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Application and Prospect of Artificial Intelligence Technology in the Field of Sports

Han Menglin[1,a], Tang Beichuan[2,b], Zhang Ziqi[3,c], Liu Wujun[1,d,*]

[1]School of Physical Education, Southwest Petroleum University, Xindu Road, Chengdu, China
[2]School of Computer Science, Sichuan University, First Ring Road, Chengdu, China
[3]School of Oil and Gas Engineering, Southwest Petroleum University, Xindu Road, Chengdu, China
[a]958430896@qq.com, [b]1822282857@qq.com, [c]1448072173@qq.com, [d]953189335@qq.com
**Corresponding author*

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Abstract: This article overviews the application of AI technology in the field of sports, focusing on the current status and development trend of the application of computer vision technology, intelligent wearable devices and big data technology in competitive sports, school sports and national fitness. The article firstly introduces the development history of the sport AI discipline, and then analyzes in detail the specific applications of the above three technologies in the field of sports, including the way of data acquisition, the use of AI algorithms, and their practical applications in sports fields. Finally, the challenges and future research directions of computer vision technology, smart wearable devices and big data technology in current applications are discussed respectively.

1. Introduction

Artificial Intelligence (AI) is a cutting-edge technology that mimics and enhances human intelligence. It includes a series of theories, methods, technologies, and application systems designed to enable machines to perform tasks that require human intelligence [1]. As a key driver of technological revolution and industrial change, AI technology is profoundly affecting our social life. Sports, as an activity that promotes health and explores the limits of movement, not only contributes to the enrichment of social culture and spiritual civilization, but also is an organized social activity. As the application of AI technology in the field of sports science and technology continues to deepen, the research and teaching of sports disciplines are experiencing great changes, prompting the gradual emergence of sports AI as an emerging discipline[2].

According to the "14th Five-Year Plan for Sports Development" released by the State General Administration of Sports in October 2021, the wide application of information technology in the field of sports has been clearly put forward [3]. This indicates that the deep integration of AI and sports has become an important trend to promote the development of sports. On this basis, we can define sports AI as: for human sports activities, using AI technology, by monitoring and sensing key parameters, establishing theories and methods of data analysis and mining, so as to reveal the laws of sports, assess sports performance, formulate scientific sports programs, and develop

auxiliary training equipment, in order to improve the level of competition and promote scientific sports.

Sports AI has a wide range of application scenarios, including competitive sports, school sports and national fitness. In the field of competitive sports, AI technology has been applied to training assistance systems for athletes, coaches, and referees, accompanying robots, tactical optimization systems, and intelligent refereeing systems, which have been widely used in training, competitions, and refereeing. In the field of school sports, the sports teaching ecosystem relying on AI and big data can help students with personalized learning and training, improve the teaching quality of teachers, and facilitate efficient teaching management. In the field of national fitness, the popularity of fitness apps and smart wearables based on human data, and the rise of intelligent sports venues have demonstrated the new ideas of AI in solving the problem of uneven sports resources.

In this paper, we will focus on the development history of sports AI and the current status of its application in various sports fields, aiming to provide sports scientists with more in-depth references to the theoretical, technological and applied research of sports AI.

2. Documentation method

In this study, we relied on the WOS Core Collection (including SCI, SSCI, and A&HCI), the world's leading and highly recognized citation databases, to obtain data. Given the interdisciplinary nature of AI and sports science, which cover a wide range of application areas, a search using only the keyword “artificial intelligence in sports” may not be able to comprehensively cover the current state of research in this field. Therefore, we select relevant buzzwords based on the current research hotspots of AI, such as machine learning, deep learning, computer vision technology, big data, smart wearable devices, natural language processing, etc., and identify the papers to be analyzed.

This study focuses on three mainstream technologies in the field of sports AI: computer vision technology, smart wearables technology, and big data technology. We will outline the methods of these technologies in data acquisition, introduce various AI-related algorithms including deep learning, and explore the current status of their research and application in the fields of competitive sports, school sports, and national fitness. Finally, we will analyze the current challenges faced by these technologies and predict future trends in the field.

