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Subjective method of control and regulation of intensity of physical activity (the rate of perceived exertion) in the training process of young basketball players aged 12-13

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Abstract

Background and purpose
Performing any physical activity is accompanied by subjective feelings of its severity. The purpose of the work is to experimentally substantiate the effectiveness of the method of controlling physical activity based on subjective feelings in the training process of basketball players aged 12-13.

Material and methods
In the experiment, the subjects were young basketball players aged 12-13 from the Youth Sports School. 24 athletes were divided into 2 groups of 12 athletes in each group. Training was conducted 3 times a week for 6 months. The experimental group trained using the Borg scale for self-regulation of physical activity (the rate of perceived exertion (RPE) scale). A control group of schoolchildren aged 12-13 trained in parallel with the experimental group. The subjects of this group performed the exercises themselves without using subjective load control. The results of the two groups were compared with each other according to the results of special endurance tests, which were conducted before the beginning of the experimental research process and after its completion.

Results
The use of the method of subjective regulation of the intensity of the load when performing exercises aimed at developing special endurance in basketball contributes to a significant increase in results compared to similar classes, but without the use of this method.

Conclusions
The results obtained indicate the need to take into account subjective feelings of the severity of the work in assessing the intensity of the load in basketball training classes. For this purpose, the verbal-digital Borg scale can be used. The use of this scale will significantly help the physical education teacher to adequately dose the load when performing exercises aimed at developing special endurance in basketball.

Keywords
basketball, Borg scale, load, heart rate

Анотація

Михайло Теслюк, Стефан Адамчак. Суб'єктивний метод контролю та регуляції інтенсивності фізичного навантаження (ступінь сприйнятого зусилля) в тренувальному процесі юних баскетболісток 12-13 років

Обґрунтування і мета	Виконання будь-якого фізичного навантаження супроводжується суб'єктивними відчуттями її тяжкості. Мета роботи – експериментальне обґрунтування ефективності методу контролю фізичних навантажень за суб'єктивними відчуттями у тренувальному процесі баскетболісток 12-13 років.
Матеріал і методи	В експерименті випробуваними були юні баскетболістки 12-13 років ДЮСШ № 13. 24 спортсменки були розподілені на 2 групи по 12 спортсменок в кожній групі. Тренування проводились 3 рази на тиждень протягом 6-ти місяців. Експериментальна група тренувалася із застосуванням шкали Борга для самостійної реогуляції фізичних навантажень (шкала ступеня сприйманого зусилля). Паралельно із експериментальною групою займалася контрольна група Баскетболісток 12-13 років. Піддослідні цієї групи виконували самі вправи без використання суб'єктивного контролю навантаження. Результати двох груп порівнювали між собою за результатами тестів на спеціальну витривалість, які проводилися перед початком процесу експериментальних досліджень та після його завершення.
Результати	Використання методу суб'єктивного регулювання інтенсивності навантаження при виконанні вправ, спрямованих на розвиток спеціальної витривалості в баскетболі сприяє достовірному підвищенню результатів порівняно з аналогічними заняттями, але без використання даного методу.
Висновки	Отримані результати вказують на необхідність урахування суб'єктивних відчуттів тяжкості роботи в оцінці інтенсивності навантаження на тренувальних заняттях з баскетболу. Для цього може використовуватися вербально-цифрова шкала Борга. Використання цієї шкали істотно допоможе вчителю фізкультури адекватно дозувати навантаження під час виконання вправ, спрямованих на розвиток спеціальної витривалості у баскетболі.
Ключові слова	баскетбол, шкала Борга, навантаження, ЧСС

Introduction

The modern process of learning in combination with sports is characterized by high intellectual and emotional stress [1–5]. However, in recent years, there has been an alarming trend of a sharp deterioration in the health of children, in particular young athletes [4, 5]. The main direction of solving this problem does not imply the exclusion of physical activity, as rightly pointed out by experts in the field of physiology, but the adequate presence of constant physical activity in combination with the use of appropriate methods of regulating physical activity.

Physical activity that meets the body's capabilities does not harm health [6–9]. This is one of the main factors in restoring and strengthening health. Therefore, an incorrectly determined and implemented amount of physical activity that does not meet the adaptive capabilities of the child's body can harm health.

In this regard, the development and improvement of a system of regulation and individual differentiation of the amount of physical activity is of great relevance [10–13]. Since the most common sports among children are game sports [14–16], let us consider the possibilities of regulating physical activity during basketball practice.

