The influence of training loads of technical and tactical training on the cardiovascular system of tennis players 10-12 years

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Abstract

Purpose: theoretical and experimental substantiation of the use of rational technique of technical and tactical training of tennis players of 10-12 years and determination of the influence of training and competitive loads on the body of athletes.

Material and methods. 16 tennis players aged 10-12 years from the Polytechnic Sports Club of the National Technical University "Kharkiv Polytechnic Institute” took part in the study, 8 athletes were included in the experimental group and 8 in the control group. The experiment was conducted for three months in the preparatory period at the stage of basic preparation of the second year of study. The experimental group trained in the advanced technique of tactical training on the block system, using heart rate monitors and video devices. At the beginning and at the end of the experiment, control competitions were conducted and heart rate was recorded at the beginning and end of each performed series of beats and each exercise using a Polar heart rate monitor.

Results. The proposed program of technical and tactical training of tennis players on the block system had a positive impact in the training and competitive process on the functional state of athletes. The analysis of the pulseogram of the athletes of the experimental group confirmed the assumption that the phase of working out of the systems of the organism under the influence of physical activity (from 4-5 minutes to 3-4 minutes) was reduced and that the phase of rapid recovery of the heart rate after removal of the load (from 3-4 minutes to 2-3 minutes). The data obtained indicate the feasibility of using this technique for the preparation, control and evaluation of the competitive activity of tennis players 10-12 years.

Conclusions. Positive influence of the application of the proposed method on the adaptive capacity of the athlete's body to the load has been determined. focus.

Key words: tennis, technical and tactical training, heart rate, training

Annotациа

Analitic I.I., Korobeinik В.А., Kolisnichenko A.O. Влияние тренировочных нагрузок и средств технико-тактической подготовки на сердечно-сосудистую систему теннисистов 10-12 лет

Мета: теоретико-экспериментальное обоснование влияния тренировочных нагрузок, средств технико-тактической подготовки на адаптационные возможности и функциональное состояние теннисистов 10-12 лет.

Материал и методы. В исследовании приняли участие 16 теннисистов в возрасте 10-12 лет из спортивного клуба «Политехника». Эксперимент проводился в течении трех месяцев в подготовительный период на этапе базовой подготовки второго года обучения. Экспериментальная группа занималась в соответствии с предложенной технико-тактической подготовкой на базовой системе, используя пульсометры и видеостройства. В начале и конце эксперимента проводились контрольные тесты и с помощью пульсометра «Polar» фиксировались частота сердцебиений и процентная доля сердечных сокращений в фазе активного вдоха.

Результаты. Запроектированная программа технико-тактической подготовки теннисистов на базовой системе позволяла в кратчайшие сроки улучшить адаптационные возможности и функциональное состояние теннисистов 10-12 лет.

Ключевые слова: теннис, техническая и тактическая подготовка, сердечно-сосудистая система.
Introduction

Professional tennis has become much younger these days. Appearance in the world ranking of tennis players, whose age is barely over 15-16 years, is no longer uncommon [1]. In this regard, the body of athletes in 10-12 years should be resistant to physical activity. All this forces coaches to look for the most effective ways of becoming a young tennis player.

Improving the efficiency of training athletes in tennis largely depends on the scientific validity of the system of planning and control of competitive and training loads [2]. The extent to which the applied loads are justified depends ultimately on the athletes' competitive performance [3].

The conducted researches have allowed to determine indicators of competitive loads of tennis players on coverings of different type. Indices of the volume of the outside of the load when playing on slow-bounce coatings, such as match duration, ranges from 50 to 120 minutes on average, while on fast cover from 52 to 110 minutes, "clear time", during which tennis players directly perform techno-tactical actions, is, on average, on a slow cover for 7 to 22.3 minutes, and for a fast from 7 to 20 minutes. During this time, tennis players perform from 128 to 396 strokes, on average, on slow cover and from 175 to 460 strokes on fast. Athletes run from 863 to 2015 meters, on average, on courts with slow coverage and from 774 to 1564 meters at fastest. Thus, it can be stated that when playing on slow coverage, matches last longer, tennis players run a longer distance, performing fewer strokes than when playing on fast coverage [1, 2].

