



METHODOLOGY FOR DETERMINING THE SPEED-POWER CAPABILITIES OF BASKETBALL PLAYERS

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Abstract

The study objective is to develop a methodology for determining the jump height and jumping endurance in basketball players of various gaming functions using modern nanotechnology and microprocessor systems, in particular smartphones, personal computers, etc.

Materials and methods. The study used a method for determining jump height and jumping endurance using capacitive sensor devices based on a combination of modern nanotechnology and microprocessor systems, in particular smartphones, personal computers.

Results. The study showed that the use of modern nanotechnology to monitor the jump height and jumping endurance allows you to study these indicators with high accuracy, which is very important in scientific research. The study showed that the absolute height of the jump in center players is 328.1 ± 7.88 cm, in attackers – 324.1 ± 6.62 cm, in defenders – 314.4 ± 8.65 cm. The relative height of the jump in defenders is 57.7 ± 6.86 cm, which is on average 8.2 cm more than in center players, and 5.3 cm more than in attackers ($p < 0.001$ and $p < 0.02$, respectively).

Conclusions. The use of modern nanotechnology and microprocessor systems to determine the parameters of jump height and jumping endurance allows you to determine these parameters with high accuracy. The use of modern, accurate nanotechnology measurement and calculation of jump height and jumping endurance indicators using graphic data analysis provided a complete description and degree of development of various "jumping" qualities of basketball players.

Studies have shown that the jump height and jumping endurance in basketball players of different roles (defenders, attackers and center) differ with a high degree of reliability.

Keywords: basketball, jumping, jumping endurance, nanotechnology.

Introduction

The physical training of basketball players in modern basketball is of particular importance due to the expansion of the range of game actions, an increase in the load during the game, which requires from basketball players maximum muscle effort in rapidly changing situations (Koryahin, 2018; Kozina, Iermakov, Cretu, Kadutskaya, & Sobyenin, 2017; Demcenco, 2017).

In order to effectively and constantly increase the physical capabilities of basketball players and, in particular, jumping height and jumping endurance, you need to know following: what requirements for certain physical qualities are imposed by the game itself, how big are these requirements, what are the physical capabilities of athletes, what means and methods are most effective (Kondrashin, & Koryahin, 1978; Fort-Vanmeerhaeghe, Montalvo, Latinjak, & Unnithan, 2016; Koryahin, 1994). It is necessary to have scientifically based tests to determine the jumping height and jumping endurance. Particular attention should be paid to ensure that the tests are scientifically substantiated and meet the requirements of test theory (Godik, 1980; Koryahin, 1998). In mod-

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ern basketball, players of different roles are subject to equally high demands on their physical fitness and, in particular, jumping ability (Anastasiadis, 2006; Asadi, Saez de Villarreal, & Arazi, 2015). Basketball players do a lot of “jumping” during the game in defense, and especially when fighting for the ball bounces off the ring. Without a sufficient level of development of jumping abilities and jumping endurance, it is very difficult to fight on the “shield” (Ferreira, Volossovitch, & Sampaio, 2014). Without a sufficient level of development of this quality, fatigue quickly occurs, the basketball player is not able to effectively throw to the basket, fight on the shield for the bounce off ball, counteract the throws into the basket by the opponent’s players, etc (Cormery, 2008; Narazaki, Berg, Stergiou, & Chen, 2009; Montgomery, Pyne, & Minahan, 2010).

The study objective is to develop a methodology for determining the jump height and jumping endurance in basketball players of various gaming functions using modern nanotechnology and microprocessor systems, in particular smartphones, personal computers, etc.

Materials and methods

Study participants and study organization

89 highly skilled basketball players took part in the research.

Capacitive sensor devices based on the combination of modern nanotechnology and microprocessor systems such as smartphones, tablet computers and others were used to create a means of controlling jumping height parameters. The basis of these devices are electronic measuring systems of the athlete’s spatial position based on capacitive sensors (Golyaka, Melnyk, & Helzhynsky, 2004; Gotra, Golyaka, & Helzhynsky 2008). Among the main advantages of modern sensor devices, we can mention versatility, high conversion accuracy, thermal stabilization, ease of use, minimal power consumption with the possibility of functioning with low-voltage power supplies (Gotra, Golyaka, & Helzhynsky 2008).