Of the objective physiological indicators used to control loads, the most informative and accessible in practice is the heart rate (HR), and even the relative HR, that is, HR expressed as a percentage of the maximum [17–20]. Nevertheless, when playing basketball, controlling physical activity by pulse is difficult, since it creates many pauses in training. In addition, it is difficult for the teacher and coach to control pulse changes during the lesson in all students at once. Much simpler and more convenient in practical work is the method of subjective control of physical activity by the students themselves [1, 5, 21, 22].

Various authors have pointed out the high efficiency and informativeness of subjective methods of load control [23–26].

However, the effectiveness and informativeness of this method for young basketball players aged 12-13 should be scientifically substantiated, which is the main goal of this work. Performing any physical work is accompanied by subjective feelings of its severity (or tension) [1, 5, 23, 24]. These feelings are of particular importance for assessing the state of the body during muscle work. A close relationship has been found between the subjectively perceived intensity of the load and various physiological indicators [5, 26, 27]. The quantitative measure of subjectively perceived intensity (PI) is estimated using special scales. The physiological measure of the intensity of the load is usually the relative heart rate [23–26].

Along with the relative heart rate, other indicators of the respiratory and cardiovascular systems are widely used. There is a high positive relationship between physiological indicators and RPE [1, 5, 23–26]. The authors who have studied this problem recommend the use of quantitative methods for determining the subjectively perceived severity of physical activity in health and sports practice [23, 24, 27, 28]. However, specific possibilities for the practical application of quantitative methods of determination in the training process of young basketball players aged 12-13 were not specifically considered.

The purpose of the work is to experimentally substantiate the effectiveness of the method of controlling physical activity based on subjective sensations in the training process of basketball players aged 12-13.

Material and methods

Participants

In the experiment, the subjects were young basketball players aged 12-13 from the Youth Sports School No. 13. 24 athletes were divided into 2 groups of 12 athletes in each group. Randomization of participants was carried out using the random number method. Female athletes were selected to participate in the experiment based on the following criteria: 1 – playing basketball for at least 1-2 years, 2 – good general health, 3 – regular attendance at training sessions.

Training was conducted 3 times a week for 6 months. The experimental group trained using the Borg scale for self-regulation of physical activity. A control group of 12-13 year old female basketball players trained in parallel with the experimental group. The subjects of this group performed the exercises themselves without using subjective load control.

Ethical Committee Statement

The ethics committee of the H.S. Skovoroda Kharkiv National Pedagogical University was

granted permission to conduct this study, as it complies with the Declaration of Helsinki of the World Medical Association - the ethical principles of medical research involving humans (No. KhNPU/PhES/EC/4/4/2024).

All participants were informed about the objectives of the study and gave their consent to participate.

Measurement methods

We determined the intensity of the load, which is perceived subjectively, using the 10-point Borg scale [23, 24]. The Borg scale is a number from 6 to 20. These numbers correspond to the verbal values of the magnitude of the load, which is perceived subjectively (Table 1).

Table 1
Scale for the subjective assessment of the magnitude of physical activity [23, 24]

Numerical scale values	Verbal scale characteristics
6	
7	very, very easy
8	
9	very easy
10	
11	easy
12	
13	moderate
14	
15	severe
16	
17	very difficult
18	
19	very, very difficult
20	

The scale is constructed in such a way that the numbers correspond to the values of HR/10, i.e. the number 6 approximately corresponds to a HR of 60 beats/min. In this experiment, the scale was used in the following way. Immediately after performing exercises aimed at developing special endurance in basketball (shuttle running, serial finishing of the ball into the basket, high-speed dribbling with subsequent throwing), the children's HR was determined. The basketball players also indicated the numbers that corresponded to their subjective assessment of the severity of the load.

The scale was also used by the "reverse" method [23–26]. The athletes performed various exercises aimed at developing special endurance in basketball for a strictly defined time (from 10-30 s to 2-15 min. Depending on the nature of the exercise), which is usually practiced in the circular method of training. The intensity of the load was subjectively regulated by the athletes themselves using the Borg scale.

Heart rate was recorded using a Polar fitness watch.

Tests for special endurance of young female basketball players aged 12-13

The results of the two groups were compared with each other according to the results of special endurance tests, which were conducted before the beginning of the experimental research process and after its completion. The following tests were used.

