DESCRIPTION, EVALUATION AND ANALYSIS OF PHYSICAL TESTS CORRESPONDING TO TENNIS PLAYERS

Nicolae-Alexandru BANCIU[1], Germina COSMA[2*], Eliana LICĂ[2]
[1,2]*University of Craiova, Romania*
* Correspondence address: germinacosma@yahoo.com

Abstract: In tennis, the technical skills specific to the sport are the predominant factors, although we note that in 2019 and certainly in the next years, a complex profile of the physical training factors is required in the performance tennis.
Physical testing scales help to examine the abilities of tennis players for performances at different levels both in the laboratory and in the field, at junior or senior level. While laboratory tests can be and are used to evaluate the basic performance characteristics of athletes in most individual sports, in a more specific approach, field-based exercise methods are more suited to the requirements of intermittent and complex sports such as tennis. An ordinary physical test carried out at different times of the year allows to obtain the performance profile of a player, as well as the ability to prescribe individual training interventions.
Thus, the objective of this scientific article is to describe, evaluate and analyze the different physical tests recommended and used by practitioners, scientists, athletes and institutions (national tennis federations). In this order of ideas, we will be able to determine methods of optimizing the physical training specific to the technical skills of the tennis players, which we will experiment and validate using the INCESA research infrastructure of the University of Craiova.
Keywords: *tennis, physical tests, physical training profile.*

Introduction

Tennis has evolved quite a bit lately, from a sport in which ability was the main condition for successful performance to a sport that also requires a complex interaction of several physical components (endurance and agility) and paths. metabolic (aerobic and anaerobic). The features and maximization of the individual improvements, as well as the efficiency of the training, the objectives and the content must be defined according to:

- a specific workload and the most important limiting performance factors;
- individual technical and physical needs, in order to achieve the optimal cost-benefit ratio for training input.

In this context, it is important to have sufficient basic and representative research to provide general directions and guidance so that players and coaches can obtain objective and representative information about players' physical performance. Thus, a general and individual adjustment of the short- and medium-term training programs is ensured, providing objective response and motivating the coaches and players to work and practice better.

Under the conditions of the development of athletes in the long term, a basic precondition is the regular assessment of physical performance, which is also an integral part of sports scientific research. A distinction can be made between unique testing procedures and complex testing. All measurements must take into account the specific criteria of the appropriate tests, which are validity, reliability and objectivity. Laboratory or specialized tests can be distinct and appear to be fundamental elements in the development of pro-athletic athletes and at the same time help to quantify the adaptation to the training and the efficiency of the program. While laboratory tests are used to evaluate basic performance characteristics in most individual sports, age-based methods are more suited to the requirements of complex, intermittent sports, such as tennis, because of the variability of the energy system, muscle groups and built-in abilities. in their performances it is difficult to reproduce in the laboratory. The specialized tests (on the tennis court) seem to be more environmentally valid, allowing the testing of a large number of participants simultaneously, in general they are easier to administer and can be used by both practitioners and researchers. However, the testing environment in the laboratory shows a higher standardization and, therefore, trainers and scientists have to decide between a comparatively higher validity and a lower but acceptable reliability (specific tests), compared to a lower value and correspondingly higher reliability (laboratory tests).The development and application of physical tests in tennis should be integrated into a complex scientific approach, which can be used to build a model of optimization of individual and specific long-term training, as can be seen in Figure 1.

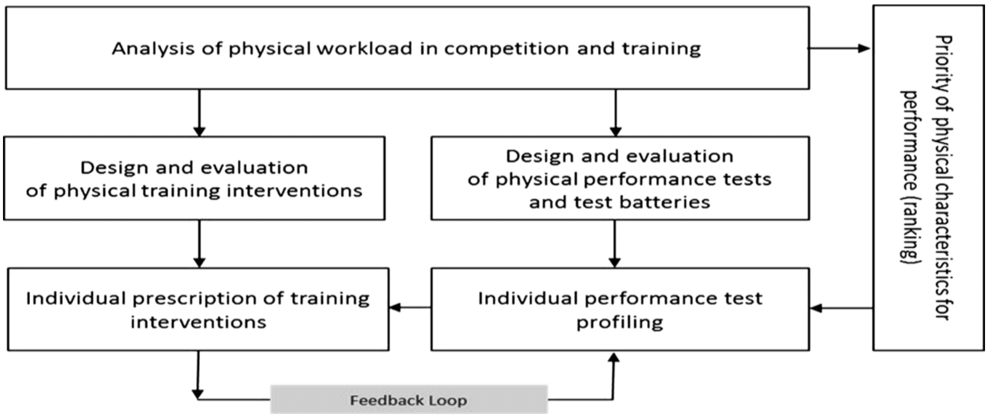

Figure 1. Model of optimization of the individual and specific training of long duration

The main stage of this model is the knowledge of the workload profile during the competition, which could be defined by describing the models of movement of the athletes, combined with the physiological requirements (sources of muscular energy, heart rate (HR)). Thus, the data obtained during the tennis competition can be used as external criteria for validating the tennis-specific tests and for designing specific training interventions.

