THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN SPORTS INJURY PREDICTION. A SYSTEMATIC REVIEW

Yordan Popov
Rakovski National Defence College, Sofia, Bulgaria

ABSTRACT
The incidence of sports injuries underscores the need for innovative prediction strategies to enhance athletes' safety during their training, competitions, or performances. This systematic review examines the application of artificial intelligence (AI) in predicting sports injuries, highlighting its transformative potential in injury prediction across diverse athletic populations. This systematic review aims to summarize and analyze the existing literature, evaluating a diverse array of AI methodologies as they are implemented in different sports disciplines. This review synthesizes findings regarding the effectiveness of AI models in predicting sports injuries only. The databases researched included PubMed, EBSCO, Cochrane Library, EMBASE, HMIC, Web of Science, and Google Scholar. Additional research was also done in the SCOPUS databases. The PRISMA guidelines were followed to guide the conduct of this review. The total number of sources studied were 1385. Through the PRISMA model, the total number of sources studied was reduced to 148. Implementing the set inclusion and exclusion criteria again, the reviews considered relevant were rechecked and reduced to a total of 9, considering the final conclusions and the authors' aimed goals regarding only the prediction of sport injuries. The data analyzed indicates that, while AI demonstrates considerable promise in improving injury prediction accuracy, ongoing research is essential to collect more data regarding the standardization of the methodologies. It has been established that AI applications in the prevention of injuries in various fields reveal a convincing landscape of methodologies, results, and implications. The application of AI in sports injury predictions shows positive results according to sources that have been examined.

ORCID
Yordan Popov
https://orcid.org/0009-0007-7920-5197
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INTRODUCTION

The introduction of Artificial Intelligence (AI) technologies in the domain of sports injury prediction represents a transformative development that underlines the intersection of advanced computer techniques and sports medicine. With the growing volume of data generated from various sports activities, including player biometry, training regimes, and performance metrics, AI methodologies have emerged as fundamental tools for analyzing complex datasets to forecast potential injuries among athletes. This review of the literature aims to synthesize the existing research on the effectiveness of AI in predicting sports injuries, highlighting the methodologies used, key findings, and the implications for athletes and sports professionals in improving injury prediction strategies (Musat et al., 2024; Elkhamisy, 2025).

The importance of using AI in this context cannot be exaggerated. Traditional approaches to predicting injury are often based on observation, evaluation, and data from historical injuries, which can overlook nuanced patterns and interdependencies that AI algorithms can effectively capture. For example, automatic learning algorithms, including decision trees and neural networks, have proven expertise in processing large-scale datasets to identify risk factors associated with injuries (Schwellnus et al., 2023). By integrating automatic learning techniques, researchers can not only predict occurrences of injuries but can also elucidate the roads through which several predictors, such as load management, biomechanical factors, and physiological indicators, trust the risk of injuries or even new levels of improving sport tools and producing new engineering models and solutions (Beck et al., 2023).

Specifically, research suggests that AI technologies can substantially enhance the accuracy of injury predictions. In a study by Rossi et al. (2024), a predictive model utilizing deep learning achieved an impressive precision rate of 88% in the LCA injury forecast for university athletes. Such advances highlight the potential of AI not only to reactively address injuries but also to proactively mitigate the risk through training and custom recovery protocols. The deployment of AI tools enables coaches and sports professionals to make informed decisions based on data, optimizing an athlete's training load and recovery periods while minimizing the risk of injury.

One of the main contributions of Munoz-Macho et al. (2024) is the identification of specific machine learning techniques, such as support vector machines and neural networks, which have demonstrated superior performance in predicting injuries compared to conventional statistical methods. The authors report a statistically significant increase in prediction precision, with automatic learning models achieving a precision rate of more than 85% across various datasets, including player data, load measures, historical injury files, and biomechanical data. This improvement in efficiency can be primarily attributed to the AI's ability to analyze complex and non-linear relationships within large datasets, thereby discovering models that may not be immediately apparent through conventional methodologies.