To control the height of the jump, a one-dimensional matrix of active band electrodes that are glued to the display wall were formed. Active electrodes will be connected to the signal converter by a signal line (electric cables harness).

In addition to the electrodes, the developed device includes following: a signal line, a signal converter, an interface, a communication line and a mobile communication system, in particular a smartphone or personal computer. In the system of measurement of jumping parameters, the matrix of electrodes forms a set of signals, by which it is possible to determine the highest and lowest point of the body of the object of control, his grouping and dynamics of movement with a time resolution of 0.01 s. Electrodes in the form of flexible conductive tapes are glued to the display wall up to 3 m high. The width of the tapes and the distance between them is 5 mm, which determines the resolution of measuring the spatial position of the object of control, in particular over the floor level.

Quantitative assessment of the basketball player’s jumping endurance can be obtained by ergometric analysis, which allows obtaining a number of indicators that characterize the manifestation of jumping endurance:

1. Maximum jump height.
2. Number of jumps made with maximum height.

Calculation of these indicators is based on the method of graphic analysis. Fig. 1 illustrates the technique and sequence of calculation operations:

1. In logarithms, the jump height indicators of all serial jumps opposite their ordinal value are postponed.
2. At the points of the highest jumps, an average line (AB), which is parallel to the abscissa axis, is made. At the point of intersection of this line with the vertical axis, the jump height (point A) is determined.
3. At points where a decrease in jump height is clearly visible, the middleline (BC) is drawn. The rate of decrease in jump height as a result of fatigue is defined as $\text{tg} \alpha$.

Determining these three indicators (the maximum jump height, the number of jumps with the maximum jump height and the rate of decrease in jump height because of fatigue) is very important. They characterize the level of development of various qualities of basketball players. The maximum jump height, for example, is determined mainly by the power of the alactate anaerobic process, and the jump endurance (the number of jumps with the maximum jump height) is determined by the capacity of the alactate anaerobic process. It is possible having a good “jumping”, but being bad in maintaining the jump height in serial jumps and vice versa. The interdependence between these indicators is neutral ($r = 0.573$). This shows that the level of development of one of these qualities does not depend on the other.

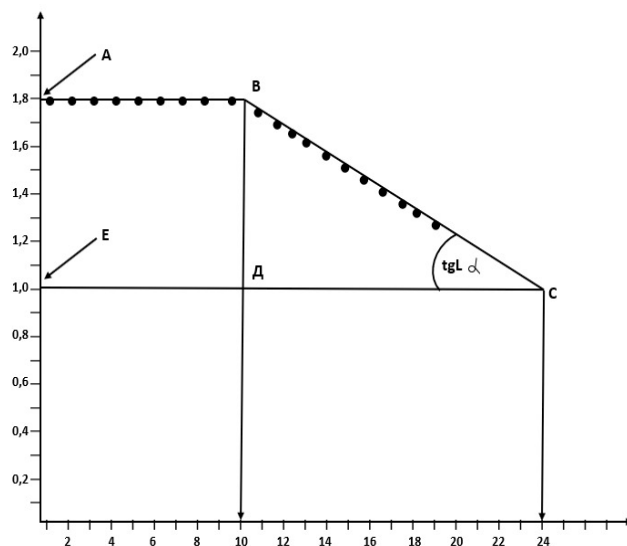


Fig. 1. Diagram for calculating jump height and jumping endurance in basketball players

Statistical analysis

To maintain a laboratory journal, to perform operations for storing the obtained research results and sorting them, and for calculating statistical data, the MS Excel program was used. The choice of methods of mathematical statistics was adequate to the purpose and objectives of our study and included the use of the following methods: the arithmetic mean according to the initial data, the error of the average value and the reliability of the difference between the data obtained.