Once a physical test or a series of tests is standardized with representative data samples (for example, different levels of performance, age and sex groups), a multiple regression statistical approach should be applied, using the national or international ranking position. as external criteria to identify the most sensitive physical characteristics of the performance. This systematic approach is directly related to the specific training principle, according to which in order to target these characteristics or components of the performance and to generate specific adaptations, the training must be focused on the desired / targeted performance elements [1] - [4].

In the final stage of the schematic representation of the training optimization model (Figure 1), the tennis players must regularly complete a series of tests, which will allow the individual profiling of the performance and an individual training recipe. This process must be repeated in a regular feedback loop, while adapting the training interventions to obtain changes in physical performance.

In tennis, research was conducted with athletes from different backgrounds (for example, age, gender, performance level, etc.) using different testing protocols, in order to identify the most influential factors in performance. However, there is a general disagreement within the scientific community regarding the most important physical performance characteristics and useful tests in tennis. In recent years, several models have been documented, mainly by the national tennis federations, which are trying to cover the complex profile of physical qualities. However, the assessment of technical competencies was usually excluded. Thus, the objective of the present analysis is to describe and evaluate the different physical tests recommended and used by practitioners, scientists, athletes and institutions (national tennis federations). As selection criteria for testing procedures, only tennis-specific tests were initially selected, followed by intermittent sports-related tests, while laboratory tests are not described in detail and will be documented in the research to be undertaken. in the doctoral internship. Because some of the different physical qualities allow a less specific approach to physical testing (for example, strength), some basic tests are included. The search included articles published before October 1, 2019, as well as theses / dissertations completed and available up to the same date, using various search engines. The search was performed using the terms "tennis", combined with "test" and "endurance, power, speed, agility and range of motion". The reference lists from the studies taken as well as the official publications of the International Tennis Federation (ITF) and the national tennis federations (those available!) Were also revised.

Physical requirements during the game of tennis

The game of tennis is characterized by intermittent efforts of the whole body, alternating short attacks (1-9 s) of high intensity exercises and short recovery actions (10-19 s) interrupted by several rest periods with a slightly longer duration. (50–90 s), with an average game time of 1.5 hours, although in some cases it may take more than 4 h. After serving approximately 190 km / h, the tennis player runs an average of 3 m on the hit and a total of 8–15 m with 3–4 changes of direction in pursuit of a point, hitting the ball 4-5 times on average and completing 1300 up to 3600 m per hour of play, depending on the level of the player and the surface of the land (slow or fast). Typically, players have to react quickly and be exceptional moves not only in a linear direction, but also multidirectional. Strength is required in muscles and joints for performance (ball speed) and to reduce injuries (joint protection).

Thus, during the tennis match, the demands alternate between providing energy for high intensity attacks / strokes (through intramuscular phosphates and glycolysis) and replenishing energy sources and restoring homeostasis in time intervals (through oxidative metabolism). Therefore, in order to be successful in the competition and to tolerate the demands of intensive training, tennis players need a mixture of speed, agility and power, combined with medium-high aerobic and anaerobic capacities linked to whole body muscle groups.

Testing the strength of tennis players

As mentioned earlier, valid approaches to testing endurance in tennis should include a physical task that is analyzed during the competition. However, this complex approach may cause some problems in terms of practicability and reliability, as well as in the interpretation of the results (for example, the distinction between the different qualities of the basic metabolic pathways). Thus, an analysis of the tennis literature on resistance testing offers extreme variability of procedures, from laboratory tests to more or less specific (semi-specific) and tennis-specific tests.

Laboratory tests

In general, laboratory exercise tests are accepted as a measure of aerobic power and, although they can be performed on a variety of ergometers, a treadmill is recommended for testing tennis players. A wide range of testing protocols with different characteristics (for example the duration and intensity of the incremental steps, the rest intervals and the number of stages) will be analyzed within the doctoral internship, in future research.

Tests on the tennis court

An interesting alternative is that laboratory-based incremental testing protocols can be transferred under age conditions, allowing groups of players (for example, all players in a tennis club) to run simultaneously (for example, on a 400 m split track). in sections / colors) and follow an acoustic signal. For practical reasons (eg club level; no technical or physiological measures are available), the "Cooper 12 min Run" test may be useful [5] - [11] although tests in this category are characterized by higher reproducibility. small because of the tactical and motivational aspects.

