Artificial Intelligence Tools in Evaluating Physical Fitness and Sports Performance:A Secondary Data Analysis

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How to Cite this Article:

RAVINDER, D. A. (2026). Artificial Intelligence Tools in Evaluating Physical Fitness and Sports Performance:A Secondary Data Analysis. International Journal of Creative and Open Research in Engineering and Management, 02(03). https://doi.org/10.55041/ijcope.v2i3.118

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Abstract

Artificial Intelligence (AI) has become one of the revolutionary technologies in the science of sports, especially when it comes to assessing the physical fitness and the performance of sports. This research is an analysis of how AI-based tools can be used to evaluate the performance of athletes based on the secondary data analysis of the available published literature of the years 2015 through 2025. The study brings together the results of peer-reviewed journals, conference papers, and reports in the fields of machine learning, computer vision, wearable sensor analytics, and predictive modeling in sports. The analysis has shown that AI technologies contribute with the high accuracy and efficiency of the performance evaluation by providing the opportunity to monitor the functioning in real time, conduct a biomechanical examination of the functioning, predict an injury, and construct individual trainers. The use of AI in the form of wearable fitness departments, motion tracking technology, and smart fitness applications can supply the information that can then be used by coaches, sports scientists, and athletes to facilitate the optimization of training plans. With these advantages, there are still several issues including high implementation costs, privacy, technical expertise and limited accessibility to developing regions which act as a major setback. The research reaches the conclusion that AI could help revolutionize the sports performance evaluation promoting objective and data-informed decision-making in training and athlete management. To create cost-effective AI systems and enhance the ethical framework should become the aim of the future research in order to implement AI in sports science and physical education fairly.

Keywords: Artificial Intelligence, Sports Performance Analysis, Physical Fitness Evaluation, Machine Learning in Sports, Sports Analytics

Introduction

Machine learning algorithms, deep learning models and neural networks that mimic the human cognitive process are considered artificial intelligence and are tools to process complex patterns of data to optimize performance, predict analytical tasks and customize interventions in sports science to optimize movements and speed up recovery (Mateus et al., 2024; Reis et al., 2024; Zhou et al., 2025)

Physical fitness assessment and sports performance analysis are key factors in the development of athletes, performance, and prevention of injuries since traditional testing approaches tend to be ineffective in multidimensional athletic dynamics and fatigue (Mateus et al., 2024; Reis et al., 2024) identification.

This is because the development of AI technologies in sports analytics and athlete monitoring has been growing rapidly due to the inventions of wearable sensors, computer vision, and the combination of big data, which are shifting subjective coaching to objective, real-time information (Mateus et al., 2024; Subramaniam et al., 2023, p. 1; Xu and Baghaei, 2025). According to recent reviews, the latest developments include the massive uptake of AI technologies in load management, technique feedback, and predictive modeling, especially in team

The use of data-driven decision making is a requirement in sports training and performance, where AI processes a large amount of data to optimise programs, foresee outcomes and reduce risks, which outperforms traditional heuristics (Reis et al., 2024, 2024, p. 1; Xu & Baghaei, 2025).

This paper utilizes the secondary data analysis technique to conduct a synthesis of existing research on the topic of AI tools to perform fitness evaluation and performance, which fills gaps in methodological evidence and can offer solid meta-insights without collecting primary data, which has been done in the preceding systematic reviews (Baladaniya and Choudhary, 2025; Reis et al., 2024) This research hypothesis fits this category of treatment, as it aims to provide an overview of the existing data on the use of AI tools to measure fitness and performance and provide conclusions about the opportunities and threats.

Methodology

The proposed research will use a secondary data analysis method as it will rely on a thorough review of the literature to investigate the application of artificial intelligences instruments in assessing physical fitness and sports performance. Scholarly sources like Google Scholar, Scopus, Web of science, and peer-reviewed academic journals, as well as publication of sports science organizations or AI research institutions, were selected as the relevant sources of information. The use of literature was supported by certain standards such as the publication that is dedicated to artificial intelligence usage in sports performance, physical fitness evaluation, and sport analytics as well as the studies that were published during the period of 20152025 to ensure that the topics of interest are covered with the latest developments in the technological sphere. Peer-reviewed journal articles and conference papers and well-known research reports were given priority to ensure academic reliability. Content analysis and thematic analysis techniques were applied in order to analyze the literature obtained, which allowed identifying the key themes, trends, applications, advantages, and problems associated with the utilization of AI tools to assess physical fitness and sport performance.

