

Artificial Intelligence Applications in Sports Training and Education: A Systematic Review

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ABSTRACT: Significant technological progress has completely transformed sports training and education from old-fashioned methods to data-driven, performance-oriented systems. Nevertheless, existing research is scattered, and a thorough summary of the latest studies is necessary. The purpose of this paper is to comprehensively analyze the use of technology and artificial intelligence (AI) in sports training and education. This review was conducted in line with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. We systematically searched the Scopus database and identified 162 records. After applying the inclusion criteria, 40 studies were included in the final analysis. AI-based tools and systems have greatly enhanced the effectiveness of coaching, learning, and acquiring skills by providing timely feedback and customised training sessions. However, there are some obstacles, including the high cost of setup, reliance on data, and ethical concerns related to data confidentiality. The paper thoroughly summarises AI applications in sports coaching and learning, highlights the role of cross-disciplinary teams, and examines ethical issues for long-term, successful deployments. Results guide and help scholars, trainers, and teachers. Besides, it pinpoints areas for new research.

KEYWORDS: artificial intelligence; sports training; sports education; performance analysis; coaching; machine learning.

I. INTRODUCTION

In recent decades, the world of sport has become increasingly competitive and science-based. Efforts to improve performance no longer rely solely on physical training, but also on the use of data and technological innovation in decision-making^{1,2}. Today's athletes are required not only to excel physically but also to be able to think tactically, make quick decisions, and maintain consistent performance under pressure³. Therefore, the existence of a structured training system, an evidence-based coaching approach, and ongoing performance monitoring are becoming increasingly important, both in professional sport and in educational settings.

Despite that, a myriad of difficulties still arise during the sports training and coaching processes. Firstly, conventional methods typically depend on the subjective judgment, the coach's experience, and limited observation; changes in the result of performance assessment and the coach's opinion may occur without their awareness^{4,5}. On the other hand, the complexity of sports performance involving biomechanical, physiological, and psychological aspects makes the analysis process increasingly difficult⁶. As a result, coaches often face challenges in effectively processing large, diverse datasets. In many cases, training programs are not fully optimised due to a lack of accurate, timely, and tailored feedback to the athlete's individual needs.

In this context, the presence of artificial intelligence (AI) opens up new opportunities to answer these various challenges⁷. Various AI technologies, such as machine learning, computer vision, deep learning, and wearable sensor systems, have been utilised to analyse performance, recognise movement patterns, predict outcomes, and even support decision-making in sports^{8,9}. With more accurate, objective, and real-time analysis capabilities, this technology helps coaches and athletes design more effective training strategies, minimise injury risks, and improve overall performance. Furthermore, AI is also beginning to play a role in sports education by providing more personalised and adaptive learning experiences.

Besides that, the incorporation of AI profoundly affects coaching and education. AI-powered platforms can provide instant responses, support personalised training, and create more immersive learning environments. This combination of factors leads to improved training effectiveness, better skill development, and greater student motivation in sports education settings. On the other

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hand, the implementation of AI does pose challenges: financial limitations, reliance on data, the intricacy of technology, and ethical matters related to athlete data privacy and monitoring are some of the issues it is still struggling with.

This study, therefore, aims to systematically review the literature on the application of artificial intelligence in sports training and education. The specific focus of the study is to determine the types of AI innovations employed, elucidate how these techniques are used to enhance athlete performance and coach training methods, and assess their influence on training and learning. In addition, the study aims to identify new challenges and the potential for future research development. We envision that this thorough synthesis will help in better understanding the function of AI in revolutionising sports training and education in the current age.

Even though the advancements in AI implementation have been very impressive, the question of how its benefits and downsides can be understood in real-life settings still puzzles the majority of people. The challenges of data quality, trustworthiness, limited access, high investment, and, most importantly, moral dilemmas hold back the growth of AI usage. Besides that, many papers studied isolated features of AI implementation. But a thorough charting of where research is going is still necessary. This will make sure that the evolution of AI-powered education tools is more efficient, evaluable, and accessible to all.

In line with this, the study aims to provide a more systematic overview of the role of AI in sports training and education. In detail, this study aims to: (1) identify the various types of AI technologies used, (2) examine their application in improving performance and training processes, (3) analyse their impact on coaching, learning, and skill acquisition, (4) evaluate their advantages and limitations, and (5) highlight the direction of future research development.

