The 20-m run; B. the test of simple reaction; C. the test of complex reaction; D. the Cooper test; E. gripping a dynamometer; F. the 100 ball test

STATISTICAL ANALYSIS

The collected results were analysed using the statistical packet STATISTICA version 13 made by StatSoft. The comparisons of results of the 1st and the 2nd term of research within each group was done with the help of t-Student Test for the dependent group if the assumption about the normal distribution was executed or Wilcoxon Test in the case it was not discharged. In the description of results of attempts were compared by a parametric method, mean statistic and standard deviation (Mean ±SD) or medium and deviation quarter (Me ±Q) in the case of variables analysed by non-parametric methods. The statistical conclusion was conducted at a standardized level of significance $p < 0.05$. Descriptions and interpretation of correlations between variables were defined on the basis of Pearson's correlation coefficient.

RESULTS

The analysis of rapidity in a group of female contestants aged 9–10 is defined on the basis of an attempt the 20-meter run, which was conducted twice during a one-year course of training, and it showed a progressive improvement. It was observed that along with the increase in female participants' age, the mean time of the test decreased. The minimal result in a group of girls both aged 9 and 10 was at the same level (4 seconds), whereas the maximum one was lower by about 0.43 and 0.58 s in the group of female tennis players aged 10. In the group of girls aged 9 and 10, the statistically significant difference of mean results was noted in the first and second term of research.

The analysis of results of a simple and complex reaction in the group of female competitors aged 9 and 10, defined by the Piórkowski device and the Krzyżowy

device, showed a gradual improvement. It was observed that the mean value of the test results increases with the players' age. In the group of participants aged 9 and 10 average results of examination of a simple reaction increased in a year's time. In the group of girls aged 9 from 45.9% to 49.8%. However, in the group of tennis players aged 10 from 50.8% to 51.7%. It was observed that the time of simple reaction in a group of female participants aged 9 and 10 was at the similar level. Whereas the results of complex reaction in the group of girls aged 9 and 10 were at the level of 6.7% in the first term of examination and 14.7% in the second one. By analogy, in the group of female tennis players aged 10, the results were 24.9% and 29.1%. It was stated that in both results of an attempt of time of simple and complex reaction, statistically significant differences of average results exist between the first and second term of research in the group of girls aged 9 and 10.

The analyses of research results of endurance run in the group of contestants aged 9 and 10 on the basis of the Cooper Test (running for 12 minutes) showed a progressive improvement. It was observed that growth of the mean value of the results of the test increases with the participants' age. A bigger progress of the mean value was observed in the group of participants aged 9. In the first examination they gained an average result of 1,363 m whereas in the second term they covered an average distance of 1,470 m. However, female contestants aged 10 improved their average record of an attempt by 5 m. It was stated that in the above attempt in the group of tennis players aged either 9 or 10, statistically significant differences existed between the first and second term of research.

The analysis of research results of the dynamometric power of a hand of female contestants defined on the basis of gripping a dynamometer showed a distinctive progress within the one-year course of training. The mean value of the test results increased with the players' age. In the group of female tennis players aged 9, average results of the above attempt grew from 10 to 11 kg in a year's time. Whereas in the group of participants aged 10, the results grew from 13 to 14.5 kg. In both age groups there were statistically significant differences of the averaged results between the first and second term of research.

Analysis of results of the dynamometric power of a hand of female participants defined on the basis an attempt of the 100 ball test showed their steady improvement in the one-year training course. The average value of results rose with the examined female tennis players' age and training experience. A distinct improvement was observed in the group of female participants aged 10. The average value of an attempt in the first research was 108 points, whereas in the second one it was 145. In the above attempt in both age groups of female participants there were statistically significant differences of average values of results between the first and second examination.

The correlation analysis between results of attempts of motor abilities and the results of special efficiency assessed on the basis of the 100 ball test showed a statistically significant dependence.

In the group of female tennis players aged 9 the correlation occurred between the results of the 20-m run, the test of complex reaction and the Cooper test versus the 100 ball test. The highest value of correlation (0.616) was noted between results of the Cooper test and the test of special efficiency. There were not correlation with the 100 ball test in the simple reaction test and gripping a dynamometer.

In the group of female tennis players aged 10 the statistically significant dependence occurred between of all attempts of motor abilities and the results of the 100 ball test. It was like in the group of participants aged 9, in which a correlation at the highest level was noted between the Cooper test and the results of special efficiency – the 100 ball test. The correlation was at the level of 0.548.

Table 1. Average values and dispersion of physical efficiency tests in the 1st and the 2nd term of female tennis players aged 9

Name of the test	1st term		2nd term	
	Mean ±SD	Min ÷ Max	Mean ±SD	Min ÷ Max
(2)	(3)	(4)	(5)	(6)
20-m run	4.8 ±0.3	4 ÷ 5.33	4.5 ±0.3***	4 ÷ 5.11
Simple reaction	45.9 ±3.1	42 ÷ 53	49.8 ±1.7**	47 ÷ 52
Complex reaction	6.7 ±1.8	4 ÷ 10	14.7 ±5.5***	7 ÷ 25
Cooper test	1363 ±164	1000 ÷ 1600	1470 ±139***	1170 ÷ 1650
100 balls test	80.7 ±18.4	58 ÷ 112	107.4 ±14***	70 ÷ 130
	Me ± Q	Min ÷ Max	Me ± Q	Min ÷ Max
Dynamometer	10.0 ± 1.0	8 ÷ 14	11.0 ± 1.5**	10 ÷ 17