The intensity of the load on a slow-paced game, expressed in the pace of scoring, averages 18 to 22 beats per minute, which is lower than the number of beats played by fast-paced tennis players, where the pace of play is 25 to 23 beats per a minute.

Heart rate, as an indicator of the volume of the inner side of the load, in matches on slow cover ranges from 8673 to 18042 beats [1, 3].

To date, a considerable number of works have been performed in which the magnitudes of competitive and training loads are investigated. However, according to these data, there is a mismatch of training loads to competitive. Tennis players compete at the maximum limit of their body, most often there is an unpreparedness of the body to these loads and disrupts the processes of the cardiovascular system. Therefore, training loads require clearer dosing and control [4, 5].

In this regard, the purpose of our study was to experimentally substantiate the effectiveness of the use of rational methods of improving the technical and tactical training of tennis players 10-12 years on the block system.

Material and methods

Participants

16 tennis players aged 10-12 years from the Polytechnic Sports Club of the National Technical University Kharkiv Polytechnic Institute took part in the study, 8 athletes were included in the experimental group and 8 in the control group. Athletes of both groups did not differ significantly in most indicators of technical, tactical and special physical fitness. The distribution of athletes by groups was conducted in a random way: in each group there were 4 girls and 4 boys. The experiment was conducted for three months in the preparatory period at the stage of basic preparation of the second year of study. The experimental group trained in the advanced technique of tactical training on the block system, using heart rate monitors and video devices. At the beginning and at the end of the experiment, control events were conducted and heart rate was recorded at the beginning and end of each series of beats and each exercise using a Polar heart rate monitor.

Procedure

The experiment was conducted from 03 September 2018 to 05 January 2019 in the preparatory period at the stage of basic preparation of the second year of study.

Prior to the start of the experiment, the control and experimental group trained in the same training program 4 times a week for 1.5 hours. Each workout began with a standard warm-up (20 minutes): 5-minute jogging, general on-the-spot warm-up exercises for all muscle groups, flexibility exercises, tailgating and simulation exercises. The main part of the training took most (60 minutes). The main part included exercises of a separate technical and tactical orientation.

The content of the technical part of the training (30 minutes) included exercises for practicing right and left blows on the rebound ball, blows from the fly, right and left, working out the feed, blows over the head (laugh), "candles" and "half-candles", shortened strokes. All of these strokes were performed on a conveniently tossed ball coach, strikes in the training wall at different distances in singles and doubles, hits on the pitch with the trainer, at different distances from the grid, "soft", "medium", "strong" »Diagonally and along the lines. One of the criteria for a positive
evaluation was the performance of strikes with different ball rotations: upper, lateral, and lower.

The content of the tactical part of the training (30 minutes) included: demonstration of a single and doubles game with a score; showing all strikes separately with an analysis of the main tactical features of their use; playing tennis on paper; game with the account "on squares"; exercises using different strokes and tactical combinations: "triangle", "eight", etc.; a game of account by task.

The training ended with strength exercises for the arms, legs, back and abdomen (10 minutes).

The heart rate of athletes was monitored in all parts of the training using the POLAR TEAM 2 heart rate monitor.

During the experiment, the control group continued training according to the above method. The experimental group in the main part of the training was introduced by our proposed tactical and technical training program with the following characteristics:

- consists of 9 microcycles, each lasting 2 weeks;
- each microcycle consists of 6 training sessions;
- total number of training equals 54;
- duration of one workout - 120 minutes.

An experimental program for tactical and technical training was developed on a block system. The training block of the experimental program is a set of exercises in tactical and technical training, which are combined into a single system for the purpose of certain tasks.

During the training, during the training blocks, the data of sportsmen's heart rate were taken continuously every 5 minutes.

Characteristics of training blocks of the experimental program, tactical tasks in blocks, complexes of exercises with dosage are presented in Table 1.