Conceptual Framework

Definition of Artificial Intelligence in Sports

Artificial Intelligence in sports means the use of machine learning algorithms, deep learning models, neural networks and other computational methods to process raw data of sports activities such as sensors, videos and other performance data to produce insights to make decisions that are actionable and changes sports science, as it is no longer based on subjective

problems but are data-driven(Subramaniam et al., 2023, p. 1; Xu & Baghaei, 2025) this is called an AI application to sports.

Types of AI Technologies Used in Sports

Machine Learning

Machine Learning, a subfield of AI, is the use of algorithms that learn through data to recognize patterns, predict outcomes, and train programs based on the individual characteristics of a person such as neural network-based athlete scouting and recruitment (2024, p. 1).

Computer Vision

Computer Vision uses AI to perceive visual images captured by cameras and videos, which are used to measure athlete movement, biomechanics, and other techniques in real-time(Bodemer, 2023, p. 1; Zhou et al., 2025). It is used to estimate poses and identify fatigue, as well as provide real-time feedback on sporting activities or contests(Mateus et al., 2024; Subramaniam et al., 2023, p. 1).

Wearable Sensor Analytics

Wearable Sensor Analytics is AI-based technology that monitors physiological scale, exercise loads, and health modification in real-time and uses them to generate individualized responses, measure injury risk, and optimise recovery to improve athlete health and performance management(Mateus et al., 2024; Zhou et al., 2025).

Predictive Analytics

Predictive Analytics is an AI application that predicts the future events with historical data, including likelihood of injury, match results, or deterioration of performance (Reis et al., 2024, 2024, p.). 1) The field of sports science can apply proactive approaches, such as load management and rehabilitation planning, which will be more effective (statistical modelling and the addition of big data) than the previous methods used (Baladaniya & Choudhary, 2025; Bodemer, 2023, p. 1).

AI Tools Used in Evaluating Physical Fitness

AI technologies are also relevant to the physical fitness evaluation, because, using more advanced technologies, it becomes possible to capture, analyze, and interpret biometric and movement data and optimize training and performance of athletes (Baladaniya et al., 2025; Reis et al., 2024; Zhou et al., 2025).

Wearable Fitness Trackers

Fitness trackers, including smartwatches and fitness bands, build on AI algorithms to constantly track physiological measurements on athletes during training and competition based on the data obtained using embedded sensors (Bodemer, 2023, p. 1).

AI-based Motion Tracking Systems

Motion tracking systems based on AI include computer vision and machine learning to analyze the movements of athletes and provide real-time feedback to help fix their form and avoid unproductive patterns(Bodemer, 2023, p. 1; Subramaniam

et al., 2023, p. 1; Zhou et al., 2025) A motion tracking system is used to track pose estimation, gait analysis, and technique refinement to give corrective feedback and prevent unproductive patterns, as well as analyze and interpret the movement of athletes using cameras or video feed.

Biomechanical Analysis Tools

The biomechanical analysis tools use AI to assess the mechanical nature of human movement such as joint angles, the force distribution and muscle activation pattern (Bodemer, 2023, p. 1; Subramaniam et al., 2023, p. 1, 2024, p.). 1) These tools also detect imbalances or inefficiencies that may cause harm or non-optimal work by working off of the data collected by motion cameras(Reis et al., 2024).

Smart Fitness Assessment Applications

Smart fitness assessment apps use AI with mobile and cloud computing to provide comprehensive data on the fitness levels, progress tracking, and recommending reports based on merged data on wearables and cameras (Mateus et al., 2024; Zhou et al., 2025).

Key Monitoring Parameters

AI tools in physical fitness evaluation primarily focus on monitoring critical parameters, including:

- **Heart rate**: Real-time tracking for cardiovascular fitness and exertion levels.
- **Speed**: Analysis of sprint and agility metrics for velocity profiling.
- **Endurance**: Assessment of sustained performance through fatigue modeling.

AI Applications in Sports Performance Evaluation

Applications in sports performance evaluation are based on AI to analyze immense data on athletes and provide strategies to achieve high results based on strategy, performance, and predictive measures in different directions beyond reactivity (Bodemer, 2023, p. 1; Mateus et al., 2024; Zhou et al., 2025).

Performance Analytics in Team Sports and Individual Sports

In the former case, team sports, AI is used to analyze the collective dynamics, player interactions, and efficiency in the tactics and apply it to the scouting and recruitment process and individual sports, like a neural network accurately analyzing the moves of players and predicting outcomes in such cases (Reis et al., 2024, 2024, p. 1).

Injury Prediction and Prevention

Injury prediction: AI has shown better results in modeling risk factors of past occurrences, physiological indicators, and training loads, tooling over traditional approaches to predicting the likelihood of injuries or fatigue-related problems.

Human Injury prediction: AI has been found to be superior in predicting risk factors of past events, physiological signals, and training load, which can be used to prevent injuries or other fatigue-related problems.

