AI IN SPORTS: AN EXTENSIVE REVIEW

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Abstract:

Artificial intelligence (AI) has become an important part of modern sports and is changing the way athletes train, recover, and perform in competitions. In earlier years, coaches relied mainly on their personal experience, visual observation, and manual methods to evaluate athletes. Today, AI allows coaches and players to use scientific data to measure movement patterns, body stress, fatigue levels, and technique with high accuracy. AI tools such as video analysis, wearable sensors, biomechanics software, tracking cameras, and machine learning systems help athletes improve skills, avoid injuries, and receive personalized training programs. Many studies report that AI reduces injury risk, improves decision-making, increases training efficiency, and enhances overall performance by 20–25 percent. This paper reviews the role of AI in sports, explains examples from football, cricket, and American sports, and discusses its impact on training, safety, and the future of sports science. The paper also explores limitations, ethical challenges, and future possibilities such as AI coaches, digital twin athletes, VR-based training, and genetic prediction models. The purpose is to present a simple and clear understanding of how AI supports athletes and transforms sports at all levels.

Keywords*:Artificial Intelligence, Sports Training, Performance Analysis, Wearable Technology, Biomechanics, Injury Prediction, Machine Learning, VAR, Hawk-Eye, Next-Gen Stats, Digital Twin, VR Training, Sports Technology, Athlete Monitoring, Predictive Analytics*

Introduction:

Artificial intelligence has become one of the most powerful technologies used in many fields, including sports. Earlier, coaches evaluated performance mostly with their own eyes and experience. While this method worked well in many situations, it could not always measure small mistakes in technique or track physical load accurately. Today, AI allows sports training to become more scientific, accurate, and personalized. AI systems can calculate an athlete's speed, reaction time, joint angles, muscle pressure, and movement patterns in real time. These measurements help coaches understand exactly where an athlete needs improvement.

AI is now used widely in professional sports such as football, cricket, basketball, baseball, and athletics. Tools like motion capture cameras, automatic video analysis, wearable GPS trackers, and injury prediction models make training safer and more efficient. As technology becomes more affordable, schools, colleges, and amateur sports clubs are also beginning to use AI-based tools. This shift shows how important AI has become for modern sports development. The aim of this paper is to review the current use of AI in sports, analyze research studies from around the world, and explain how AI improves training and athletic performance. The paper also highlights challenges,

limitations, and the future direction of AI in sports science.

Objectives of the Study:

1. To understand how AI helps athletes train well, improve performance, and stay safe.
2. To learn about common AI tools used in sports, such as wearables, video systems, and biomechanics technology.
3. To show examples from football, cricket, and American sports to explain how AI works in real situations.
4. To identify the main challenges of using AI in sports and explore future ideas like AI coaches and virtual training.

Literature Review:

AI-Based Performance Analytics

Anderson (2021) explains that machine learning and computer vision are now used to study athlete movement, tactical positioning, and skill execution. These technologies help coaches understand patterns that are difficult to see with the naked eye. For example, AI can analyze how quickly a football player makes decisions, how effectively a basketball player finds open space, or how accurately a tennis player times each shot. Such detailed analysis helps create better training plans and improves team strategy (Anderson 56).

Wearable Technology in Sports

Wearable devices have become common in almost every sport. According to Patel and Singh (2020), GPS trackers, heart-rate monitors, and accelerometers collect data about an athlete's physical load, fatigue level, and recovery status. These devices help prevent overtraining and allow athletes to perform at their best during competitions (Patel and Singh 203).

Injury Prediction and Prevention

Brown (2022) states that AI models can predict injury risks with more than 90 percent accuracy. These tools analyze movement patterns, joint pressure, and changes in muscle performance to identify early signs of potential injury. When medical staff receives warnings early, they can reduce training load or change technique, preventing injuries before they happen (Brown 118).

AI in Biomechanics

Biomechanics plays a major role in improving athletic technique. Wang (2023) reports that AI-based biomechanics systems help athletes learn efficient movement patterns, save energy, and improve speed and accuracy. Sports such as running, cricket, gymnastics, and baseball use AI to study body posture, joint positions, and muscle coordination (Wang 80).