Table 1. The results of the study of the jump height in highly qualified basketball players

Game functions	Indicators	Height with outstretched arm standing on tiptoes M ± SD	Jump height, cm	
			Absolute M ± SD	Relative M ± SD
Center (n = 27)		279.6 ± 6.1	328.1 ± 7.88	49.5 ± 5.59
Attackers (n = 15)		271.0 ± 6.33	324.1 ± 6.62	52.4 ± 3.74
Defenders (n = 27)		256.9 ± 5.85	314.4 ± 8.65	57.7 ± 6.86
Reliability of difference				
C - A		p < 0.001	p < 0.05	p < 0.05
C - D		p < 0.001	p < 0.001	p < 0.001
A - D		p < 0.001	p < 0.001	p > 0.02

Results

The results of the studies of the jump height in highly qualified basketball players (masters of sports) are presented in table.1. The table shows that the height with an outstretched hand up, standing on tiptoes, in high-class basketball players is: in the center players – 279.6 ± 6.1 cm, in attackers – 271 ± 6.33 cm, in defenders – 256.9 ± 5.85 cm.

The absolute height of the jump is: in the center – 328.1 ± 7.88 cm, in attackers – 324.1 ± 6.62 cm, in defenders – 314.4 ± 8.65 cm. The difference in these indicators is natural because players of different roles have different height. As for the relative height of the jump, the center players recorded not very high rates, as well as the attackers, which indicates a significant reserve to increase in their jump as can be seen from the table, defenders have a jump height of 57.7 ± 6.86 cm, which is on average 8.2 cm more than in center players, and 5.3 cm more than in attackers (p < 0.001 and p < 0.02, respectively).

When determining jumping endurance, it is best to perform jumps to a height of 90% of the maximum, until complete fatigue and refusal to continue working. When performing a series of jumps, the interval between it should be 3c. This time is enough for the basketball player to take a comfortable position and effectively perform the next jump – the interval of 3c is best set with the help of a metronome signal.

Our correlation analysis between height indicators and indicators in the jump height in highly qualified basketball players showed that there is a dependence between these indicators, but negative (r = -0.555). Differences that are restrained in our studies can be explained by the different ages of basketball players and their qualifications, as well as what we determined between jump height and height with an elongated arm upwards, standing on the toes, and not just growth. The differences that are obtained in our research can be explained by the different ages of basketball players and by differences in their qualifications, as well as the fact that we determined relation between the jump height and height with an outstretched up arm, standing on tiptoes, not just height. The relation between these indicators is presented in Fig. 2.

Discussion

The question of the importance of determining the jump height and jumping endurance was considered by many scientists and basketball coaches (Gomelsky, 1972; Poplavsky, 2004; Sushko & Mustafa, 2015) and others.

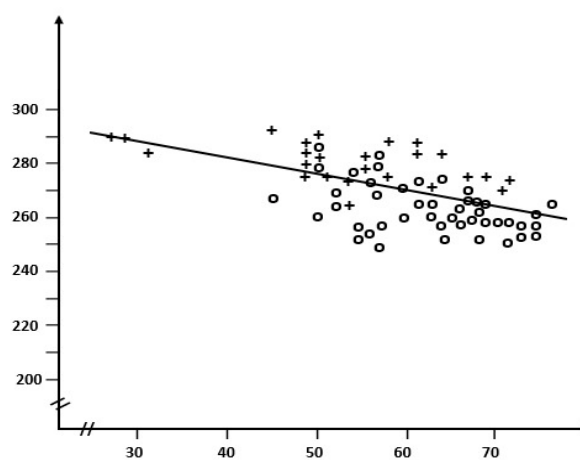


Fig.2. Dependence between relative jump height and height indicators with an outstretched upwards arm in highly qualified basketball players. On the ordinate axis - height, standing on tiptoes with outstretched upwards arm, cm. On the axis of the abscissa - the relative jump height, cm. Marks + - center, * - attackers, o - defenders

The results of our research are consistent with a number of scientific developments (Boichuk, Iermakov, & Nosko, 2017; Gonzalo-Skok, Sánchez-Sabaté, Izquierdo-Lupón, & Sáez de Villarreal, 2019; Iedynak, Galamandjuk, Kyselytsia, Nakonechnyi, Hakman, & Chopik, 2017) on the feasibility of improving the system of control over the state of physical, technical, tactical and psychological training of athletes.