To answer these objectives, several research questions were formulated as follows:\

RQ1:What types of artificial intelligence technologies are used in sports training and education? RQ2:How is artificial intelligence applied to improve athlete performance and training processes? RQ3:What impact does the use of artificial intelligence have on training, learning, and skill acquisition in sports? RQ4:What are the advantages and limitations of applying artificial intelligence in sports training and education? RQ5:What future research directions can be developed regarding the use of artificial intelligence in this field?.

II. METHODS

A. (Search Strategy

A systematic literature search was conducted to identify relevant studies related to the application of artificial intelligence in sports training and education. The search process focused on the main electronic database, namely Scopus. The search strategy was developed by grouping keywords into three main categories, namely: (1) terms related to artificial intelligence, (2) terms related to sports training and education, and (3) terms related to performance and learning.

To optimise search results, Boolean operators such as AND and OR are used to combine keywords. An example of a search string for a database is: ("artificial intelligence") AND ("sports training") AND ("performance analysis" OR performance OR training OR learning). By this search, only articles written in English and categorised as journal articles would be considered, and they should be published in the 2024-2026 timeframe. The timeline is selected to cover the recent and most advanced developments of artificial intelligence technology and its usage in sports.

B. Inclusion Criteria

Including criteria that focus on the relevance and academic quality of the papers was a primary concern when conducting this review. Several main points were taken into account for study selection. First, regarding the thematic focus, the papers needed to address the deployment of artificial intelligence in training, coaching, or education.Sports. Second, regarding the publication form, only peer-reviewed journal articles were accepted to ensure scientific rigour and credibility. Third, considering the publication date, only papers published between 2024 and 2026 were eligible to account for the most recent advancements in the area. Fourth, the medium of publication was a further point of reference, whereby only papers written in English were selected. In addition, in terms of content focus, selected studies must cover at least one of the following aspects: the use of artificial intelligence technologies (such as machine learning, deep learning, or computer vision), sports performance analysis, training and coaching processes, skill acquisition, or their application in the context of sports education.

C. Exclusion Criteria

The review excluded a study if it met one or more of the following conditions: firstly, the study was non-sports-related, for instance, research on artificial intelligence generally or in health fields that have no link with sports. Secondly, studies that targeted only medical or clinical rehabilitation and didn't include elements of sports training. Thirdly, articles that have not undergone peer review include conference papers, book chapters, editorials, or other non-scientific articles. Fourth, the studies either lacked a clear methodology or were based on insufficient data. Fifth, the articles that appeared as duplicates in more than one database were considered duplicates.

D. Study Selection Process (PRISMA)

This research has followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for selecting the studies. First, 162 articles were found through database searches. After removing duplicates, the number was reduced to 148 articles, which were screened. Further, title and abstract screening were done, and 98 articles were excluded for lack of sufficient relevance to the sports context or the use of artificial intelligence. The remaining 50 articles underwent full-text analysis to assess their eligibility. According to the assessment results, 10 articles were excluded for inadequate relevance or methodological issues. However, 40 articles met all inclusion criteria and were included in this systematic review.

