

# Application of Artificial Intelligence in the Sports Industry: A Review Article

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## ABSTRACT

Artificial Intelligence (AI) is transforming the sports industry by enhancing athletic performance, improving predictive analytics, managing health, boosting fan engagement, and ensuring accurate officiating. This review provides a comprehensive examination of AI's applications in sports, drawing from a systematic literature search across databases such as PubMed, IEEE Xplore, and Google Scholar. The methodology involved selecting recent, relevant studies that contribute to understanding AI's impact in sports, with data extraction focusing on AI applications, specific sports contexts, observed benefits, challenges, and future opportunities. In enhancing athletic performance, AI analyzes data from sensors, cameras, and wearable devices to identify strengths and weaknesses, optimizing training programs. Examples include AI-driven platforms in football and basketball that track player positions and actions, providing actionable insights for coaches. Predictive analytics, another crucial AI application, involves forecasting game outcomes and evaluating player performance through historical and current data, aiding in strategic decision-making. AI also plays a vital role in health management and injury prevention by analyzing biomechanical and physiological data to predict potential injuries and monitor recovery, ensuring athletes' well-being and prolonging careers. Fan experience is significantly enhanced through personalized recommendations, virtual assistants, and augmented reality experiences, deepening engagement and satisfaction. Officiating benefits from AI technologies like VAR in football, which review and analyze controversial decisions to ensure accuracy and fairness. Despite the promising applications, challenges such as data quality, cost, and ethical concerns, including privacy and bias, remain. Future opportunities lie in developing real-time feedback systems and integrating AI with the Internet of Things (IoT) for comprehensive data collection, further revolutionizing performance analysis and injury prevention. This review highlights AI's transformative potential in sports, emphasizing the need for high-quality data, cost-effective solutions, and ethical considerations to maximize its benefits and address existing challenges.

**Keywords:** Artificial Intelligence, Sports Analytics, Athletic Performance, Predictive Analytics, Fan Engagement.

## 1. Introduction

Artificial Intelligence (AI) is a revolutionary technology that is reshaping numerous industries, and the sports industry is no exception. AI's ability to process and analyze large datasets quickly and accurately has opened new possibilities for enhancing athletic performance, predicting outcomes, managing health, engaging fans, and ensuring fair officiating (Hersh et al., 2020). The integration of AI in sports is not only transforming how athletes train and compete but also how fans experience sports and how officials make critical decisions during games. In recent years, the sports industry has seen an unprecedented influx of data (Lewis, 2004). This data comes from various sources, including sensors embedded in sports equipment, wearable devices monitoring athletes' physiological metrics, high-resolution cameras capturing every moment of a game, and even social media interactions from fans (Li et al., 2016). The sheer volume and complexity of this data present a significant challenge, but also a tremendous opportunity (Zhou et al., 2014). Traditional methods of data analysis are often inadequate for extracting meaningful insights from such vast and varied datasets. This is where AI steps in, offering advanced algorithms and machine learning techniques that can sift through large amounts of data, identify patterns, and provide actionable insights (Ramkumar et al., 2022).

AI-driven analytics are revolutionizing athletic performance by offering personalized training programs that are tailored to an individual athlete's needs. For example, AI can analyze an athlete's movements in real-time, providing instant feedback and suggesting adjustments to improve technique and reduce the risk of injury (Mulgan, 2016). This level of detailed analysis was previously unattainable, giving athletes and coaches a powerful tool to enhance performance (Beal et al., 2019). In sports like basketball and football, AI systems track players' positions and movements, providing insights that help in strategizing and optimizing plays. These systems can also predict an opponent's moves based on historical data, giving teams a competitive edge (Van Eetvelde et al., 2021).

Moreover, AI's predictive capabilities extend beyond the field. Predictive analytics can forecast game outcomes with remarkable accuracy by analyzing historical game data, player statistics, weather conditions, and other relevant factors. This capability is invaluable for coaches and team managers as they develop game strategies and make crucial decisions about player lineups and tactics. Sports bettors also

benefit from AI's predictive power, gaining insights that help them make more informed bets (Ramkumar et al., 2022).

Health management and injury prevention are critical aspects of sports where AI is making significant strides. Athletes' careers can be severely impacted by injuries, and AI offers a proactive approach to managing health. By continuously monitoring athletes through wearable devices, AI systems can detect early signs of fatigue or stress, predicting potential injuries before they occur. This allows for timely interventions, such as adjusting training intensity or providing targeted physiotherapy, thereby reducing the incidence of injuries and ensuring athletes maintain peak performance levels (Wei Wei, 2019).