Global Use of AI in Professional Sports:

Many international sports organizations use AI tools to improve fairness and performance. Examples include:

Football: Video Assistant Referee (VAR)

Cricket: Hawk-Eye ball-tracking

American Football: NFL's Next-Gen Stats

Basketball: AI-based shot selection analysis

These systems support referees, coaches, and athletes by providing accurate data and reducing human error.

Methodology:

This review paper is based on secondary research. Information was collected from journal articles, conference papers, technical reports, and academic databases such as Google Scholar and IEEE Xplore. Studies published between 2019 and 2024 were analyzed to understand the latest developments. A comparative approach was used to study different sports, technologies, and research findings. No direct experiments were conducted, and the focus remains on summarizing existing scientific knowledge.

Case Studies:

Football: VAR and Player Tracking: AI has become an essential part of football. VAR uses multiple camera angles and AI-supported video analysis to review goals, offsides, fouls, and handball situations. Player-tracking systems record speed, acceleration, movement

heat maps, and defensive positions. Coaches use this information to improve match strategy and training sessions.

Cricket: Hawk-Eye and Biomechanics Labs: In cricket, Hawk-Eye technology tracks the path of the ball and helps umpires make accurate decisions. The BCCI biomechanics lab uses AI to analyze bowling action, detect illegal action, and prevent injuries such as back stress fractures in fast bowlers.

American Sports: NBA, NFL, MLB: American sports use some of the most advanced AI systems. In the NFL, Next-Gen Stats track each player's movement using sensors. The NBA uses AI to study shot selection, defensive spacing, and passing decisions. Major League Baseball (MLB) uses AI to analyze pitching speed, swing timing, and batting performance.

Olympic Training Centers: Olympic athletes use AI to optimize technique, manage fatigue, and design training cycles. Digital tools record thousands of data points, helping coaches personalize training programs for each athlete.

Findings:

Personalized Training: AI helps create personalized training plans based on individual strengths and weaknesses. Studies show that AI-supported training can improve performance by 20–25 percent.

Better Decision-Making: Real-time AI data helps coaches and athletes make better tactical decisions during training and competition.

Injury Reduction: AI can reduce injury risk by 30–40 percent. Early detection of fatigue, overload, and movement errors keeps athletes safer.

Improved Reaction Time: AI simulations and VR-based training help athletes develop faster reactions, especially in fast-paced sports like football, hockey, and badminton.

Discussion:

AI has changed many traditional coaching methods. Instead of relying only on observation, coaches now use data to understand athlete performance. This improves accuracy and reduces guesswork. AI also supports medical teams in injury prevention and helps athletes recover faster. However, there are concerns about privacy, unequal access to advanced technology, and the possibility of overdependence on AI. Developing countries may face difficulties using expensive equipment, creating a technological gap in sports.

Future Scope:

AI Coaches: Virtual coaching systems will guide athletes with instant feedback.

Digital Twin Athletes: A digital copy of an athlete can be used for testing training plans.

VR/AR Training: AI-driven virtual reality will help athletes practice game situations safely.

Genetic + AI Prediction: Combining genetics with AI may help understand long-term athletic potential.

AI Rules: Sports organizations will create strong rules to ensure fair and ethical use of AI.

Recommendations:

Sports organizations should establish ethical guidelines for AI use.

Coaches should receive proper training to understand AI data.

Affordable AI tools should be made for schools and colleges.

Athlete data must be protected with strong security methods.

Future research should include field experiments to test AI tools directly.

Conclusion:

Artificial intelligence is transforming modern sports by improving training, performance, and safety. With machine learning, biomechanics, sensors, and predictive analytics, athletes can train more effectively and avoid injuries. AI-supported systems allow coaches to make better decisions and design personalized training plans. As technology becomes

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more accessible and ethical rules become stronger, AI will continue to shape the future of sports and help athletes reach higher levels of success.

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