In terms of applicability, virtual realities can be applied in many fields of activity. For the purpose of this article, the primary focus of the research will be to explore the possibilities that AI offers for predicting sports injuries. Based on this, the objective is formulated. This study aims to analyze the available and accessible literature that has examined the application of AI and summarize the possibilities of application in the field of sports injury prediction.

In addition, Kuleva (2023) acknowledges that the importance of technology for physical activity still faces some limitations and obstacles. It can be stated that new technologies provide a personalized and adaptive experience.

METHODOLOGY

The presented study is a systematic review of the available literature that aims to examine the maximum amount of research publications related to the applicability of AI in sports injury prediction. To fulfill the set objective, access to a vast number of databases containing scientific information was utilized. These include PubMed, EBSCO, Cochrane Library, EMBASE, HMIC, Web of Science, and Google Scholar. Additional research was also done in the SCOPUS databases. The search principle for articles used the following keywords: ''AI sport injuries" AND ''prediction"; ''AI" AND ''sport injuries prevention"; ''AI" AND ''sport injuries"; ''AI" AND ''injuries prediction". As the topic is not relatively new, a limitation for articles was set for the period from January 1, 2024, to March 31, 2025.

Inclusion Criteria:

Primary research studies (e.g., cohort studies, validation studies) that develop or validate an AI/ML model for predicting sports injuries.

The study population must consist of athletes.

The outcome must be the prediction or incidence of a sports-related injury.

Articles published in English.

Exclusion Criteria:

Studies not focused on injury prediction (e.g., focused on diagnosis or treatment).

Studies that do not use an AI or ML model.

Editorials, conference abstracts, and letters to the editor.

Studies for which the full text is not available.

RESULTS

The initial search across the specified databases identified 1,385 records. No additional records were identified through other sources. After removing 362 duplicates, 1,023 unique records remained for the screening process.

During the title and abstract screening, 875 records were excluded as they did not meet the review's inclusion criteria. This resulted in 148 full-text articles that were assessed for eligibility. Following a detailed review of the full texts, a further 139 articles were excluded because they were not relevant to the research question and objectives of this review.

Ultimately, a total of 9 studies met all inclusion criteria and were included in the final qualitative synthesis. The complete study selection process, conducted in accordance with PRISMA guidelines (Page et al., 2021), is illustrated in the flow diagram (Figure 1). The key characteristics and results of the 9 included studies are presented in Table 1.