Running 5·20 m, p. The athlete stood on the front line of the basketball court. On the command "March" he started running, at the 20 m mark he touched the marked line with his hand and turned back. At the front line he touched the line again, turned and ran again to the 20 m mark. The number of runs of the marked distance of 20 m was 5.

Driving the ball with a throw in motion, 4*26 m, p. The athlete started from the front line with dribbling the ball. On the opposite side of the court, he made a throw in motion, picked up the ball, returned back with the ball, then this cycle was repeated. If the number of hits was less than 2, the result was not counted.

Dribbling 4*26 m, with a circle around the center circle, p. The athlete started from the front line with the ball, circled the center circle, dribbled the ball to the opposite side of the court, returned back with the ball and a circle around the center circle, then this cycle was repeated.

Shuttle run 6*20 m, p. The athlete stood on the front line of the basketball court. On the command "March" he started running, at the 20 m mark he touched the marked line with his hand and returned back. On the front line, he again touched the line, turned around and ran to the 20 m mark again. The number of runs of the marked distance of 20 m was 5.

30 throws from 5 points, s. Throws were made from 5 standard points outside the 3-second zone at a distance of 1.5 m from this zone. The time of execution of 30 throws was recorded. If the number of hits was less than 15, the result was not counted.

Statistical analysis

The results of the study were analyzed using mathematical statistics methods with the determination of descriptive statistics indicators, normal distribution according to the Kolmogorov-Smirnov method. The reliability of differences in mean indicators was determined by the Student method, since the Kolmogorov-Smirnov method showed that the samples corresponded to a normal distribution ($p>0.05$). The reliability of the differences between the control and experimental groups was determined based on the results of special endurance tests before and after the experiment, and the reliability of intragroup changes as a result of the experiment was also determined.

Results

The results showed the adequacy of the practical application of the method of subjective assessment of the severity of physical exertion. In the case of the development of special endurance using the method of subjective control of the intensity of physical exertion, the increase in fitness is greater than when using conventional methods of controlling physical exertion. The test results in the control and experimental groups, which did not differ before the experiment ($p>0.5$), after the experiment began to differ significantly from each other: in the experimental group, the time for performing special endurance exercises was significantly less than in the control group after the experiment ($p<0.5$).

The experiment showed that the use of the studied method has a positive effect on the development of special endurance. The groups, which were initially identical (no significant differences according to Student's t-test), after the experiment demonstrated significantly better results in five tests of special endurance (Table 2).

In all 5 tests used, the differences between the two groups are greater after the experiment than before it. The increase in results is more pronounced in the experimental group (Table 2) than in the control group.

Table 2

Results of special endurance tests in the control and experimental groups of young female basketball players after the experiment

Test name	Control group, n = 12		Experimental group, n = 12		Significance of differences between groups before the experiment		Significance of differences between groups after the experiment	
	$x \pm S$	Change, %	$x \pm S$	Change, %	t	p	t	p
Running 5·20 m, s (before the experiment)	30.4±0.6	4.3	30.3±0.3	11.9	0.52	>0.05	-	-
Running 5·20 m, s (after the experiment)	29.1±0.5		26.7±0.2*		-	-	15.42	<0.05
Driving the ball with a throw in motion, 4*26 m, s (before the experiment)	30.10±2.4	0.0	30.12±0.5	12.5	0.03	>0.05	-	-
Driving the ball with a throw in motion, 4*26 m, s (after the experiment)	30.11±2.3		26.36±0.4*		-	-	5.57	<0.05
Driving the ball 4*26 m, with a stroke of the central circle, s (before the experiment)	25.4±0.4	7.0	25.2±0.6	9.0	0.96	>0.05	-	-
Driving the ball 4·26 m, with a stroke of the central circle, s (after the experiment)	23.6±0.4*		22.9±0.4*		-	-	4.28	<0.05

Shuttle run 6*20 m, s (before the experiment)	36.7±3.2	0.0	36.5±3.6	7.7	0.14	>0.05	-	-
Shuttle run 6*20 m, s (after the experiment)	36.6±3.3		31.1±3.1*		-	-	4.21	<0.05
30 throws from 5 points, s (before the experiment)	40.2±4.2	0.0	40.5±5.2	8.4	0.07	>0.05	-	-
30 throws from 5 points, s (after the experiment)	40.4±2.3		35.1±3.1*		-	-	4.76	<0.05

Notes: * - significant at p<0.05

Discussion

The conducted study proved the effectiveness of the method of regulation and control of physical activity based on subjective sensations according to the 10-point Borg scale. The obtained data expand and complement the conclusions of other authors. Researchers [5, 8, 9] obtained data indicating the adequacy of both means of applying the scale of subjective assessment of the severity of the load, which coincides with the data obtained by us. Kozina [5] also notes that the second method of using the scale has a number of advantages in comparison with the first in practical application, since, with a high informativeness of the method, the possibility of overload is practically excluded, since the intensity of the load is determined by the athletes independently.