) p < 0.05; **) p < 0.01; *) p < 0.001*

Table 2. Average values and dispersion of physical efficiency tests in the 1st and the 2nd term of female tennis players aged 10

Name of the test	1st term		2nd term	
	Mean ±SD	Min ÷ Max	Mean ±SD	Min ÷ Max
(2)	(3)	(4)	(5)	(6)
20-m run	4.4 ±0.4	4 ÷ 4.9	4.1 ±0.2***	4 ÷ 4.53
Simple reaction	50.8 ±2	48 ÷ 54	51.7 ±1.3	49 ÷ 54
Complex reaction	24.9 ±8.1	7 ÷ 39	29.1 ±6.2	13 ÷ 40
Cooper test	1600 ±55	1450 ÷ 1800	1605 ±25**	1550 ÷ 1850
100 balls test	108 ±6	70 ÷ 116	145 ±15***	116 ÷ 187
	Me ± Q	Min ÷ Max	Me ± Q	Min ÷ Max
Dynamometer	13 ±2.7	9 ÷ 18	14.5 ±2.6***	10 ÷ 19

) p < 0.05; **) p < 0.01; *) p < 0.001*

Table 3. The mean of rate of correlation and test probability (p) in the test of significance of correlation between results of efficiency attempts of female tennis participants aged 9 and 10 in respective terms of research. The following values given in the regular font refer to the 1st term of research and in the bold one refer to the 2nd term of research

Attempts of motor abilities	Players aged 9	Players aged 10
20-m run	**-0.461** **P = 0.010**	**-0.51** **P = 0.003**
Simple reaction	0.0748 *P* = 0.814	**0.391** **P = 0.031**
Complex reaction	**0.439** **P = 0.016**	**0.427** **P = 0.022**
Cooper test	**0.616** **P = 0.000**	**0.548** **P = 0.002**
Dynamometer	0.3512 *P* = 0.199	**0.478** **P = 0.047**

DISCUSSION

Movement emphasizes an activity of a human being which involves a great variety of his or her personality features, health, physical and mental condition. The development of motor skills depends on numerous factors that have an influence on each other and come from two basic sources conditioned by genetics and the background [17–20].

The long-standing process of sports training requires a constant flow of information on the issue of biological development of people practising sport, their physical efficiency, the training load and the human organism's reaction to physical efficiency during training and tennis tournaments.

The presented study involves a very essential issue for youth sport and mutual relationships of comprehensive (general) motor agility and special agility (tennis), which are two basic forms reflecting motor abilities of a human being. Ziemann and Garsztka [8], Królak [14], pay attention to the fact that it is necessary to carry out tests on comprehensive and special efficiency of tennis players because they give essential information at the early stage of training to a coach and a participant about his or her progress. Besides, they illustrate a contestant's attitude towards sports fight and they make training courses attractive. The above research confirms the opinion of outstanding sports specialists that information about the level of comprehensive and special agility of tennis competitors who start from scratch serves not only optimization of training but it also takes into consideration a competitor's individual predispositions and mastering motor skills. Additionally, the knowledge allows anticipating particular stages of training and effects of sports career [10, 21].

Analysing and comparing the results of research of endurance abilities of tennis players aged 9–10 from the Podlaskie Voivodeship assessed on the basis of the Cooper test with reference to the scoring system recommended by Królak [14], it is noted that female tennis players from Podlasie scored 30 points out of 100, which put them under the average level. With reference to this scale, the results of the 20-m run in a group of female tennis players show that in early periods of research the results were at an extremely low level. Out of 10 points, they scored hardly 1 point; the average result on the test was 4.8 and 4.4 sec., whereas at the second stage of research they scored 6 points in 4.5 and 4,1 sec. The low results which young female tennis players aged 9 from the Podlaskie Voivodeship scored at the early period of research were probably caused by their too short training experience.

The next test in which we can evaluate the examined female tennis players and compare them with the youth from Poznań is gripping a dynamometer. The average results according to the rules recommended by Osiński and Biernacki [22] are ranked above average. The result scored by tennis players aged 9 is 11.00 kg, and the result scored by players aged 10 is 14.5 kg.

Comparing the results of research of special efficiency with the results of Adam Królak's research in the 100 ball test, the girls aged 10 were the best, and they scored 145 points, achieving in second to last level of a beginner. The younger examined group of female tennis players ranked in the first scale at the first beginning level scoring 107 points.

The correlation analyses in the group of female tennis players aged 9-10 showed that statistically significant dependences exist among the results of the 20-m run, the time of simple and complex reaction and the results of the test of special agility defined on the basis of the 100 ball test. A lot of specialists who are interested in tennis confirm the opinion that just the speed of reaction distinguishes outstanding tennis players among the best ones. It is associated with considerable growth of speed and power of playing owing to better mastered technical-tactical abilities and tennis players' comprehensive physical preparation. The process of tournament actions grows in speed and dynamic because of offensive and aggressive style of playing. Contemporary rivalry in tennis characterises by possibility of playing of finishing hit from each position at the court [1, 7, 23, 24].

CONCLUSIONS

1. There is a tremendous variation among examined female tennis players at the level of overall and special efficiency in the group of female tennis players aged 9 and 10.

2. Substantial statistical differences between average results of the first and the second term of research were noted in all the attempts assessing motor abilities and special efficiency. It testifies that training affects the level of physical efficiency.

3. In a group of female tennis players aged 9 and 10, a statistically significant dependence exists between the results of attempts evaluating speed and endurance in the 20-m run, the simple reaction test, the complex reaction test and the Cooper test and the results of test assessing the special efficiency in the 100 ball test. It suggests that speed has an essential impact on special efficiency in tennis.

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