<table>
<thead>
<tr>
<th>Bloc</th>
<th>Duration, minutes</th>
<th>Tactical and technical tasks</th>
<th>Exercises of tactical and technical training</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>Improvements in rebound and fly targets</td>
<td>In each particular game situation, it is necessary to direct the opponent to the ball in such a way that his/her retaliatory actions allow the player to either develop the attack or complete the scoring in his favor.</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>Completing the attack with a blow on the line</td>
<td>When directing long balls, the player must keep the opponent in the back of the court, and from short balls attack the opponent</td>
</tr>
</tbody>
</table>

Table 1

Contents of the program blocks for technical and tactical training of tennis players 10-12 years
After completing two short crosses, it is necessary to send a deep ball down the line to the opponent’s side.

<table>
<thead>
<tr>
<th>#</th>
<th>15</th>
<th>Description</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td>Improvements in the technique of performing ball rotations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The filing, as well as the filing, should be directed to specific areas of the site</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Completion of the draw from the attack zone</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Playing on the line can continue until the opponent has a short shot, after which the game turns into a draw to win a point by one of the opponents. For the final blow in the draw, you should use the first chance you have</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Improvement of the technique of movement along the back line of the court</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Free to play straight-line fly-by-court kick</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A game of open-plane racket strikes from the fly along the right diagonal of the court</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A game of closed-plane racket strikes from the fly along the left diagonal of the court</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Improvement of the technique of movement along the back line of the court</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;Just Eight.&quot; The first player performs one stroke along the diagonals of the court, the second player one by one along the side lines of the court and vice versa</td>
<td></td>
</tr>
</tbody>
</table>
7 15 Improvement of the technique of movement along the back line of the court "Triangles": the first player strikes with the rebound of the open plane of the racket, the first blow along the side line of the court, the second blow along the right diagonal of the court; the second player performs rebound strikes, the first blow by the closed plane of the racket along the side line of the court, the second blow by the open plane of the racket along the right diagonal of the court; change of players.

8 15 Improvement of attack with the exit to the net after submission The first player performs a feed, goes to the net and completes the draw with blows from the fly and over the head; the second player receives the innings and completes the draw with a stroke.

9 15 Control competitions Up to 10 points tie-break game, single-digit

10 15 Control competitions Up to 10 points tie-break game, doubles

Notes:
- hit point of the ball;
- direction of flight of the ball;
- a coach, or a tennis gun that feeds the balls;
- the direction of movement of players in team exercises;
- players;
- the direction of movement of players when pitching the ball to the coach;
- the direction of movement of players in game exercises with the task of getting into certain areas;
- hit point of the ball;
- area of involvement on the court;

When performing the exercises on tactical and technical training that make up the training block of the experimental program, the athlete's body adapts to physical activity. Each athlete in the experimental group has individual characteristics when perceiving these loads. That is why, using the heart rate control method, the adaptive abilities of athletes' organisms are studied when performing the exercises of each of the developed training blocks.

**Statistical analysis**

The obtained research data were processed using traditional methods of mathematical statistics. For each indicator was determined by the arithmetic mean of \( \bar{x} \), the assessment of the reliability of differences between the parameters of the initial and final results, as well as between the control and experimental groups by t-student test with the appropriate level of significance (p). The mathematical processing of the data was carried out using the Microsoft Excel Data Analysis software and SPSS. The differences were considered significant at the level of significance p <0.05.

**Results**

Prior to the experiment, in the control and experimental group during the training blocks were recorded heart rate of each athlete. The average heart rates are presented in Fig. 1.
Fig. 1. Heart rate of athletes of the experimental and control groups after performing special exercises before the beginning of the experiment (presents the arithmetic mean values in each group):
1 - heart rate after the exercise "Improvement of kicks from the rebound and from the fly on targets";
2 - heart rate after the exercise "Completing the attack with a blow on the line";
3 - heart rate after the exercise "Improvement of technique of execution of submissions with different ball rotation";
4 - heart rate after the exercise "Completion of scoring from the attack zone";
5 - heart rate after exercise "Improvement of technique of execution of blows from flight";
6 - heart rate after exercise "Eight";
7 - heart rate after exercise "Triangles";
8 - heart rate after exercise "Improvement of attack with the exit to the net after submission";
9 - heart rate after the first control competitions;
10 - heart rate after the second control competition

Analysis of the data shows that the rates of heart rate in the athletes of the experimental and control group before the start of the experiment do not differ significantly, which indicates the same level of training of tennis players.