3. The Evolution of Artificial Intelligence in Sports

The development of artificial intelligence (AI) in sports can be divided into three stages. Initially, AI research focused on solving mathematical and linguistic problems, such as the first academic conference on artificial intelligence held at Dartmouth College in the United States in 1956, which marked the formal formation of the field of AI. Between the 1940s and the 1980s, AI research focused on educational uses and gradually expanded into industrial manufacturing. However, due to technical and hardware limitations, AI technology experienced a period of stagnation in its development.

Entering the 1980s, AI began to see new opportunities for development as computer memory and computing speed increased. The focus of research during this period shifted to providing domain expertise for different systems, such as the XCON user order configuration system developed by Carnegie Mellon University for an enterprise in 1980. However, the further development of AI was limited by the lack of open source software and open data standards, as well as the complexity of human knowledge structures [4].

The arrival of the 21st century marked a new era of AI technology, especially the unsupervised learning training method based on deep belief networks proposed by Hinton in 2006, which prompted the academic community to start studying deep learning in depth. During this period, AI

technology made significant progress in several fields, especially in sports. For example, the NBA introduced the “Sport VU” system as early as 2013, which combines 3D camera and sensor technology to realize the dynamic capture and analysis of sports data.

Overall, the combination of sports and AI has gradually progressed from the initial experimental applications to technical training, healthcare and game prediction. With the rapid development of information technology and the popularization of the Internet, sports AI technology has realized a more comprehensive and deeper integration in the fields of competitive sports, school sports and national fitness [5].

4. Application of Computer Vision Technology in Sports

Computer vision technology, as an important branch of artificial intelligence, mainly utilizes cameras to capture target objects and performs image processing and human movement recognition through artificial intelligence algorithms. In recent years, this technology, especially the deep learning model based on convolutional neural networks, has made significant progress in image classification and gesture recognition, providing important support for motion monitoring and training decisions.

4.1. Data acquisition and analysis

Current visual image acquisition is mainly through high-speed cameras, which are categorized into two ways: infrared 3D motion capture based on reflective markers and markerless motion capture. The former relies on multi-camera tracking of marker points to obtain 3D position information, which is highly accurate but expensive and cumbersome in data processing; the latter utilizes machine learning algorithms to automatically analyze the video, which is easy to operate and less expensive [6]. Multi-camera systems such as Vicon, Qualysis, and Microsoft Kinect are widely used for motion action recognition [7]. The placement of the camera for monitoring in the sports venue is critical if the athlete's movements are to be captured and recognized more accurately. For example, Kasuya, Montoliu and Leo set up multiple cameras in a stadium to capture motion images of the entire stadium from a bird's eye view.

Depth camera technology, through structured light, optical time-of-flight method, and binocular stereo vision method, provides an effective way to acquire 3D spatial coordinates, which facilitates real scene reconstruction and object recognition. The key steps in human action recognition include extracting motion information from images, modeling behavioral patterns, and establishing associations between visual features and action categories [8]. Deep learning algorithms such as CNN and RNN play an important role in automatic feature extraction and information integration.

4.2. Current status of applications in competitive sports

Artificial intelligence technology captures the trajectory of athletes and balls through high-speed cameras, and combines with machine learning algorithms to realize accurate tracking and action recognition of targets in complex scenes, which significantly improves the precision of technical and tactical analysis [9]. The markerless motion capture system based on computer vision relies on deep learning algorithms to carry out continuous three-dimensional motion reconstruction, providing coaches with real-time motion quality assessment and personalized training feedback, and enhancing the scientific level of training. At the same time, in order to overcome the limitations of traditional penalties, video-assisted refereeing systems have been gradually popularized: since the introduction of the “Hawk-Eye system” to realize the movement trajectory reproduction in tennis in 2006, MLB, NBA and other leagues have widely used 3D animation to assist in decision-making; in

the field of soccer, through the VAR technology (activated in 2016) and the SAOT technology of the 2022 World Cup (integrating high-speed video cameras and data processing), the position of the player is tracked and the offside position is automatically generated in real time. soccer through VAR technology (launched in 2016) and the 2022 World Cup SAOT technology (integrated high-speed cameras and data processing), real-time tracking of player positions and automatically generate offside three-dimensional images, effectively reducing misjudgments [10].Together, these technologies promote the transition of competitive sports to data-driven transformation, optimizing decision-making, training fairness, and tournament justice.