Fan engagement is another area where AI is having a transformative impact. Modern sports fans expect a personalized and immersive experience, and AI technologies are enabling this by analyzing fan behavior and preferences (Spitz et al., 2021). AI-driven recommendation systems can suggest content tailored to individual interests, such as highlights of favorite players or upcoming matches of interest. Virtual assistants and chatbots enhance fan interaction by providing real-time updates, answering queries, and facilitating ticket purchases (Spitz et al., 2021). Additionally, augmented reality (AR) and virtual reality (VR) experiences, powered by AI, offer fans interactive and immersive ways to enjoy sports, such as virtual stadium tours or live game overlays that provide detailed statistics and replays (Owens et al., 2003).

Officiating in sports has always been subject to human error, but AI is helping to minimize these errors and ensure fair play. Technologies like the Video Assistant Referee (VAR) in football use AI to analyze video footage from multiple angles, assisting referees in making accurate decisions. Similarly, in tennis, the Hawk-Eye system uses AI to track the ball's trajectory, determining whether it is in or out with high precision. These AI systems not only improve the accuracy of officiating but also enhance the overall integrity of the sport (Yan, 2022).

In conclusion, AI is revolutionizing the sports industry by providing advanced tools and technologies that enhance every aspect of sports, from athletic performance and health management to fan engagement and officiating. The integration of AI in sports is creating a more dynamic, engaging, and fair sporting environment, benefiting athletes, coaches, fans, and officials alike (Nalbant & Aydın, 2022; Yan, 2022). As AI technology continues to evolve, its impact on the sports industry is expected to grow, bringing even more innovative solutions and improvements. The future of

sports, intertwined with AI, promises to be more data-driven, precise, and interactive, marking a new era in how sports are played, viewed, and experienced (Koseler & Stephan, 2017).

## 2. Methods and Materials

This review is based on a comprehensive examination of current literature, including peer-reviewed journals, industry reports, and case studies. The following detailed methodology was used to gather, analyze, and synthesize the relevant information:

### 2.1. Literature Search

The first step in our methodology involved conducting a systematic search of several electronic databases. These databases included PubMed, MEDLINE, WOS, SCOPUS, Google Scholar, and other reputable academic and industry platforms. The search strategy employed a range of keywords and phrases such as "Artificial Intelligence in sports," "AI applications in athletics," "machine learning in sports," "sports analytics," and "predictive analytics in sports." Boolean operators (AND, OR) were used to combine these terms effectively, ensuring a comprehensive search of the literature.

### 2.2. Inclusion Criteria

To ensure the relevance and quality of the articles included in this review, specific inclusion criteria were established:

1. **Relevance to Topic:** Articles had to be directly related to the application of AI in the sports industry.
2. **Recency of Publication:** Preference was given to studies published within the last decade (2010-2024) to capture the most recent advancements in AI technology.
3. **Contribution to Understanding:** Only articles that made a significant contribution to understanding the applications, benefits, challenges, and future opportunities of AI in sports were included.
4. **Language:** Only articles published in English were considered to avoid translation errors and ensure clarity.

### 2.3. Exclusion Criteria

Certain exclusion criteria were also set to maintain focus and relevance:

1. **Non-relevant Studies:** Articles not directly related to AI applications in sports were excluded.

2. **Older Publications:** Publications older than ten years were generally excluded unless they were seminal works that provided foundational knowledge essential for the review.

3. **Non-English Articles:** Articles not available in English were excluded to maintain consistency and accuracy in the review.

### 2.4. Data Extraction

Once the relevant articles were identified, key information was extracted systematically from each study. The data extraction process involved:

1. **Type of AI Application:** Identifying the specific AI technologies and methodologies used in the study (e.g., machine learning algorithms, predictive analytics and computer vision).
2. **Specific Sport or Context:** Documenting the sport or context in which the AI application was implemented (e.g., football, basketball, health management).
3. **Benefits Observed:** Summarizing the benefits and improvements reported in the study due to AI implementation.
4. **Challenges Identified:** Noting any challenges, limitations, or barriers to the effective use of AI highlighted in the study.
5. **Future Opportunities:** Recording any future research directions or potential advancements suggested by the authors.

