



# Summary of the Research Status of Artificial Intelligence in Sports Performance Analysis of Athletes

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## Abstract

Using literature, logical analysis and other methods to systematically sort out and reflect on the domestic and foreign frontier research progress in the field of artificial intelligence to improve sports performance. It is found that the current research on artificial intelligence to improve sports performance mainly focuses on four aspects: the evaluation of athletes' physical function status and sports posture, the analysis of winning rules, the regulation of pre-match mental state, and the prevention and treatment of sports injuries.

## Subject Areas

Sports Science

## Keywords

Artificial Intelligence, Sports Performance, Smart Sports, Athletes

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## 1. Introduction

Intelligent sports refers to the use of artificial intelligence technology as a means to comprehensively analyze sports big data, understand the hidden patterns, relationship changes, abnormal characteristics and distribution structures behind it, and form a knowledge system that can be used for early warning, decision-making, and analysis, so as to support sports decision-making. Provide theoretical methods and supporting technologies [1]. China's smart sports started in the 1990s. With the development of artificial intelligence technology, China's tradi-

tional sports industry has undergone new changes. In 2017, the General Administration of Sport of China put forward the view that “Olympic preparations need the support of the latest scientific and technological achievements” at a special report meeting on “Science and Technology Boost Sports”. It can be seen that artificial intelligence has become an indispensable factor on the road to the realization of the current goal of becoming a sports power. Looking at the current domestic and foreign theoretical and applied research on artificial intelligence to enhance athletes’ sports performance, China’s level in this field is obviously lagging behind that of Western countries. The competitive sports training in our country is still in the extensive mode of “high input, low output”, and the low efficiency of training level seriously restricts the development of competitive sports in our country. Before the construction of a large-scale sports performance database has not been completed, artificial intelligence not only covers the expected functions of technological assistance, but at the same time often faces the realistic dilemma that traditional sports development problems cannot be effectively solved. Therefore, this article intends to comprehensively and systematically summarize the research progress in this field at home and abroad, explore the future development trend of artificial intelligence to improve sports performance, and provide practical theoretical methods and practical basis for the development of this field in China.

## 2. Research Methods

Using the literature method, in foreign language databases such as Web of science and Ebsco, use “Athletes”, “Players”, “Sports Performance”, “Sports Competitions”, “Sports Training” and other keywords as keywords to search for documents related to “sports performance”; At the same time, “Artificial Intelligence”, “Deep Learning”, “Machine Learning”, “Computer Vision” and “Speech Recognition” were used as keywords to retrieve documents related to “artificial intelligence”. With keywords such as “artificial intelligence”, “sports performance”, “competition” and “athlete”, search for relevant literature on “sports performance” and “artificial intelligence” in Chinese databases such as HowNet, VIP, and Wanfang. After careful reading of the above-mentioned literature, using logical analysis method, the research frontier progress at home and abroad in this research field is summarized, the difficulties and problems in it are examined, and the future development trend of artificial intelligence improving sports performance is explored.

## 3. Research Results and Analysis

Artificial intelligence technology enhances sports performance of athletes, which is mainly reflected in the strengthening of athletes’ physical function state, the evaluation and analysis of sports posture, the analysis of winning rules, the regulation of mental state before competition, and the prevention and treatment of sports injuries.

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### 3.1. Evaluation and Analysis of Body Function Status and Exercise Posture

#### 3.1.1. Physical Function Status

Athlete's functional state refers to the functional level of the athlete's body when the various organ systems work together during exercise [2]. Athletes' functional state is an important factor in determining their level of competition. At present, indicators such as heart rate, blood pressure, and maximum oxygen uptake are commonly used to evaluate athletes' functional state [3]. At present, a wearable GNSS tracking device is widely used to monitor athletes' displacement distance, speed, and training load. By wearing this device, you can also understand your own health status according to your movement trajectory and heart rate. Secondly, smart clothing has built-in embedded sensors, which can realize real-time capture of body movements, and then provide feedback on the functional status of athletes through the classification and analysis of machine learning algorithms; in addition, due to the heat dissipation of athletes, the body temperature of athletes can be accurately measured. The narrow-band smart watch based on the Internet of Things technology and the black ball meter of environmental heat load has been widely used in the training and competition of athletes, creating the possibility for the efficiency of athlete training and competition.

#### 3.1.2. Sports Posture

Exercise posture refers to the position and state of the body and various parts of the body in different stages of exercise during the exercise process, which can be divided into start posture, process posture and end posture [4]. Correct exercise posture is conducive to athletes' efficient mastery of movement techniques, improvement of athletic performance, and control of mental processes. In the daily training of athletes, because the number of coaches is far less than the number of players, it is impossible to take into account all the players by only relying on the naked eyes of the coaches to judge whether the athletes' exercise posture is reasonable. Therefore, coaches and related technical personnel can use high-definition cameras to record athletes' movement postures one by one during training, and then use dynamic 3D model technology to restore the movement posture. Problems with posture can be corrected accordingly.