4.3. Current status of application in the field of school sports

Constructing school athletic training and teaching system to improve the teaching effect of physical education classroom, applying intelligent camera and analysis software, the human-computer interaction athletic training teaching system monitors students' movements in real time and provides personalized training programs and visual progress feedback. For example, an AI-based athletic training teaching model uses an intelligent camera system and analytics software to automatically monitor students' physical activity, provide personalized training programs, and visually display students' progress [11]. Constructing an intelligent prediction system for physical education classrooms to accurately assess students' risk of sports injuries, the intelligent prediction system for sports injuries integrating machine learning effectively reduces the risk of sports injuries by comparing the movement postures with the standard model, identifying technical deviations and issuing on-the-spot corrective guidance [12]. For example, by comparing students' movement postures with standardized movements, the system can provide corrective suggestions in real time to reduce the risk of sports injuries.

4.4. Current status of application in the field of fitness for all

Based on intelligent video and somatosensory interaction to capture real-time motion data, neural network algorithms to achieve action scoring and real-time guidance, to build an immersive exercise and fitness system, to promote the development of home “AI fitness meta-universe” [13]. This technology is particularly useful during epidemics and provides innovative solutions for home-based fitness.

Intelligent fitness coaching systems use visual recognition technology to dynamically analyze the details of the user's movements and output personalized training recommendations, with typical applications such as intelligent basketball gymnasiums generating real-time sports highlights and interactive feedback to enhance the fitness experience. For example, the intelligent basketball gym system can monitor the game in real time, providing sports highlight moments and interactive experience.

In summary, the application of computer vision technology in physical education, sports injury prediction, and fitness guidance demonstrates its important role in promoting the development of sports science and technology, which not only improves the quality of teaching, but also provides a new technical solution for national fitness and sports safety.

5. Smart Wearables in Sports

Smart wearable devices, which utilize embedded technology and integrate sensors in sports equipment, can capture movement and physiological data such as position, speed, and heart rate. Since 2016, these devices have continued to dominate the global fitness trend, and are especially widely favored by consumers in the national fitness sector. At a stage where internet and sensor

technologies are not yet fully intelligent, smart wearables face challenges such as the need to adapt to fast movements, wide-range monitoring, etc., but these challenges have been gradually overcome through AI technologies.

5.1. Data acquisition and analysis

Intelligent wearable devices are categorized into general, training and scientific research types according to different needs, which are suitable for different usage scenarios. These devices can be classified according to the wearing parts (e.g., head, hand, torso, and lower limbs) to realize all-round human-computer interaction. With the improvement of multi-sensor AI fusion algorithms, these devices are able to collect movement indicators and biological indicators in an integrated way, which has become a hotspot for movement science research [14].

5.2. Current status of applications in competitive sports

Smart wearable devices can monitor cardiorespiratory, fluid and neuromuscular indicators, providing coaches with intuitive data from the training process and facilitating personalized training planning. With this data, coaches can more accurately develop training programs, prevent injuries and improve the quality of athletes' careers. The artificial neural network-based multimodal sensing system (integrated IMU/ECG/EMG) captures cardiorespiratory metabolic and biomechanical parameters in real time, and realizes early warning of sports injury risk through LSTM time series modeling (accuracy >93% [15]); the miniaturized design (weight <1g) of sweat lactate sensor breaks through the traditional invasive detection limitations, and builds a non-invasive fatigue assessment The key advances are in three aspects[16]. The key progress is reflected in three aspects: 1) deep integration - the Chinese freestyle skiing team demonstrated the application of smart suits embedded with MEMS sensors to synchronize 16-dimensional physiological and kinematic data streams, which reduces the error by 62% compared with that of a single device [17]; 2) multi-source fusion for decision-making -The BSNs technology integrates inertial/optical/physiological sensing networks, and the Imeasureu system in kayaking and other sports realizes the cross-modal correlation analysis of paddling frequency and heart rate through the decision-making dashboard; 3) Closed-loop training optimization: The intelligent management system constructed by Sun Jinhai's team integrates the joint moment inversion into the kinematics data stream, which is the most effective way to optimize the training. combines joint moment inversion algorithm with training load control to empirically improve the quality of technical movements ($p < 0.01$). Currently, mainstream R&D focuses on three major technology axes: non-invasive, low-latency (<80ms), and self-powered, to promote the transformation of athletic training to the paradigm of “biomechanical precision quantification, injury prevention and control, and human-machine integration and adaptation”.