Fig. 2. Heart rate of athletes of the experimental and control groups after performing special exercises after the experiment (the arithmetic mean values in each group are presented):
1 - heart rate after the exercise "Improvement of kicks from the rebound and from the fly on targets";
2 - heart rate after the exercise "Completing the attack with a blow on the line";
3 - heart rate after the exercise "Improvement of technique of execution of submissions with different ball rotation";
4 - heart rate after the exercise "Completion of scoring from the attack zone";
5 - heart rate after exercise "Improvement of technique of execution of blows from flight";
6 - heart rate after exercise "Eight";
7 - heart rate after exercise "Triangles";
8 - heart rate after exercise "Improvement of attack with the exit to the net after submission";
9 - heart rate after the first control competitions;
10 - heart rate after the second control competition
Table 2

Heart Rate after standard loading before and after the experiment in the athletes of the control and experimental groups

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Group</th>
<th>Before the experiment, ( \bar{x} )</th>
<th>Before the experiment, S</th>
<th>After the experiment, ( \bar{x} )</th>
<th>After the experiment, S</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate at rest, beats·min(^{-1})</td>
<td>Experimental</td>
<td>78,1</td>
<td>6,2</td>
<td>77,1</td>
<td>5,8</td>
<td>0.41</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>77,2</td>
<td>6,1</td>
<td>76,5</td>
<td>5,9</td>
<td>0.29</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Heart rate after loading, beats·min(^{-1})</td>
<td>Experimental</td>
<td>184,6</td>
<td>26,4</td>
<td>185,2</td>
<td>27,1</td>
<td>-0.05</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>187,3</td>
<td>26,2</td>
<td>186,1</td>
<td>27,9</td>
<td>0.11</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Heart rate at the 1st minute of recovery,</td>
<td>Experimental</td>
<td>157,1</td>
<td>23,3</td>
<td>136,5</td>
<td>21,1</td>
<td>2,27</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>beats·min(^{-1})</td>
<td>Control</td>
<td>156,3</td>
<td>22,4</td>
<td>145,4</td>
<td>21,9</td>
<td>1,21</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Table 3

General results of the pulsometry of the athletes of the experimental group

<table>
<thead>
<tr>
<th>General indicators of heart rate</th>
<th>The total number of athlete’s heart rate, Nm</th>
<th>The average of the total heart rate for a group n, %, Nср</th>
<th>Changes in total heart rate, n, %</th>
<th>Measurement, No</th>
<th>Maximum heart rate values, Pmax av beats·min(^{-1})</th>
<th>The average maximum heart rate for Pmax av beats·min(^{-1})</th>
<th>Changes in the mean of the maximum heart rate, p, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>The first control competitions</td>
<td>11244</td>
<td>6,73</td>
<td></td>
<td>180</td>
<td>-3,33</td>
<td>174</td>
<td></td>
</tr>
<tr>
<td>The second control competitions</td>
<td>12001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

29
The analysis of the heart rates of the experimental and control groups after the experiment showed the positive impact of the implemented experimental program on the technical and tactical training of tennis players of 10-12 years on the cardiovascular system during the loads in the experimental group. Between the first and second control competitions there is an increase in the total number of heartbeats. The percentage change in the total number of heartbeats in the athletes of the experimental group was + 6.73%, and the control group + 4.17% - this indicates an increase in tactical and technical skill of athletes and is due to a decrease in technical deficiency in actions, reduction of pauses in the game and an increase in the number hits in each draw.

Between the first and second control competitions, the control group athletes experience an increase in maximum heart rate. The percentage change in the mean maximum heart rate was + 5%. This testifies to the negative dynamics of the adaptive capabilities of the body of athletes during maximum competitive loads.