Training Optimization and Coaching Support

The use of AI in training optimization uses individual feedback to improve personalized training, adjusting to individual feedback through machine learning algorithms that monitor progress and fatigue (Bodemer, 2023, p. 1, 2024, p. 1). Coaching aids evaluate the results and offer coaches practical advice such as technique, load management, and recovery, how the sensor and simulation respond to data, requests, and events to facilitate effective individualized training (Baladaniya et al., 2023, p. 1).

Game Strategy Analysis

Game strategy analysis: AI processes match data, player trends, and played history and provides the optimal play suggestions by using deep learning models(Subramaniam et al., 2023, p. 1, 2024, p.). The first is used in predictive simulations to analyze formation, substitution, and decision scenarios to increase competitive advantages in a team setting (Mateus et al., 2024; Xu and Baghaei, 2025).

Real-Time Athlete Performance Monitoring

Monitoring is a form of real-time software that uses computer vision to capture and analyse live data in the form of exertion, adjustments in technique, and performance deceleration during activities providing instant feedback and facilitating on-the-fly coaching and safety measures (Bodemer, 2023, p. 1; Mateus et al., 2024).

Advantages of AI in Sports Performance Evaluation

The application of AI in sport performance analysis provides radically beneficial effects on accuracy, efficiency, and safety of athletes both in training and competition (Bodemer, 2023, p. 1; Mateus et al., 2024; Zhou et al., 2025).

Fitness assessment: Basing their suggestions on precise and data-driven formats of evaluating athletes, AI-specific devices like wearables or biomechanical analyzers can use biometric and movement data to make accurate measurements of their abilities and track their progress (Baladaniya and Choudhary, 2025; Bodemer, 2023, p. 1; Mateus et al., 2024; Zhou et al., 2025).

Real-time control over athletes: round-the-clock tracking of an athlete by sensors and computer vision can display immediate indicators of heartbeat, speed, endurance, and form, which can be adjusted and interventive actions are implemented in real-time (Bodemer, 2023, p. 1; Mateus et al., 2024; Subramaniam et al., 2023, p. 1)

More efficient training: The use of machine learning programs optimize programs based on the analysis of responses, fatigue, and performance metrics and provide individual feedback and the distribution of resources based on maximum benefit (Baladaniya & Choudhary, 2025; Bodemer, 2023, p. 1; Xu and Baghaei, 2025).

injury prevention and rehabilitation: Predictive models will be able to identify the risk of training loads and biomechanics, and AI will be used to be implemented with data-driven training interventions that are applied individually, which will reduce downtime and encourage longevity (Baladaniya and Choudhary, 2025; Reis et al., 2024; Xu and Baghaei, 2025; Zhou et al., 2025) 50.

Challenges and Limitations

However, even though AI has the potential to revolutionize sport performance assessment, there are various obstacles and constraints that prevent its large-scale use (Bodemer, 2023, p. 1; Reis et al., 2024; Zhou et al., 2025).

High cost of AI technologies: Even advanced AI systems, such as wearables, sensors, and computational infrastructure, cost a lot of money, which restricts them to frequently well-equipped teams and organizations (Subramaniam et al., 2023, p. 1; Xu and Baghaei, 2025).

Data privacy and ethical issues: The vast amount of biometric and performance data brings up privacy issues, data security problems, and ethical considerations in monitoring and decision making procedures of the athletes(Bodemer, 2023, p. 1; Zhou et al., 2025)

Technological expertise is required: The use of AI tools and their interpretation is a task under the obligations of specialized skills in the field of machine learning, analysis of data, and integration of software, which many coaches and sports specialists lack (Reis et al., 2024; Subramaniam et al., 2023, p. 1).

Regional accessibility: The inequality of the infrastructure, lack of economics and technological opportunities block the implementation of AI in developing regions, which contribute to the already existing global inequality in sports performance enhancement (Xu and Baghaei, 2025; Zhou et al., 2025).

Discussion

Interpretation of Findings from the Reviewed Literature

The literature analysis demonstrates that AI has become a central component of the sports performance evaluation system and can be improved, primarily because of multimodal data criteria which it generates with greater accuracy compared to the traditional methods (feedback on performance, injury prevention, and training optimization, game strategy, and real-time monitoring, etc.), but ethical integration and reduced deployment in developing areas remain essential issues (Bodemer, 2023, p. 1; Subramaniam et al., 2023, p. 1).