5.3. Current status of applications in the field of school sports

In traditional physical education, the monitoring of exercise load mostly relies on the subjective judgment of the teacher and lacks precision and continuity. The smart wearable devices optimized with artificial intelligence technology can effectively solve this problem and realize the accurate monitoring of students' sports status [18]. For example, by wearing sports bracelets or smart watches with embedded GPS and accelerometers, students' exercise ability and load can be accurately assessed. The development of smart wearable devices also facilitates the comprehensive monitoring of students' health status. For example, real-time monitoring of blood oxygen saturation helps in understanding the physical condition of students. With the advancement of AI technology, the

accuracy and functionality of the devices are constantly improving, such as the processing of photoelectric volumetric pulse wave signals through adaptive filtering algorithms, which effectively reduces motion interference. The wide application of smart blood oxygen exercise rings also reflects this trend. Virtual reality technology has been widely used in the field of education and sports, which aims to integrate the physical and virtual worlds [19]. This technology provides visual, tactile, and auditory experiences of real sports through head-mounted display devices and human-computer interaction technology, thus increasing students' interest in learning and motivating them to shift from passive to active learning.

5.4. Current Application Status in the Field of National Fitness

The development of smart wearable devices is not limited to recording basic exercise data such as steps and heart rate. Instead, by integrating "knowledge graphs + deep learning algorithms," they enable dynamic monitoring and recording of the entire fitness activity process, providing users with personalized fitness recommendations and movement corrections to prevent exercise-related injuries. For age-related diseases and movement disorders, smart wearable devices record physiological data and send it to doctors via 5G networks, supporting telemedicine. The combination of smart wearable devices and smart machine learning algorithms also makes personalized treatment and telemedicine possible. For example, embedded inertial sensors can collect patient movement data to design beneficial functional exercises, while other devices can create exercise plans to restore movement capabilities.

6. The Application of Big Data Technology in the Sports Field

The core of big data technology in the sports field lies in uncovering the laws of movement through in-depth analysis of multi-source heterogeneous data, overcoming the limitations of traditional causal analysis, and constructing predictive models to optimize training and competition strategies. This technology plays a central role in various application scenarios, including athlete selection, physical conditioning, and performance enhancement, leveraging artificial intelligence to achieve multi-dimensional analysis of complex training processes. With the widespread adoption of inertial sensors and intelligent capture systems (such as FIFA Player Monitoring), the current key challenges are: 1. Integrating heterogeneous data to build digital twin models; 2. Breaking down barriers to cross-domain data collaboration; 3. Enhancing the value conversion efficiency of exploring competitive patterns and promoting public health.

6.1. Data acquisition and analysis

Before the integration of big data technology and the sports industry, the traditional evaluation model, which relied on expert observation, suffered from a lack of objectivity due to subjectivity and data limitations, necessitating automated, precise, and quantitative technical solutions. Modern devices utilize computer vision and intelligent sensor technology to collect data, which is then processed using intelligent algorithms. During data transmission, efficient mechanisms are crucial for real-time feedback on athletes' conditions. Finally, in the data processing stage, designing effective filters is necessary to ensure the accuracy and validity of the data [20]. In terms of data analysis, sports science relies on a data-intensive research paradigm to reveal complex movement patterns through quantitative processes. Therefore, the "data-driven precision training" theoretical paradigm emphasizes the collection of multi-dimensional training metric data, processing and analyzing the data through deep mining algorithms, to enhance training efficiency [21].

6.2. Current status of applications in competitive sports

Big data and AI technologies utilize multi-dimensional data analysis to construct personalized training models, playing a crucial role in tactical optimization, injury prediction, and cycle training management. The technical pathways include: dynamic modeling, such as using machine learning to build “AI+big data” models based on full-cycle data (from the beginning of training to retirement)to achieve pre-match injury warnings, in-match decision support, and long-term performance evaluation. Injury prevention and control, such as using sensors (IMU/GPS) and deep learning to quantitatively control exercise load, significantly reducing injury risk through multi-source data fusion—the Premier League training vest achieved a 50% reduction in injuries , the Spanish League AI system reduced absence time by 65%, with prediction accuracy reaching 83%-90% [22,23] (typical cases include: Thornton decision tree predicting rugby injuries, Kautz neural network monitoring beach volleyball load, Ruddy machine learning assessing football players' hamstring strength, Naughton multi-sensor quantification of collision intensity, and Tammimi anterior cruciate ligament prediction algorithm). The construction of intelligent service platforms, such as integrating physiological parameters to build precise training platforms (e.g., Smartabase), provides real-time transmission via 5G for condition analysis, nutritional management, and visualization solutions, and enables data-driven decision-making through cloud computing [24]. Contemporary training systems must integrate the “modeling-prevention-platform” technical closed loop to achieve scientific improvements in competitive ability.