Other protocols such as the "Montreal Road Test" or the "We-eval" test [12] - [17] were initially designed to run on a track following acoustic signals, providing an indirect estimate. However, the lack of specificity of this mode of evaluation (i.e. continuous running) does not reflect the intermittent nature of team sports and missiles.

In the last 10 years, efforts have been made to develop incremental discontinuous tests to improve the specificity of assessment modes. Their goal is to establish maximum aerobic power under acoustically controlled conditions for distance covered and running speed. These tests are validated by measurements, and the estimates can be predicted by equations related to sex and age. Because tests include accelerations, decelerations and changes of direction, they can be classified as semi-specific. However, based on the requirements of intermittent sports, the relevance of these continuous tests has been questioned, which has led to the development of several valid and reliable sports-specific tests, such as intermittent Yo-Yo (IR) and 30-15 recovery. intermittent resistance tests (30–15IFT) ([18] - [23]). The Yo-Yo IR tests consist of speeds of 2 × 20 m speed, with a 10 s rest period of active recovery (controlled by audio signals). Level 1 (Yo-Yo IR1) starts at a lower speed, being more moderate than the Level 2 test (Yo-Yo IR2) (IR1: 10 km / h, IR2: 13 km / h). The Yo-Yo IR1 test evaluates an individual's dual ability to repeat intermittent exercises with a larger aerobic component compared to the Yo-Yo IR2 test, which taxes aerobic and anaerobic energy systems.

In tennis, the use of these semi-specific tests (Yo-Yo IR and 30-15IFT) seems to be a good recommendation, although, according to our knowledge, there is not much scientific information on their use in tennis specific tests and only a few normative values are offered for Yo-Yo IR. Furthermore, it should be emphasized that in all the tests presented, the running distances, movement characteristics and muscle groups involved still make considerable differences compared to the specific tennis program.

To reduce the gap, tennis researchers are trying to develop more specific protocols. Two major qualities seem to make the difference between a

semi-specific test and a specific one of tennis resistance:
(1) use of the dimensions of the tennis court and
(2) combination of specific parts and impact actions.
In the last decade, different models have been published with acceptable accuracy under standardized conditions. Weber and Hollmann [25] - [27] were the first authors to describe an incremental exercise test in court for assessing aerobic power in tennis players. The particular component for standardizing this test was the use of a ball-throwing machine, which designed the balls alternately at the right and left corners of the baseline. Players had to alternately hit in a prescribed pattern (ie, ball speed, height and landing points) .40 45 The intensity of the incremental testing protocol is controlled by adjusting the ball frequency, as shown in Figure 2.
Based on this initial approach and with some methodological differences, several test models have been developed that evaluate various physiological criteria and skills performance, all using a ball-throwing machine, 41-44, and measuring / radar equipment. Moreover, the basic test criteria (rhythm, direction and speed of the ball) and the characteristics of the player's movement (strokes, running details) are difficult to standardize. Thus, they are not commonly used and reliable and representative comparisons can be made between tennis professionals.

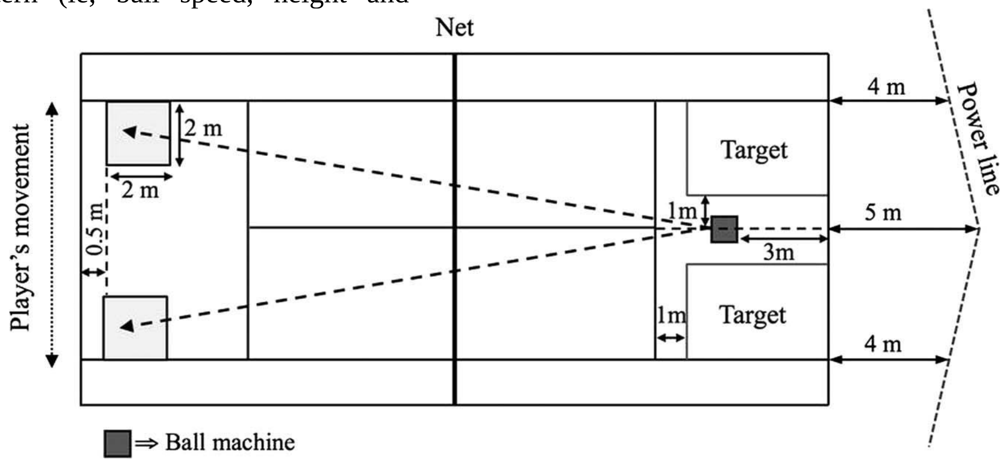

Figure 2. Adjusting the frequency of the ball in the tennis court

In order to improve reproducibility and practicability (that is, expensive equipment is not required), two different approaches have been published (Girard test and Hit & Turn test) ([28] - [31]). Both methods follow an incremental protocol until exhaustion, including tennis and race simulation, with speeds and directions of movement controlled by visual or acoustic feedback. The test stages have a duration of 40-50s and are interposed with 10-20s at rest, as shown in Figure 3. Running direction, movement technique and stroke position are more variable and partly uncertain during the Girard test, comparatively. with the Hit & Turn test. This ensures a more careful approach to real tennis, but complicates the preparation and execution of the tests. Considering the practical use of these tests, the Hit & Turn Test offers normative values correlated with age and sex groups, as shown in Tables 1 and 2.