Comparison of Different AI Tools and Their Effectiveness

AI tools are important in assessing physical fitness and sports performance and technologies like machine learning, deep learning, computer vision, and neural networks have shown various strengths in various fields of sports. Injury prediction, personalized training and performance benchmarking form some of the common uses of machine learning. Experiments show that the machine learning models are better at risk modelling and adaptive training compared to traditional statistical ones, which allows predicting the results in the field of athletics more accurately (Baladaniya and Choudhary, 2025; Reis et al., 2024; Xu and Baghaei, 2025). On the same note, deep learning is especially effective at understanding game tactics, the patterns of opponents. Deep learning systems predict a game offering the best guidelines and complement human speculation in a competitive sport, such as tactical decision-making (Subramaniam et al., 2023, p. 1; Subramaniam et al., 2024, p. 1).

Even in computer vision technologies, on the contrary, this technology is mainly used in real-time performance measurement and biomechanical analysis of movement. The systems can give real-time focus on the posture, speed, and movement patterns, which allows athletes and coaches to adjust the training or competition on the spot (Bodemer, 2023, p. 1; Mateus et al., 2024). It is also necessary to consider neural networks which are used in sports analytics both to aid in talent discovery and to consider team dynamics as a whole, which facilitates more effective scouting and recruitment of athletes using data (Reis et al., 2024, p. 1; Xu & Baghaei, 2025). Generally, machine learning and deep learning are widely versatile and possess high predictive accuracy especially in dynamic team sports and computer vision is best when analyzing individualized and real-time performance. Multiple AIs are frequently improved in performance when combined, and such aspects as the quality of data, computational requirements, and the complexity of systems are still valuable factors in real life (Zhou et al., 2025).

Implications for Sports Scientists, Coaches, and Athletes

To the sports scientists, AI technologies will provide an unprecedent level of analytical rigor and allow them to conduct serious research on the well-being of athletes and their performance optimization, but will require retraining in the field of ML interpretation (Mateus et al., 2024; Subramaniam et al., 2023, p.). 1) The implications will enable coaches to have actionable, real-time insights on strategy and load management, leading to efficient and tailored coaching that adjusts the training gaps and avoids disparities in sport excellence(Baladaniya, coach; Choudhary, coach). 2) The results of the strategy and load management will allow instructors to promote the development of sports in a cordial and safeguarding way that will not lead to disparities, but rather be applied in the sport excellence democratization (Reis et al., 2024; Zhou et al., 2

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Implications for Sports Education and Training

Integration of AI Technologies in Sports Training Programs

The use of Artificial Intelligence technologies in training plans in sports provides a range of opportunities to improve the quality and effectiveness of training of athletes. The existing AI-fuelled systems can be represented by wearable devices, motion-sensing technologies, and smart fitness apps that can track the physiological and biomechanical measurements of athletes in real time. These gadgets also give coaches and trainers real-time feedback of the indicators of performance like heart rate, stamina, speed, and efficiency of movement. Consequently, the training programs can be planned to be more personalized and adaptive, so that every athlete will obtain training instructions that will be focused on his/her abilities and performance patterns. By implementing AI-based training technologies in sports education institutions, evidence-based coaching practice can be supported, scientific athlete development practices can be encouraged, and other students studying physical education and sports science courses can learn more effectively.

Role of AI in Sports Science Research and Athlete Development

Artificial Intelligence can also be a key point in developing sports science and improving an athlete. The AI algorithms help researchers process high amounts of performance data, patterns, and insightful prediction information, which has been hard to retrieve traditionally through the analytical approaches used. This functionality enables the sports scientists to explore the risk factors with regard to injury, training load optimization, and performance trend better. In the case of athletes, AI-based engines can give individual training intensity, recovery and injury prevention suggestions. With the help of such technologies, an athlete is in perfect physical shape with the minimum risk of overtraining and muscle fatigue. Thus, AI incorporation in sports research and development of athletes, in its turn, adds to making better-informed decisions, enhancing athletic performance, and making the career sustainable.

Conclusion

The paper has explored the application of Artificial Intelligence tools within analyzing physical fitness and sports performance by conducting a secondary analysis of the literature sources. The results have shown that machine learning, computer vision, wearable sensor analytics, and predictive modeling AI technologies have all enhanced the accuracy and efficiency of sports performance evaluation to a considerable degree. The technologies permit the real-time control over the sportsmen and the individual training, as well as the personal approach to training and preventing the injuries, thus the conventional methods of sports training and athletes management are also transformed. Although these strengths exist, issues like high costs of implementation, issues over data privacy, need to have technical know-how and availability of

advanced technologies, are obstacles to the common use despite these advantages. This will be necessary to overcome these limitations to enhance the supply of AI to sports science. In general, the research points to the increased role of AI-based analytics in the contemporary sports setting and the necessity to conduct further studies to make AI products more convenient, ethically, and effective and utilize them in future to facilitate athlete performance and sports education.

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