6.3. Current status of applications in the field of school sports

Computer-Assisted Instruction (CAI) utilizes computer technology to transmit information and accomplish teaching tasks in physical education, while also stimulating students' interest in learning and enhancing teaching effectiveness. CAI integrates multimedia technology to assist students in learning technical movements through the display of images and videos. The autonomous intervention model of artificial intelligence objectively evaluates students' athletic performance and provides suggestions for improvement. The construction of smart campus platforms integrates modern information technologies such as the internet, cloud computing, and big data, aiming to create an environment for comprehensive learning and uninterrupted education. Sports information technology classrooms use wearable devices to record students' physical condition and exercise intensity in real time, which is then displayed on a visualization platform through wireless transmission technology and AI technology, improving teaching efficiency and accuracy. Additionally, the application of technologies such as digital twin feedback systems enhances the safety and scientific nature of sports classrooms.

6.4. Current Application Status in the Field of National Fitness

By leveraging technologies such as the Internet of Things (IoT) and cloud computing, smart fitness paths and smart sports parks can be developed to advance the smartification of public fitness spaces. Through data mining and integration, intelligent digital models can be constructed to enable continuous iteration and updating of information. For example, a public fitness database for sports parks can be designed and developed, utilizing physical fitness monitoring data and residents' daily fitness data to automatically generate exercise plans via AI algorithms. Smart sports venues such as the TEBS system combine 5G, AI, and big data technologies to provide an immersive viewing experience. Personalized exercise plans are a new strategy for addressing health issues. By establishing a database of exercise prescriptions tailored to different populations, the personalization and precision of prescriptions can be enhanced, and personalized exercise

guidelines can be generated using internet technology. For example, a public sports venue exercise recommendation system for patients with chronic diseases can provide personalized exercise prescription recommendations [25]. Smartphone sensors can remotely assess balance, flexibility, and muscle strength to generate personalized sports exercise plans.

7. Conclusions

Although computer vision, smart wearable devices, and big data technology have been deeply integrated into the three major areas of competitive sports, mass fitness, and school sports, demonstrating significant benefits, they still face a series of challenges: While computer vision technology has improved the efficiency of training and competition analysis, its application is limited by bottlenecks such as shooting angle deviations, athlete obstructions and interference, and time-consuming video processing; In mass fitness and school sports settings, manual video analysis relies on multiple camera deployments and is susceptible to obstruction, resulting in high operational costs.

Smart wearable devices are commonly banned in large-scale competitions, and their daily applications face issues such as cumbersome wearing and fragmented data collection, necessitating iteration toward miniaturization and integration. Although sports data resources are abundant, data silos are prominent, requiring the development of integrated analysis methods and theoretical models to unlock data potential.

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References

[1] STEPHEN L, DANNY K. Artificial intelligence in the 21st century [M]. 2nd edition. Dulles, Virginia: Mercury Learning and Information, 2015:29-31.

[2] Guo Jianghao, Xiong Wen. Artificial Intelligence in Physical Education: Interpretation of Its Meaning, Ethical Risks, and Mitigation Strategies [J]. Research in Physical Education, 2025, 39(02): 21-31.

[3] National Sports Administration Policy and Regulations Department. Interpretation of the “14th Five-Year Plan” for Sports Development [EB/OL]. (2021-10-25) [2023-05-19].

[4] McCarthy J. Artificial Intelligence: A General Survey [M]. Holland: Artificial Intelligence, Elsevier, 1974: 317-322.

[5] BROOKS J F P. No silver bullet: Essence and accidents of software engineering [J]. IEEE Computer Society, 1987(10): 8-11.

[6] VAN DER K E, REIJNE M M. Accuracy of human motion capture systems for sport applications; state-of-the-art review [J]. European Journal of Sport Science, 2018, 18(6): 806-819.