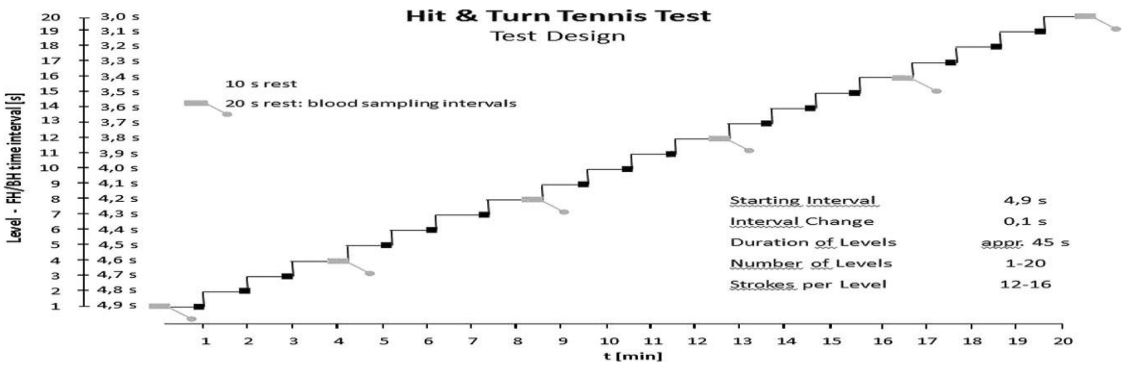

Figure 3. Hit & Turn test

Qualities	Measurements	U12 (n=7)	U14 (n=10)	U16 (n=8)
Anthropometry	Height (cm)	148.9	169.4	178.1
	Weight (kg)	44.8	56.3	62.6
	BMI - Body Mass Index	16.8	18.5	19.9
Strength and power	Grip strength (Dominant hand) (kg)	21.3	23.5	25.7
	CMJ – Counter Movement Jump (cm)	28.9	31.0	36.5
	Service velocity (km/h)	131.5	157.7	170.1
	Medicine ball throw	502.6	612.3	713.2
Speed and agility	10 m (s)	2.05	1.95	1.84
	20 m (s)	3.66	3.37	3.22
	Shuttle sprint FH-forehand (s)	3.06	2.93	2.73
	Shuttle sprint BH-backhand (s)	3.12	3.08	2.94
Endurance	Hit & Turn Test (level)	12.5	14.2	15.7

Table 1. Example of physical qualities evaluated in the test model, as well as average strength, speed and endurance values for U12 to U16 male players

Qualities	Measurements	U12 (n=5)	U14 (n=11)	U16 (n=6)
Anthropometry	Height (cm)	149.3	162.1	170.3
	Weight (kg)	38.2	49.0	57.5
	BMI - Body Mass Index	17.1	18.8	20.8
Strength and power	Grip strength (Dominant hand) (kg)	21.1	23.5	25.7
	CMJ – Counter Movement Jump (cm)	28.2	30.2	32.1
	Service velocity (km/h)	111.5	127.7	150.1
	Medicine ball throw	505.6	610.2	709.1
Speed and agility	10 m (s)	2.02	1.96	1.94
	20 m (s)	3.6	3.5	3.41
	Shuttle sprint FH-forehand (s)	3.1	2.98	2.88
	Shuttle sprint BH-backhand (s)	3.21	3.1	3.01
Endurance	Hit & Turn Test (level)	11.7	12.7	13.5

Table 2. Example of physical qualities evaluated in the test model, as well as average strength, speed and endurance values for female players U12 to U16

Conclusions

The use of regular tennis resistance tests provides the framework for developing an individualized database and a more effective physical training program, especially for juniors. Based on the selection criteria of the above tests, tables 1 and 2 summarize the most suitable tests for tennis players, with the average age and sex group of the test models performed in two consecutive months, October 2019 and November 2019 in training sessions with the children and juniors we deal with. With the results obtained from the test models and the normative values, the tennis coaches and the physical trainers can develop individual results of the players, based on the percentages of age and sex group, with their strengths and eaknesses. This would lead to a more efficient design of physical training programs, saving time for tennis-specific training.

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