Borg [23, 24] indicates the existence of interindividual differences in subjective sensations of the magnitude of physical activity with the same absolute physiological shifts in the body. Such differences can be determined by age, gender, race, social status and other factors [23, 24, 26].

This feature of the tension perceived during the load of a game nature can be associated with various factors, including emotional tension, characteristic of any sports game, including basketball. In addition, when playing basketball, the player can subconsciously regulate the intensity of the load himself. This is due to the need to demonstrate high accuracy of technique and operational thinking during the game and combine these qualities with high manifestations of physical qualities: speed, strength, endurance. However, accuracy, as a rule, decreases in conditions of its manifestation at high intensity of physical exertion, which is associated with such a characteristic as resistance to obstacles. As a result, the player, in order to maintain the required accuracy, periodically during the game reduces the intensity of the load, i.e. he may not start defensive actions after the attack, not participate in a quick breakthrough, reduce the frequency of passes under the ring, etc., in order to maintain the necessary state of neuropsychic processes for the successful manifestation of the accuracy of technical and tactical actions [11–15].

As he recovers, the player increases the intensity of his game, the level of which is maintained as long as technical and tactical actions can be adequately performed against his background. Then there is a slight decrease in the intensity of the load again. The mechanism of regulation of this process is usually not realized by the player. This idea is consistent with the hypothesis of Borg [24] that a person has a mechanism that controls the distribution of physical work by time and quantity. He believes that the manifestation of this mechanism is most characteristic of sports. In sports, it is especially clearly manifested that a person is able to regulate the load in accordance with his physical capabilities and reserves and accordingly adapt the intensity of the work performed. Exhaustion usually does not develop until the goal is achieved.

Therefore, under normal conditions, people are able to avoid premature fatigue or exhaustion, and thus optimally develop their reserves of working capacity. Observations of this plan led to the hypothesis that a person has a mechanism that controls the distribution of physical work in time and quantity. If such a mechanism really exists, then exhaustion and strain are in this case signs of decompensation of the specified regulatory mechanism. Such decompensation occurs when the balance between tension and recovery is disturbed under the influence of external influences [28]. In this regard, the restoration of the mechanism of subjective regulation of the magnitude of physical exertion is a primary task of physical education of basketball players to preserve and improve their health.

Self-regulation of the load during a game of basketball can be an example of the manifestation of this hypothesis. The human body is a self-organizing system [16, 18, 20], to which these principles are suitable. Applying these principles to the game activity of a basketball player, we can come to the disappointing conclusion that subjectively perceived tension can be a certain regulating factor of the

intensity of the load. With increasing work intensity, the intensity of its subjective perception increases. At some point, a signal appears about the expediency of further increasing the intensity of the load, and the player subconsciously begins to strive to reduce it until the necessary compensation from the side of recovery processes occurs.

Thus, there is a cyclical increase and decrease in the intensity of the load during the game of basketball. The emotional mood during the game, on the one hand, increases the release of catecholamines into the blood, leads to an increase in heart rate, respiratory rate, and on the other hand, reduces the intensity of the load, which is subjectively perceived. Both factors, along with an increase in the volume of muscle mass, lead to the fact that at the same heart rate, the subjectively perceived tension during the game of basketball is lower than during cyclic work [5, 25, 27].

Between physiological changes in the body during muscular work and subjective sensations its severity there is a high correlation. The results obtained are consistent with other authors [11–15, 26, 27]. On the other hand, RPE correlates with relative values of HR more than with absolute values [11–16]. It is believed that relative values of HR most adequately reflect the state of the body when performing physical work. However, obtaining relative values of HR during a training session is quite laborious and not always possible [1, 5, 17, 18]. Obtaining quantitative values of subjective feelings of the severity of work is much easier.