### 2.5. Analysis and Synthesis

The extracted data were then analyzed and synthesized to provide a comprehensive overview of the current state of AI applications in sports. This involved:

1. **Categorization:** Grouping the information into major themes and categories such as performance enhancement, predictive analytics, health management, fan engagement, and officiating.
2. **Thematic Analysis:** Conducting a thematic analysis to identify common patterns, trends, and insights across the different studies.
3. **Critical Evaluation:** Critically evaluating the quality and rigor of the studies, considering factors such as sample size, methodology, and validity of conclusions.
4. **Comparative Analysis:** Comparing and contrasting findings from different studies to highlight areas of consensus and divergence.

## 2.6. Synthesis of Findings

The final step involved synthesizing the findings into a coherent narrative that provides a detailed and up-to-date overview of AI applications in sports. This synthesis aimed to:

1. **Highlight Key Applications:** Emphasize the most impactful and innovative uses of AI in sports.
2. **Identify Benefits and Challenges:** Provide a balanced view of the benefits and challenges associated with AI in sports.
3. **Suggest Future Directions:** Offer insights into potential future developments and areas for further research.

By following this rigorous methodology, the review aims to present a comprehensive, accurate, and insightful analysis of the role of AI in transforming the sports industry. This structured approach ensures that the findings are well-supported by current evidence and provide valuable guidance for researchers, practitioners, and stakeholders in the sports industry.

## 3. Results

This section presents the findings of the comprehensive review on the applications of Artificial Intelligence (AI) in the sports industry. The results are categorized into five main areas: enhancing athletic performance, predictive analytics and game outcome prediction, health management and injury prevention, enhancing fan experience, and officiating and game monitoring.

### 3.1. Enhancing Athletic Performance

AI has revolutionized how athletes train and perform. By leveraging machine learning algorithms and data analytics, AI systems can process vast amounts of data from sensors, cameras, and wearable devices to provide detailed insights into athletes' performance. This capability allows coaches to design personalized training programs tailored to individual athletes' needs.

**Football:** In football, AI platforms track players' movements, positions, and actions in real-time. These platforms analyze data to offer actionable insights that help coaches optimize strategies and improve team coordination. According to Dadi (2020), AI systems have significantly enhanced the ability to track and analyze player performance, leading to more effective training regimens and improved game strategies (Dadi & Yildiz, 2022).

**Basketball:** Similarly, in basketball, AI analyzes shooting techniques, defensive patterns, and player conditioning. This data helps coaches tailor training programs to individual needs and reduce the risk of injuries (Van Eetvelde et al., 2021).

For example, AI can identify subtle inefficiencies in a player's shooting form that might not be noticeable to the naked eye, allowing for targeted improvements.

**Tennis:** AI applications like Hawk-Eye technology provide real-time data on ball trajectories, player movements, and match statistics in tennis. This data helps players refine their techniques and strategize better against opponents (Yan, 2022).

### 3.2. Predictive Analytics and Game Outcome Prediction

AI's predictive capabilities are transforming how teams prepare for games and how fans engage with sports. Predictive analytics involves using historical and current data to forecast future events, such as game outcomes and player performance.

**Predicting Match Outcomes:** AI algorithms analyze past game data, player statistics, weather conditions, and other relevant factors to predict match outcomes. This predictive capability is invaluable for coaches and team managers as they develop game plans and make crucial decisions about player lineups and strategies. According to Davis et al. (2019), AI-driven predictive analytics has become a critical tool for sports teams, providing insights that were previously impossible to obtain.

**Player Performance Analysis:** AI-driven platforms evaluate individual player performance by analyzing metrics like speed, accuracy, and endurance. In baseball, for instance, AI systems can analyze pitcher statistics to predict pitching success and potential fatigue. This information allows coaches to manage player workloads more effectively and make strategic decisions during games (Kellermann, 2024).

### 3.3. Health Management and Injury Prevention

AI plays a crucial role in health management and injury prevention, which are vital for maintaining athlete wellness and prolonging careers. **Injury Prediction:** AI systems analyze biomechanical and physiological data to predict potential injuries. For example, in football, AI can detect patterns in player movements that indicate a high risk of injury. Lee and Kim (2018) highlight how AI systems can analyze data from wearable devices to monitor athletes'

physical conditions continuously, enabling early detection of signs of fatigue or stress.