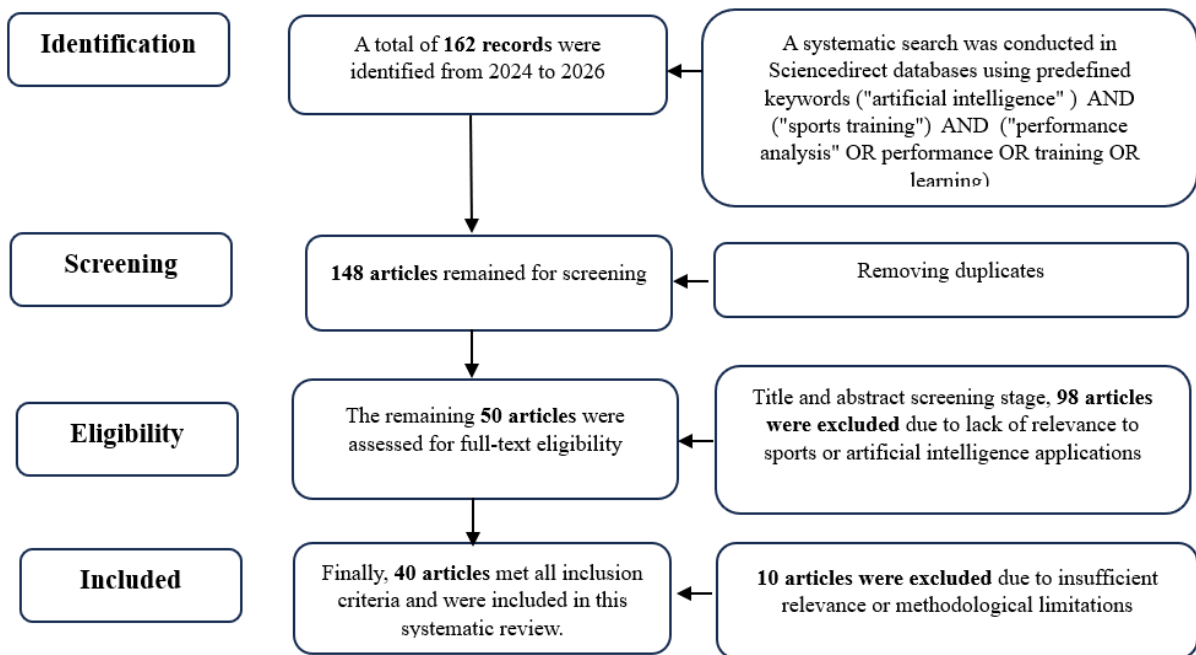


Figure 1. Study Selection Process (PRISMA).

III. RESULT

A screening process following PRISMA guidelines yielded 40 articles that met the criteria and were subsequently analysed in this review. These studies examined the application of technology and artificial intelligence (AI) in sports training and education across diverse contexts and methodological approaches. To facilitate analysis, the findings of each study were systematically grouped according to the type of technology and AI used, the sport studied, the research objectives, and the main results obtained. A summary of the selected studies is presented in Table 1, which then serves as the basis for further discussion to answer the research questions (RQ1–RQ5).

Table 1. A summary of the selected studies based on research question

No	Author (Year)	AI Technologies	Applications	Impacts	Advantages & Limitations	Future Directions
1	Zhang et al. [10]	Sensor + AI	Motion monitoring	Improved performance	High accuracy in detecting movement patterns; however, it requires specialized sensors and a high implementation cost	Development of scalable real-time monitoring systems integrated with wearable devices
2	Li et al. [11]	VR + AI	Training enhancement	Improved learning	Offer an immersive learning experience, though limited by the high cost and technical complexity	Combining virtual reality and AI-based adaptive learning platforms
3	Pan [12]	VR System	Training system	Enhanced learning	Provides interactive training environments; however, difficult to implement in large-	Expansion of interactive and accessible VR-based

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					scale settings	training platforms
4	Ferrier et al. [13]	Visual AI	Skill acquisition	Improved learning	Improves observational learning and technique refinement; limited scalability in real training environments	Development of hybrid models that combine physical and AI-assisted learning.
5	Wang et al. [14]	Wearable AI	Monitoring	Real-time feedback	One of its features is that it makes continuous performance monitoring possible, but it is reliant on how accurately sensors are programmed and on the quality of the data.	Progress of smart wearable systems with enhanced data reliability
6	Chang et al. [15]	VR Simulation	Training simulation	Performance improvement	Supports simulation-based training; requires high computational resources	Development of efficient and cost-effective simulation systems
7	Zhang & Zhong [16]	Kinect AI	Motion recognition	Skill improvement	Accurate gesture recognition is limited by sensor range and environmental conditions	Improvement of gesture-based AI systems for diverse training contexts
8	Emamian et al. [17]	ANN	Performance prediction	Improved accuracy	High predictive capability; reliable on large datasets for accuracy	Development of more robust predictive models with smaller datasets
9	Grzegorz et al.[18]	Deep Learning	Activity recognition	High accuracy	Effective for complex pattern recognition; risk of overfitting and model dependency	Optimization of deep learning models for generalizability
10	Wang & Guo [19]	CNN	Motion tracking	Performance analysis	Delivers accurate tracking; quite computationally intensive	Creation of lightweight and low power tracking systems
11	Li et al. [20]	ML Prediction	Injury prediction	Risk reduction	Allows for early detection of injuries; however, accuracy heavily relies on the quality and consistency of the data.	Introducing predictive models into preventive training systems
12	Kim et al.[21]	Transformer AI	Feedback system	Improved coaching	This improves the accuracy of the feedback; however, the complexity makes it difficult to implement the project to a large extent.	Development of adaptable and easy-to-use feedback systems
13	Chen[22]	AI + Tracking	Training optimization	Better performance	Improves training efficiency; needs a really good infrastructure	Step-by-step personalisation of coaching systems using AI-powered data
14	Wang et al.[23]	Wearable AI	Evaluation	Real-time feedback	Enables real-time evaluation; sensor dependency may compromise reliability	Enhancement of sensor fusion and system reliability
15	Zhang et al. [24]	AI Sensor	Behavior detection	Improved tracking	Quite efficient at motion detection; however, they have limited ability to grasp the context.	Integrated with systems of contextual data analysis
16	Lyu & Huang[25]	CNN	Recognition	High accuracy	Has powerful classification capability; dependent on the quality of model training	Hybrid AI models development for better accuracy
17	Liu & Bai [26]	CNN	Performance analysis	Better insights	Offers thorough insights into performance; extremely reliant	Data processing improvement by using