### 3.2. Analysis of Winning Rules

Big data mining and machine learning technology are also current research hotspots in the analysis of winning laws of sports events. The law of victory refers to the objective law that coaches and athletes must follow to defeat their opponents and strive for excellent sports performance within the limits of the competition rules [5]. As early as the 1970s, the United States applied "data collection and analysis" to the field of baseball. Although the intelligence level of tools was low at that time, it pioneered the application of artificial intelligence technology in sports. In the 1990s, Aphon *et al.* [6] constructed a preliminary

framework for the application of artificial intelligence in the analysis of winning rules in sports competitions. In the 21st century, McCabe [7] used neural network algorithms to predict and analyze the results of sports competitions. Reed *et al.* [8] verified for the first time that the ability of artificial intelligence and computerized methods to analyze the winning rules of the game surpassed that of humans, and proposed to establish a sports information database to further enhance the application of artificial intelligence technology in the field of sports. On the basis of previous studies, McCabe *et al.* [9] further used the multi-layer perceptron model to capture and analyze the technical movements of athletes, thereby improving the accuracy of the study of winning laws. Due to factors such as data diversification and complex structure, the current application requirements in this field are mainly in the aspects of synchronous data collection, multi-source heterogeneous data integration, storage technology, data analysis and visualization. Low-granularity, high-precision, and long-term raw and inferred data will directly affect the quality of training monitoring, analysis, and decision-making. Due to the complexity of competitions and competition guarantees, data integrity, accuracy, and consistency will become new principled requirements under the premise of ensuring data quality in the future [10].

### 3.3. Regulation of Mental State before the Game

The psychological state of competition refers to the level of mental activity of athletes under the conditions of competition, competition or participation [11]. Studies have shown that the mental state of athletes before the competition is closely related to their sports performance, and good psychological intervention for athletes before the competition can achieve good results. At present, artificial intelligence has been widely used to assist athletes to adjust their mental state. Among them, Bailon *et al.* found that [12], EEG coupling is closely related to sports performance, which reflects the efficiency of collaborative work between brain regions. Through EEG coupling, athletes no longer choose the content of imagery training based on individual experience, thus optimizing the effect of imagery training; Takagi uses interactive evolutionary computing technology for psychological measurement and training to achieve quantitative analysis of the range of emotional perception [13]; Through the integration of deep learning technology and mental health early warning system, Li Jianxiao and others successfully realized the real-time tracking and analysis of “one-to-many” mental state [14]; Qian Jinxin *et al.* proposed an adaptive evaluation method, which The method can effectively reduce the number of questions required for the assessment, thereby shortening the answering time, and has a higher information extraction ability than the traditional paper-and-pencil test [15]. These studies provide evidence for how athletes perform at their best in competitive play. Through the use of machine learning algorithms, traditional statistical methods can more accurately identify the key psychological factors that affect the competitive state, thus forming a targeted training plan.

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### 3.4. Prevention and Treatment of Sports Injuries

Sports injury refers to the injury of the motor system that a person encounters during exercise or activity, including bone structure, joints, muscles, ligaments, synovium and other body structure and tissue injuries [16]. The pursuit of “higher, faster and stronger” in modern competitive sports makes all sports emphasize high-intensity and large-volume exercise in training, and it is inevitable for athletes to suffer sports injuries in this mode. Sports injuries are sometimes even devastating to athletes, and sports careers may end. For example, Oden, the No. 1 pick in the 2007 NBA draft, was unable to bid farewell to the NBA because of repeated injuries. It can be seen how important the prevention and treatment of sports injuries are to athletes. Many scholars have applied artificial intelligence technology to the prevention and treatment of sports injuries. Albu *et al.* tried to use artificial intelligence to provide technical support for athletes’ medical decisions [17]; Tang’s intelligent system based on deep learning and machine learning methods realized athletes’ The classification and diagnosis of ECG signals have effectively improved the efficiency of injury risk classification and identification, and realized the monitoring of the training process [18]; Zhuang *et al.* proposed that deep convolutional neural networks can improve the accuracy of image detection and rehabilitation to improve the arrhythmia of martial arts athletes. Disease detection ability and accurate diagnosis information of arrhythmia [19]; Oliver *et al.*’s fatigue diagnosis system with convolutional neural network as the core can use embedded processors to realize advanced diagnosis of athletes’ skeletal muscles [20]. Although artificial intelligence has been widely used in this field, there is a great demand for the prevention of athletes’ diseases and injuries. How to prevent diseases and sports injuries in the preparation and training phase and establish a clinical practice of common sports injuries in sports? The big data system for diagnosis and treatment is also a problem that needs attention.

## 4. Conclusion and Recommendations

### 4.1. Conclusion

In the era of artificial intelligence, artificial intelligence technology has become an important driving force for the development and transformation of all walks of life. In the field of sports, artificial intelligence technology, as an important auxiliary means, has obvious value in improving the performance of Chinese athletes.

### 4.2. Recommendations

In the future training of Chinese athletes, coaches and related technical teams should use artificial intelligence technology to evaluate athletes’ physical function status and sports posture, analyze winning rules, adjust athletes’ pre-match mental state, and prevent and treat sports injuries, to improve the overall competitive level of Chinese athletes!

## Conflicts of Interest

The author declares no conflicts of interest.

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