**Recovery Monitoring:** AI aids in recovery management by tracking rehabilitation progress and providing personalized recovery plans. Wearable devices collect data on heart rate, sleep patterns, and physical activity, which AI algorithms analyze to optimize recovery protocols. Thompson (2022) notes that AI-driven health management systems are becoming indispensable tools for sports teams, ensuring athletes recover fully and return to peak performance levels safely.

### 3.4. *Enhancing Fan Experience*

AI significantly enhances the fan experience by providing personalized interactions and engaging content.

**Personalized Recommendations:** AI-driven recommendation systems analyze fan behavior to offer personalized content, such as tailored highlights, merchandise suggestions, and ticket offers. For example, sports streaming platforms use AI to recommend matches and highlights based on a viewer's history. Davis et al. (2019) discuss how these personalized recommendations enhance fan engagement by providing content that aligns with individual interests.

**Virtual Assistants and Chabot's:** AI-powered chatbots engage with fans by answering queries, providing real-time updates, and facilitating ticket purchases. These virtual assistants enhance fan satisfaction by offering instant support and information (Dadı & Yıldız, 2022).

**Augmented Reality (AR) Experiences:** AI and AR technologies combine to create immersive experiences for fans, such as virtual stadium tours and interactive game overlays. These innovations deepen fan engagement and provide unique viewing experiences (Owens et al., 2003).

### 3.5. *Officiating and Game Monitoring*

AI's integration into officiating and game monitoring ensures accuracy and fairness in sports.

**VAR Systems in Football:** Video Assistant Referee (VAR) systems use AI to review and analyze controversial decisions. By examining multiple camera angles and slow-motion replays, VAR ensures accurate and unbiased officiating (Tien, 2017).

**Real-Time Decision Making:** AI aids referees in making real-time decisions by providing instant feedback on plays. In tennis, the Hawk-Eye system determines whether balls are

in or out, providing precise and fair judgments (Reis et al., 2024).

**Performance Metrics for Officials:** AI also evaluates the performance of officials by analyzing their decision-making patterns and accuracy. This data helps in training and improving the skills of referees and umpires, ensuring a higher standard of officiating (Bodemer, 2023)

In summary, AI's applications in the sports industry are diverse and impactful, enhancing performance, predicting outcomes, managing health, engaging fans, and ensuring fair play. The integration of AI into sports is revolutionizing the industry, offering unprecedented insights and improvements across all aspects of sports.

## 4. **Conclusion**

The application of Artificial Intelligence (AI) in the sports industry is transformative, bringing about significant changes in various aspects such as performance enhancement, predictive analytics, health management, fan engagement, and officiating. While the benefits are evident, the integration of AI also presents several challenges and limitations that need to be addressed to fully harness its potential.

### 4.1. *Enhancing Athletic Performance*

AI's role in enhancing athletic performance is profound, yet it comes with its own set of challenges. The ability of AI to analyze vast datasets from sensors, cameras, and wearable devices allows for the creation of personalized training programs. These programs can identify specific areas where an athlete needs improvement and provide real-time feedback to optimize performance. However, the accuracy and effectiveness of these AI-driven insights heavily depend on the quality and granularity of the data collected. In sports like football and basketball, where player movements and strategies are complex, ensuring the precision of data collection is crucial (Beal et al., 2019).

Moreover, the adoption of AI technologies requires a significant investment in infrastructure and training. Smaller teams or organizations may struggle to afford such advanced technologies, potentially widening the gap between well-funded teams and those with limited resources. Ensuring equitable access to AI technologies is a challenge that needs to be addressed to prevent disparities in competitive advantages.

#### 4.2. Predictive Analytics and Game Outcome Prediction

Predictive analytics powered by AI offers valuable insights that were previously unattainable, enabling teams to make data-driven decisions. The ability to predict game outcomes, player performance, and injury risks can revolutionize game planning and strategy formulation. However, the reliance on historical data and the inherent unpredictability of sports can sometimes limit the accuracy of these predictions (Reis et al., 2024).

One major limitation is the dynamic nature of sports, where numerous unpredictable variables can influence the outcome of a game. While AI can provide probabilities based on historical data, it cannot account for all real-time variables, such as sudden changes in weather, player injuries during a game, or unexpected strategic moves by the opposing team. Therefore, while AI can enhance decision-making, it should be viewed as a tool that complements, rather than replaces, human judgment and expertise.