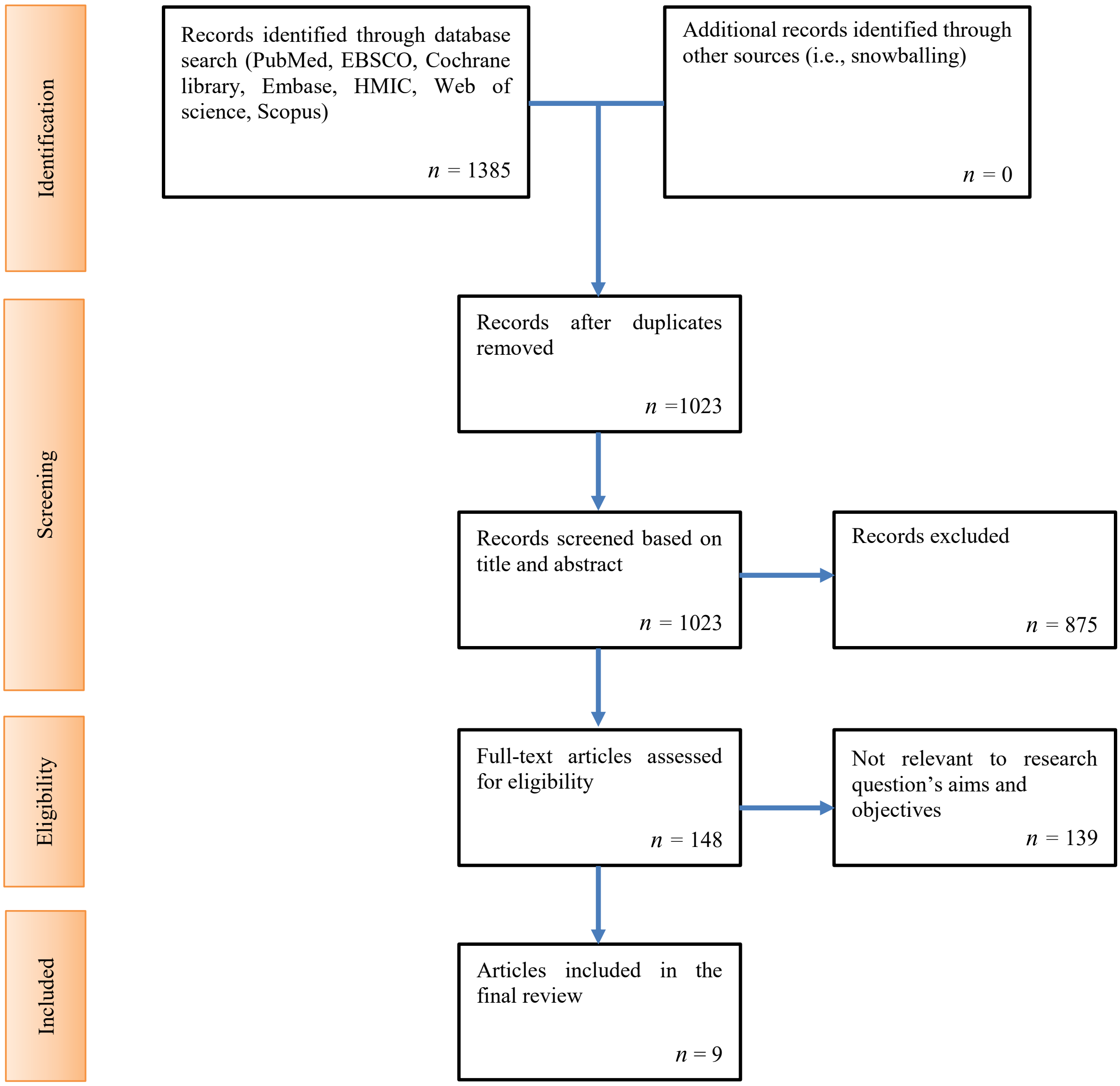

Figure 1. *PRISMA Flow diagram of identified studies via databases*

Table 1. *Characteristics of the identified studies*

N	Paper Reference	Year	Purpose	Aim	General effect reported
1	Desai, V. (2024, April). The Future of Artificial Intelligence in Sports Medicine and Return-to-Play. In Seminars in Musculoskeletal Radiology (Vol. 28, No. 02, pp. 203–212). Thieme Medical Publishers, Inc.	2024	Compare the effects of AI applications versus current techniques in preventing sports injuries.	Aiding in injury assessment, optimizing recovery plans, monitoring rehabilitation progress, and predicting return to play.	Positive
2	Zou, R. (2025). Exploring the Role of Artificial Intelligence in Sports Injury Prevention and Rehabilitation. Scalable Computing. Practice and Experience, 26(1), pp.316–325.	2024	The potential applications of AI in sports medicine include diagnostic imaging, exercise prescription, medical supervision, surgical treatment, sports nutrition, and scientific research.	Aiding, predicting, and preventing sports injuries.	Positive