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					on data.	advanced analytics
18	Du et al. [27]	RNN	Strategy training	Improved decisions	Enables tactical decision-making; complicated implementation	The development of smart tactical training systems
19	Wang & Ren [28]	CNN	Prediction	Accurate results	Accurate predictions at a high level; needs a lot of data	Enhancement of methods for building predictive models
20	Yuan & Zhou [29]	AI Pose	Posture correction	Improved accuracy	Improves posture alignment; restricted by hardware limitations.	Integration with IoT for real-time posture monitoring
21	Wang [30]	AI Planning	Training system	Optimized movement	Optimisation of movement patterns; however, the system's complexity may make it difficult for users to operate.	Making AI planning systems that are easier for people to use
22	Hou et al. [31]	Thermal AI	Monitoring	Better tracking	Allows monitoring of physiological parameters; however, equipment purchase is expensive	Affordable sensing technologies development
23	Tang [32]	Data Fusion AI	Performance training	Improved outcomes	Aggregates various data sources; involves sophisticated data manipulation.	Development of integrated and simplified data systems
24	Sun et al. [33]	Deep Learning	Motion tracking	Accurate analysis	High precision tracking; computationally demanding	Real-time AI processing systems
25	Peng & Zheng [34]	CNN	Detection	High accuracy	Accurate detection of movements; limitations in variability model	Improvement of adaptive detection models
26	Mutawa et al. [35]	AI Video	Prediction	Improved insights	Provides predictive insights; dependent on video quality	Enhancement of video analytics systems
27	Mamen et al. [36]	ML + IoT	Fatigue detection	Early detection	Effective fatigue monitoring; system complexity and cost issues	Integration of AI with IoT-based real-time monitoring systems
28	Brindha et al. [37]	Deep Learning	Recognition	Accurate classification	Strong classification performance; data dependency	Development of robust and scalable models
29	Softić et al. [38]	Wearable AI	Monitoring	Performance improvement	Supports continuous monitoring; cost and accessibility issues	Expansion of wearable AI adoption
30	Yang [39]	AI Sensors	Health monitoring	Better decisions	Improves decision-making; requires high-quality data	Smart health monitoring systems
31	Liu & Liu [22]	AI System	Tactical training	Improved strategy	Enhances tactical planning; complexity limits application	Development of practical tactical AI tools
32	Bai [40]	AI Model	Teaching	Improved learning	Supports teaching effectiveness; limited scope in pedagogy	Development of comprehensive educational AI models
33	Han et al. [41]	AI Pose	Tracking	High precision	Accurate pose estimation; complexity model	Real-time pose estimation systems
34	Zhang et al. [42]	IoT + AI	Teaching	Increased engagement	Enhances engagement; requires infrastructure support	Smart and connected learning environments
35	Li & Guo [43]	AI System	Evaluation	Automated feedback	Enables automated evaluation; system dependency	Intelligent coaching systems
36	Wu et al. [44]	AI Education	Learning behavior	Increased engagement	Improves engagement; adoption challenges remain	AI adoption frameworks in

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						education
37	He et al. [45]	Visual AI	Teaching system	Improved effectiveness	Enhances teaching quality; technological limitations	Interactive and adaptive teaching systems
38	Li [46]	Bi-LSTM	Learning system	Data-driven learning	Supports analytical learning; complex model design	Development of intelligent learning platforms
39	Huang & Wu [47]	CNN	Teaching	Skill improvement	Enhances skill acquisition; dependency model	AI-based pedagogical models
40	Nan et al. [48]	VR + AI	Instruction	Enhanced learning	Provides immersive learning; high cost limits access	Development of affordable VR learning systems

IV. DISCUSSION

A systematic review of 40 selected articles reveals that the application of artificial intelligence (AI) in sports training and education is advancing rapidly and in diverse ways. These studies cover a wide range of sports, including soccer, badminton, tennis, martial arts, and physical education, demonstrating the broad scope of AI applications in modern sports^{20,28,35,48}.