[7] NAKANO N, SAKURA T, UEDA K, et al. Evaluation of 3D markerless motion capture accuracy using Open Pose with multiple video cameras [J]. Frontiers in Sports and Active Living, 2020, 2: 50.

[8] Wang Yuhong, Lai Jing. Application of Human Motion Recognition Technology in Physical Education Teaching [C]//Chinese Society of Sports Science, Sports Information Branch. Proceedings of the 15th National Sports Information Technology Academic Conference. Beijing Sports Vocational College; 2024:100-101.

[9] ZHANG K, WU J, TONG X, et al. An automatic multi-camera-based event extraction system for real soccer videos [J]. Pattern Analysis and Applications, 2020, 23(2): 953-965.

[10] Tan Jiamin. An Empirical Study on the Introduction of VAR Technology in the 2018 Chinese Super League Season [D]. Wuhan: Wuhan Institute of Physical Education, 2019.

[11] WEI S, WANG K, LI X. Design and implementation of a college sports training system based on artificial intelligence [J]. International Journal of System Assurance Engineering and Management, 2022, 13(S3): 971-977.

[12] SUN Y, ZHENG Y, HE L, et al. Application of visual sensing techniques in computational intelligence for risk assessment of sports injuries in colleges [J]. Computational Intelligence and Neuroscience, 2022: 1-9.

[13] Zhao Chen. Application of Virtual Reality and Artificial Intelligence Technologies in Fitness Clubs [J]. Engineering Mathematics Problems, 2021: 1-11.
[14] ACSM Fitness Trends [EB/OL]. (2023-01-02) [2023-01-31]. https://www.acsm.org/education-resources/trending-topicsresources/acsm-fitness-trends.
[15] STAUDENMAYER J, POBER D, CROUTER S, et al. Artificial Neural Network Estimation of Physical Activity Energy Expenditure and Activity Type Identification Based on Accelerometer Data [J]. Journal of Applied Physiology, 2009, 107(4): 1300-1307.
[16] Su Bingtian, Li Jianliang, Xu Huihua, et al. Scientific Training Assistance: Application of Flexible Wearable Sensors for Movement Monitoring [J]. Science China: Information Sciences, 2022, 52(1):54-74
[17] Beijing Winter Olympics Exploration: Overview of Various Sensors [EB/OL]. (2022-05-25) [2023-03-27]. https://www.sensorexpert.com.cn/article/57680.html
[18] Sun Jinhai, Wang Jiahong, Ma Yunchao, et al. Research and Application of a Multi-Sensor-Based Information Fusion Analysis System for Canoe Training [J]. Journal of Beijing Sport University, 2015, 38(5): 115-121.
[19] LI Z, WANG H. Research on the Effectiveness of University Physical Education Teaching Based on Artificial Intelligence Methods [J]. Journal of Intelligent and Fuzzy Systems, 2021, 40(2): 3301-3311.
[20] Liu Zhihui, Zhang Quanling. A Review of Big Data Technology Research [J]. Journal of Zhejiang University (Engineering Edition), 2014, 48(6): 957-972.
[21] Yan Qi, Liao Ting, Zhang Yujia. The Philosophy, Progress, and Practice of Digital Physical Training [J]. Sports Science, 2018, 38(11): 3-16.
[22] TTHORNTON H R, DELANEY J A, DUTHIE G M, et al. The Importance of Various Training Load Indicators in the Incidence of Injuries Among Professional Football Players [J]. International Journal of Exercise Physiology and Performance, 2017, 12(6): 819-824.
[23] TAMMIMI I, BALLESTEROS J, LARA A P, et al. An Artificial Intelligence-Based Predictive Model for Primary Anterior Cruciate Ligament Injuries [J]. Journal of Sports Medicine and Orthopaedics, 2021, 9(9): 23259671211027543.
[24] Human Performance Optimization Software: Smart Base [EB/OL]. (2022-12-06) [2023-01-10]. https://smartabase.com/.
[25] NETZ Y, YEKUTIELI Z, ARNON M, et al. Personalized Exercise Programs Based on Remote Assessment of Physical Fitness: A Pilot Study for Healthy Individuals Aged 65 and Above [J]. Gerontology, 2022, 68(4): 465-479.