RPE values at least accurately characterize the state of the body than relative values of functional shifts. Researchers of this problem [5, 18, 19] believe that subjective indications of a working person are more informative than individual physiological ones, since subjective feelings arise as a result of the integration of all processes occurring in the body. Experiment [5] showed that the RPE value equal to 14-15 points coincides with the beginning of a nonlinear increase in LH. In this regard, it is logical to assume that the VN value equal to 14-15 points and characterized as "heavy" coincides with the anaerobic threshold. It follows that the performance of anaerobic glycolytic loads is accompanied by subjective sensations expressed as "above average", "heavy" and higher, and the performance of aerobic loads is accompanied by subjective sensations expressed as "easy" and "below average", i.e. up to 13-14 points on the Borg scale.

Conducting training with subjective control of the intensity of the load by the athletes themselves according to the scale numbers given before the start of the exercise showed the adequacy of the application of the technique in the development of special endurance of basketball players. The latter is also supported by the high correlation between the value of the given RPE and the working heart rate ($r=0.72$, $p<0.01$) [5]. However, it should be noted that when using the method of subjective control and load intensity, it is advisable to use not too high scale numbers (up to 15-16 points), because according to the data of the pedagogical experiment, further purposeful independent increase in the load intensity does not give the desired results.

In general, the results of this study showed that with a subjective feeling of the severity of the work, one can reliably judge the physiological changes in the body that occur during the work. Using the method of subjective regulation of the load intensity when performing exercises, for example, for the development of special endurance of basketball players, gives significantly higher results compared to similar training, but without using this method.

Conclusions

1. The use of the method of subjective regulation of the intensity of the load when performing exercises aimed at developing special endurance in basketball contributes to a significant increase in results compared to similar classes, but without the use of this method.

2. The results obtained indicate the need to take into account subjective feelings of the severity of the work in assessing the intensity of the load in basketball training classes. For this purpose, the Borg verbal-digital scale can be used. The use of this scale will significantly help the physical education teacher to adequately dose the load when performing exercises aimed at developing special endurance in basketball.

In the future, it is planned to expand research on the possibilities of controlling and regulating the magnitude of the load in basketball.

Conflict of interest

The authors declare no potential conflicts of interest.