Technologically speaking, our breakdown indicates that the most influential methods in the field are deep learning, convolutional neural networks (CNNs), and machine learning, which are often integrated with wearable devices and virtual reality (VR)-based systems. Such predominance gives a clear sign that present-day scientific inquiries are largely focused on handling intricate visual and motion information^{19,26,42,43}. Furthermore, the use of smart sensors and wearable devices also strengthens AI's ability to provide real-time performance data^{29,39}.

Besides that, the most common uses of AI in sports are performance analysis, motion tracking, injury prediction, and game strategy development. For instance, AI-based systems can precisely analyse athlete movements, spot technical errors, and even foresee injury risks^{21,34,37}. Furthermore, AI is also used in tactical decision-making in sports such as soccer and tennis^{23,28}. This indicates that the primary focus of research remains on the technical and measurable aspects of sports performance.

In terms of impact, employing AI has been shown to improve education, make training more effective, and enhance the quality of feedback in coaching. AI-supported systems help in providing immediate, highly personalised feedback so that sportsmen learn more about their doing in-depth^{22,24}. Regarding sports education, employing AI has been proven to boost participation and enhance learning outcomes by providing a more interactive and adaptive method^{45,48,49}.

But, even with the benefits, there are still some major drawbacks. For one thing, the costs of setting up these systems can be very high. Besides that, because the systems require large amounts of data to work properly, they are dependent on it. The technological complexity is yet another setback, making it quite a challenge for coaches and sports institutions to easily integrate it into their routines. Last but not least, there are also other concerns like the ethics of using these technologies, for instance, data privacy and athlete monitoring, which are certainly very relevant when it comes to AI in sports^{50,51}. This highlights the gap between technological advancements and readiness for real-world implementation.

Nonetheless, despite the positives, these still come with many major cons. That is Firstly, setting up these systems can be extremely expensive. Apart from that, as the Systems rely on huge amounts of data for their functioning, they will be vulnerable to dependence. The technological intricacies are another difficulty, making it quite a task for the coaches and sports institutions to seamlessly integrate it into their operations. Besides these points, there are some other issues like the morality of using such technologies, for example, the privacy of data and the constant surveillance of the athletes, which are undoubtedly very significant when it comes to sports transformation with the aid of AI^{30,37}. Furthermore, interdisciplinary approaches that combine sports science, technology, and education are important directions for future research.

Overall, this research reveals that AI has played an instrumental role in significantly enhancing the capabilities and efficacy of sports training. Nevertheless, there is a great desire for developing a dual track; hence, besides concentrating on the technical matter, one should also consider educational aspects and the contextual practice of the world.

CONCLUSION

This systematic review serves as a detailed guide to the use of AI technology in sports training and education. Different studies suggest that a number of AI technologies, including machine learning, deep learning, computer vision, and wearable-based systems, have been widely implemented to review athletes' performance and support more up-to-date training approaches. The primary emphasis of AI is performance analysis, motion tracking, injury prediction, and tactical decision-making, which enable a more objective, data-driven approach than traditional methods.

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Apart from this, the integration of AI has a deep impact on the training and learning aspect as well. AI-enabled systems can provide instant feedback, assist with customised training, and design more engaging learning environments. All these result in heightened training efficiency, skill attainment, and increased student interest in sports education scenarios. Yet, AI adoption is not without its hurdles; budget constraints, reliance on data, technological complexity, and ethical concerns about athlete data privacy and surveillance are among the issues it is still grappling with.

Looking ahead, research directions highlight the importance of developing more integrated AI systems, particularly through combinations with Internet of Things (IoT) technologies and real-time analytics, as well as enhancing personalised training models. Furthermore, interdisciplinary approaches linking sports science, technology, and education are becoming increasingly relevant. Overall, this study confirms that AI has significant potential to transform sports training and education, while also opening up opportunities for the development of more adaptive, inclusive, and sustainable innovations in the future.

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