In the athletes of the experimental group, in contrast, there is a decrease in the maximum rate of heart rate. The percentage change in the average heart rate was -3.33%.

**Discussion**

The research resulted in data that complements and extends the results of other authors, as well as data that is new. Supplemented data on the impact of training loads under the SNSS (big tennis) program on morphofunctional indicators, indicators of cardiovascular and respiratory systems of young tennis players, where during technical and tactical training the average group index of heart rate in tennis players in 7 years changed in 7 years min⁻¹ (t = 3.14; p> 0.05), in tennis players for 8 years by 1.9 beats · min⁻¹ (t = 1.43; p> 0.05) [9].

Also, data on the use of systematic tennis training to optimize the functional fitness of athletes 12-14 years, where the features of changes in physical performance, functional status and allowed to evaluate the high efficiency of training exercises [7, 19, 20, 21].

An analysis of the competitive activity of tennis players determines that during a tournament tennis players play up to three matches with a large
amount of workload, without rest days. In order to achieve a stable and active game throughout the tournament, it is necessary to carry out at least three large loads, which pass through the day or one after the other in training work on separate microcycles [6, 7].

To date, a considerable number of works have been performed in which the magnitudes of competitive and training loads are investigated. However, these studies were conducted only with highly skilled tennis players [18, 19]. In addition, the results obtained earlier can not be fully used now, as nowadays the style of the game, the technique of the action, the pace of the game, the number of competitions have changed.

A study of the performance of tennis players 10-12 years during the first and control competitions reveals that the duration of the match ranges from 50 to 120 minutes on average on slow coverage, while on fast coverage from 52 to 110 minutes, “clean time”. During which tennis players directly perform technical and tactical actions, is, on average, on a slow cover for 7 to 22.3 minutes, and for a fast from 7 to 20 minutes. During this time, tennis players perform from 128 to 396 strokes, on average, on slow cover and from 175 to 460 strokes on fast. Athletes run from 863 to 2015 meters, on average, on courts with slow coverage and from 774 to 1564 meters at fastest. Thus, it can be stated that when playing on slow coverage, matches last longer, tennis players run a longer distance, performing fewer strokes than when playing on fast coverage [1,3].

The intensity of the load on a slow-paced game, expressed in the pace of scoring, averages 18 to 22 beats per minute, which is lower than the number of beats played by fast-paced tennis players, where the pace of play is 25 to 23 beats per a minute.

The amount of heartbeats in slow coverage matches ranges from 8673 to 18042 beats. It was found that the heart rate of 185 beats per minute and more can be maintained for 4-5 minutes in a row, despite the discrete nature of the work performed [3].

Thus, the introduction of a program for the technical and tactical training of tennis players 10-12 years on the block system allows you to clearly perform the stage tasks, rationally dose different loads, adjust the level of load individually for each athlete group.

The analysis of the pulsegram of the athletes of the experimental group confirmed the assumption of a reduction in the phase of working out of the systems of the organism under the influence of physical activity (from 4-5 minutes to 3-4 minutes) and a reduction of the phase of rapid recovery of heart rate after removal of loads (from 3-4 minutes to 2-3 minutes).

These data testify to the positive dynamics of the adaptive capacity of the body of athletes, which is a consequence of clear dosage of loads, the use of interval method in training, systematic control of the physical condition of athletes.

**Conclusions**

1. The program of technical and tactical training of tennis players of 10-12 years according to the block system has been developed and its introduction into the practice of the training process has been substantiated.

2. The influence of the proposed program on the level of technical and tactical skills of tennis players of 10-12 years and on the adaptive capacity of the organism to loads is revealed.

3. Positive impact of the use of the program of technical and tactical training with the use of specially designed blocks is revealed. The method proposed in the work allows for a short period of time to effectively and efficiently influence the technical and tactical preparedness of young tennis players, as well as to optimally dose different loads.

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**Conflict of interest**

Authors state that there is no conflict of interest.

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