References

1. Chen W, Yang W, Lee Y, Wu H, Huang C, Liu C. Acute Effects of Battle Rope Exercise on Performance, Blood Lactate Levels, Perceived Exertion, and Muscle Soreness in Collegiate Basketball Players. Journal of strength and conditioning research. 2020;34(10):2857-66. doi:10.1519/JSC.0000000000002661
2. Sarlis V, Chatziilias V, Tjortjis C, Mandalidis D. A Data Science approach analysing the Impact of Injuries on Basketball Player and Team Performance. Information Systems. 2021;99.
3. Kozina ZhL. Scientific and methodological ways of individualization of the educational and training process in sports games [Nauchno-metodicheskie puti individualizacii uchebno-trenirovochnogo processa v sportivnykh igrakh]. Problemy i perspektivy razvitiia sportivnykh igr i edinoborstv v vysshikh uchebnykh zavedeniiakh. 2005;1(1):188-189
4. Kozina ZL Basic scientific and methodological approaches to the process of individualizing the training of athletes (by the example of basketball). Fiicheskoe vospitanie studentov tvorcheskikh spetsialnostey. 2005;1(1):8-20.
5. Kozina ZhL, Iermakov SS, Crełu M, Kadutskaya L, Sobyanin F. Physiological and subjective indicators of reaction to physical load of female basketball players with different game roles. Journal of Physical Education and Sport. 2017; 17(1): 378 – 382. https://doi.org/10.7752/jpes.2017.0105
6. Adams C. Influence of exercise mode and selected ambient conditions on skin temperature. Ann. NY Acad. Sci. 1977;301:110-127.
7. Kullik L, Stork M, Kellmann M, Puta C, Jakowski S. Impact of sleep-wake patterns and daily rhythms including training on midsleep time in adolescent basketball players during the COVID-19 pandemic. German journal of exercise and sport research. 2024;54(3):393-401. doi:10.1007/s12662-023-00933-3
8. Nouble B. Validity of perception during recovery from maximal exercise in men and women. Perc. Mot. Skills. 1979;49:91 – 897.
9. Taber C, Sharma S, Raval M, Senbel S, Keefe A, Shah J, et al. A holistic approach to performance prediction in collegiate athletics: player, team, and conference perspectives. Scientific reports. 2024;14(1). doi:10.1038/s41598-024-51658-8
10. Lever J, Murray A, Bartlett J, Aurellado I, Duffield R, Fullagar H. Revisiting the playbook: Coaches' opinions and current views of performance, development and load monitoring in highly-trained male youth basketball players. International journal of sports science & coaching. 2025. doi:10.1177/17479541251342023
11. Li G, Shang L, Qin S, Yu H. The impact of internal and external loads on player performance in Chinese basketball association. BMC sports science medicine and rehabilitation. 2024;16(1). doi:10.1186/s13102-024-00983-6
12. Li H, Huang X. Intelligent Dance Motion Evaluation: An Evaluation Method Based on Keyframe Acquisition According to Musical Beat Features. Sensors. 2024;24(19). doi:10.3390/s24196278
13. Molina R, Lapresa D, Arana J, Alvarez-Marín I, Salazar H. A proposal for load monitoring in basketball based on the joint use of four low-cost tools. Apunts educacion fisica y deportes. 2025;(160):26-34. doi:10.5672/apunts.2014-0983.es.(2025/2).160.04
14. Spyrou K, Armendáriz M, Alcaraz P, Carrasco R, Udayanga M, Freitas T. Does Total Playing Time Affect the Neuromuscular, Physiological, and Subjective Recovery of Futsal Players during a Congested Period? Sports. 2024;12(5). doi:10.3390/sports12050139 doi:10.3390/sports12050139
15. Ortega V, Fernández-Ozcorta E, Suero F. Relationship between technical-tactical complexity in the training session and internal load in female basketball. Sport tk-revista euroamericana de ciencias del deporte. 2017;6(1):163-8.
16. Daub B, Mclean B, Heishman A, Peak K, Coutts A. The Relationship Between Mental Fatigue and Shooting Performance Over the Course of a National Collegiate Athletic Association Division I Basketball Season. Journal of strength and conditioning research. 2024;38(2):334-41. doi:10.1519/JSC.0000000000004624
17. Myles W. et al. A comparison of response and production protocoles of assesing perceived exertion. Eur Y. Appl. Physiol. 1986;55:585 – 587. doi:10.14198/jhse.2023.184.01
18. Batalla-Gavalda A, Beltran-Garrido J, Garrosa-Martín G, Cecilia-Gallego P, Montoliu-Colás R, Corbi F. Long-Term Analyses of the Rate of Perceived Exertion as an Indicator of Intensity in Women's Basketball during a Relegation Play-off. Biology-basel. 2022;11(11). doi:10.3390/biology11111592
19. Cabarkapa D, Cabarkapa D, Eserhaut D, Fry A. Relationship between internal and external load metrics in professional male basketball players. Journal of human sport and exercise. 2024;18(4):755-62. doi:10.14198/jhse.2023.184.01
20. Burger J, Henze A, Voit T, Latzel R, Moser O. Athlete Monitoring Systems in Elite Men's Basketball: Challenges, Recommendations, and Future Perspectives. Translational sports medicine. 2024;2024. doi:10.1155/2024/6326566
21. Michel A. Smutor et al exercise intensiti: subject v regulation by perceived exertion. Arcp. Phus. Med. Rch. 1980; 61
22. Michevic P. M. Sensori cues for perceived exertion: a review. Med. And Sciens in Sport and exers. 1981; 13:150 – 163.
23. Borg Y. Perceived exertion as an indicator of somatic stress. Sprt.Y. Rehab. Med. 1970;3:92 – 96.
24. Borg Y. Psychophysical bases of perceived exertion.

Med. And Sciens in Sport and exers. 1982;1:377 – 382.
25. Shi R, Wu ZZ. Design of optical sensors based on computer vision in basketball visual simulation system. Optical and Quantum Electronics. 2024;56(3).
26. Yin Z, Li Z, Li H. Thermal radiation optical motion capture based on depth camera perception for basketball fatigue detection simulation. Thermal science and engineering progress. 2024;56. doi:10.1016/j.tsep.2024.103072
27. Sánchez R, Alonso-Pérez-Chao E, Calleja-González J, Sáiz S. Heart Rate Variability in Basketball: The Golden Nugget of Holistic Adaptation? Applied sciences-basel. 2024;14(21). doi:10.3390/app142110013
28. Yang K. Quarterly fluctuations in external and internal loads among professional basketball players. Frontiers in physiology. 2024;15. doi:10.3389/fphys.2024.1419097

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