#### 4.3. Health Management and Injury Prevention

AI's contribution to health management and injury prevention is one of the most promising applications in sports. By continuously monitoring athletes' biomechanical and physiological data, AI systems can predict potential injuries and suggest preventive measures. This proactive approach can significantly reduce the incidence of injuries and extend athletes' careers (Najjar, 2023).

However, the implementation of such AI systems raises concerns about privacy and data security. The continuous collection and analysis of sensitive health data necessitate stringent measures to protect athletes' privacy. Ensuring that data is securely stored and only accessible to authorized personnel is paramount. Additionally, there is the ethical concern of how this data might be used, particularly in professional sports where contracts and careers are heavily influenced by an athlete's health status (Vales-Alonso et al., 2010).

Another challenge is the acceptance and trust in AI-driven health recommendations. Athletes and coaches may be hesitant to rely on AI for health-related decisions, preferring traditional methods and human expertise. Building trust in AI systems through transparent processes and demonstrating their efficacy through successful case studies is essential for wider adoption.

#### 4.4. Enhancing Fan Experience

AI has the potential to revolutionize the fan experience by providing personalized and engaging content. AI-driven recommendation systems, virtual assistants, and augmented reality experiences offer fans a more immersive and interactive way to engage with sports. These technologies can enhance fan loyalty and satisfaction by providing content tailored to individual preferences (Spitz et al., 2021; Tien, 2017).

However, the personalization of fan experiences also raises privacy concerns. Collecting and analyzing fan behavior data requires robust data protection measures to ensure that personal information is not misused. Moreover, there is the risk of creating echo chambers where fans are only exposed to content that aligns with their existing preferences, potentially limiting their exposure to a broader range of content and experiences.

Another consideration is the digital divide. Not all fans have equal access to advanced technologies and high-speed internet, which are often required for enhanced AI-driven experiences. Ensuring that AI technologies are accessible to a wider audience is crucial to prevent excluding a segment of the fan base.

#### 4.5. Officiating and Game Monitoring

AI's role in officiating and game monitoring is pivotal in ensuring fair play and reducing human errors. Technologies like VAR in football and Hawk-Eye in tennis have already demonstrated their value in providing accurate and unbiased decisions. These technologies enhance the credibility of officiating and contribute to the integrity of sports (Reis et al., 2024; Tien, 2017).

Despite these benefits, there are challenges in integrating AI into officiating. One significant issue is the resistance to change from traditional methods. Some purists argue that the human element in officiating adds to the drama and unpredictability of sports. Balancing the use of technology with maintaining the essence of the sport is a delicate task.

Moreover, the implementation of AI in officiating can be costly, and the technology needs to be constantly updated and maintained to ensure accuracy. This again poses a challenge for smaller leagues and less financially robust sports organizations.

#### 4.6. Future Directions

The future of AI in sports holds exciting possibilities. Developing real-time feedback systems that provide instant analysis and recommendations during training can further enhance athlete performance. Integrating AI with the Internet of Things (IoT) can enable continuous data collection and analysis, offering deeper insights into athlete performance and health (Pottala, 2018). Additionally, enhancing fan engagement through more interactive and personalized platforms, combining AI with VR and AR technologies, can offer fans unique and immersive experiences. These advancements will not only enhance fan satisfaction but also create new revenue streams for sports organizations (Vales-Alonso et al., 2010).

In conclusion, while AI is significantly transforming the sports industry, it is essential to address the associated challenges and limitations. Ensuring data quality, affordability, privacy, and ethical use of AI technologies will be crucial in realizing their full potential. As AI technology continues to evolve, its impact on sports is expected to grow, bringing innovative solutions and improvements across all aspects of the industry.

#### Authors' Contributions

K.G. conceptualized the study, designed the research methodology, and supervised the systematic literature review process. L.S., the corresponding author, conducted the comprehensive database search, screened relevant studies, and led the drafting and revising of the manuscript. M.N.F. assisted with data extraction, contributed to the analysis of AI applications in various sports contexts, and supported the synthesis of findings. N.M. provided critical insights into the discussion of observed benefits, challenges, and future opportunities, contributed to the literature review, and helped in refining the manuscript. All authors participated in discussing the findings, critically reviewed the manuscript for important intellectual content, and approved the final version for publication.

#### Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

#### Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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#### Declaration of Interest

The authors report no conflict of interest.

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#### Ethics Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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