These results of studies have shown that the use of modern nanotechnology for monitoring the jump height and jumping endurance allows you to determine these indicators with high accuracy, which is very important not only in scientific research, but also in the practical work of trainers. This makes it possible to develop training programs for basketball players, taking into account objective indicators of the state of their jump height and jumping endurance, which coincides with the results of the conclusions of a number of other researchers (Khudolii, 2019; Raiola, Altavilla, Tafuri, & Lipoma, 2016; Tyshchenko, Hnatchuk, Pasichnyk, Bubela, Semeryak, 2018).

The results of the study complement information on the control of such important qualities for basketball players as jump height and jumping endurance, and make it possible to do this with high accuracy (Demcenco, 2017; Poplavsky, 2004; Tyshchenko, Hnatchuk, Pasichnyk, Bubela, Semeryak,

2018). In further studies, this technique has a great perspective in the examination of basketball players of different age groups, athletes of different qualifications. The proposed method of determining the jump height and jumping endurance will have great importance for scientific research.

Conclusions

1. The use of modern nanotechnology and microprocessor systems to determine the parameters of jump height and jumping endurance allow to determine these parameters with high accuracy.

2. Studies have shown that the indicators of jump height and jumping endurance in defenders, attackers and center differ with a high degree of difference, which indicates the need for an individual approach to basketball players of different game ampoule in the preparation of training programs.

2. The use of modern, accurate nanotechnology and calculation of jump height and jumping endurance indicators using graphic analysis give a complete characteristic, the degree of development of various "jumping" qualities of basketball players.

Conflict of interest

The authors declare no conflict of interest.

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МЕТОДИКА ВИЗНАЧЕННЯ ШВИДКІСНО-СИЛОВИХ МОЖЛИВОСТЕЙ БАСКЕТБОЛІСТІВ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 5 с., 1 табл., 2 рис., 25 джерел.

Мета дослідження – розробити методику визначення висоти стрибка та стрибкової витривалості у баскетболістів різних ігрових функцій з використанням сучасних нанотехнологій та мікропроцесорних систем, зокрема смартфонів, персональних комп'ютерів тощо. Розробити рекомендації, які спрямовані на підвищення ефективності тренувань висоти стрибка і стрибкової витривалості.

Матеріали та методи. У дослідженні був використаний метод визначення висоти стрибка і стрибкової витривалості з використанням ємнісних сенсорних пристроїв, які ґрунтуються на поєднанні сучасних нанотехнологій та мікропроцесорних систем, зокрема смартфонів, персональних комп'ютерів. Основою цих пристроїв є електронні вимірювальні системи просторового положення спортсмена на базі ємнісних сенсорів.

Результати. Проведене дослідження показало, що використання сучасних нанотехнологій для моніторингу висоти стрибка і стрибкової витривалості дозволяють з високою точністю дослідити ці показники, що є дуже важливим при проведенні наукових досліджень.

Дослідження показало, що абсолютна висота стрибка у центрових становить $329,1 \pm 2,31$ см, у нападників – $324,1 \pm 3,65$ см, у захисників – $314,4 \pm 3,42$ см. Відносна висота стрибка у захисників становить $57,7 \pm 2,71$ см, що в

середньому на 8,2 см більше, ніж у центрових, та на 5,3 см більше, ніж у нападників ($p \geq 0,999$ та $p \geq 0,98$ відповідно). Цей факт, безумовно, необхідно враховувати при плануванні тренувального процесу гравців різного амплуа.

Висновки. Використання сучасних нанотехнологій та мікропроцесорних систем для визначення параметрів висоти стрибка і стрибкової витривалості дозволяють з високою точністю визначити ці параметри. Використання сучасних, точних нанотехнологій вимірювання і розрахунків показників висоти стрибка та стрибкової витривалості за допомогою графічного аналізу даних надає повну характеристику і ступінь розвитку різних «стрибкових» якостей баскетболістів.

Представлена в роботі методика визначення таких важливих показників, які характеризують ступінь розвитку різних якостей баскетболістів, таких як максимальна висота стрибка, кількість стрибків з максимальною висотою, а також можливість визначення швидкості зниження висоти стрибка в результаті втоми.

Дослідження показали, що показники висоти стрибка і стрибкової витривалості в баскетболістів різного амплуа (захисників, нападаючих і центрових) різняться з високим ступенем достовірності.

Ключові слова: баскетбол, стрибучість, стрибкова витривалість, нанотехнології.

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