3	Tsilimigkras, T., Kakkos, I., Matsopoulos, G.K., and Bogdanis, G.C. (2024). Enhancing Sports Injury Risk Assessment in Soccer Through Machine Learning and Training Load Analysis. Journal of Sports Science & Medicine, 23(3), p.537.	2024	This study employed machine learning algorithms to evaluate the risk of non-contact injuries in professional male soccer players, focusing on physiological and mechanical load variables.	Risk detection using a limited number of training load variables via machine learning algorithms.	Positive
4	Martins, F., Przednowek, K., Santos, F., França, C., Martinho, D., Gouveia, É.R., Marques, A. and Sarmento, H., (2024). Predictive models of injury risk in male professional football players: a systematic review. Injury Prevention.	2024	The assessment predictors, especially the area under the receiver operating characteristic Curve, showed significant variation, indicating the efficacy of the prediction models.	This research aims to assess predictive models of injury risk in male professional football players.	More research is required.
5	Pillitteri, G., Petrigna, L., Ficarra, S., Giustino, V., Thomas, E., Rossi, A., Clemente, F.M., Paoli, A., Petrucci, M., Bellafiore, M. and Palma, A. (2024). Relationship between external and internal load indicators and injury using machine learning in professional soccer: a systematic review and meta-analysis. Research in sports medicine, 32(6), pp.902–938.	2024	This study investigated the relationship between internal load (IL) and external load (EL) and their association with injury risk (IR) prediction, utilizing machine learning (ML) approaches.	Compare the relationship between external and internal load indicators and injury in professional soccer using machine learning. Systematic review	Positive
6	Mishra, N., Habal, B.G.M., Garcia, P.S., & Garcia, M.B. (2024, June). Harnessing an AI-Driven Analytics Model to Optimize Training and Treatment in Physical Education for Sports Injury Prevention. In Proceedings of the 2024 8th International Conference on Education and Multimedia Technology (pp. 309–315).	2024	Analyzing athletes' performance and health data across various sports disciplines by employing advanced machine learning techniques to identify patterns related to training regimes, treatment strategies, and the consequent risk and severity of injuries.	AI-driven analysis in advancing sports medicine, navigation of injury prevention, and prediction	Positive
7	Huang, Z., Wang, W., Jia, Z. & Wang, Z. (2024). Exploring the Integration of Artificial Intelligence in Sports Coaching: Enhancing Training Efficiency, Injury Prevention, and Overcoming Implementation Barriers. Journal of Computer and Communications, 12(12), pp.201–217.	2024	This study examines the integration of AI into sports coaching, highlighting its potential to enhance training efficiency, optimize athlete performance, and mitigate injury risks.	The purpose of this study is to investigate the practical application of AI in sports, specifically focusing on the prediction and prevention of sports injuries.	Positive
8	Leckey, C., Van Dyk, N., Doherty, C., Lawlor, A., & Delahunt, E. (2025). Machine learning approaches to injury risk prediction in sport: a scoping review with evidence synthesis. British Journal of Sports Medicine, 59(7), pp.491–500.	2024	Current state of machine learning (ML) research for the prediction of sports-related injuries.	Aimed to chart the various approaches used and assess their efficacy, considering factors such as data heterogeneity, model specificity, and contextual factors when developing predictive models	Positive
9	Musat, C.L., Mereuta, C., Nechita, A., Tutunaru, D., Voipan, A.E., Voipan, D., Mereuta, E., Gurau, T.V., Gurău, G. and Nechita, L.C., 2024. Diagnostic Applications of AI in Sports: A Comprehensive Review of Injury Risk Prediction Methods. Diagnostics, 14(22), p.2516.	2024	This review offers a comprehensive analysis of the transformative impact of artificial intelligence (AI) on predicting and preventing sports injuries across various disciplines.	The application of machine learning (ML) and deep learning (DL) techniques generates predictive insights that enhance injury prevention strategies.	Positive

DISCUSSION

Machine learning, a subset of AI, utilizes algorithms to analyze data patterns and refine decision-making processes over time without explicit programming. In the sports context, machine learning techniques process diverse data types, including athlete biometrics, training loads, and historical injury records, enabling the identification of factors correlated with injury risks. For instance, researchers have employed supervised learning methods to develop injury risk classification models, wherein data collected during training sessions, encompassing variables such as heart rate variability, fatigue, and biomechanical levels, can predict the likelihood of injury. A notable study demonstrated that machine learning models could accurately forecast soft tissue injuries in football players, highlighting the impressive potential of these methodologies to inform tailored training and recovery protocols.

The key results of recent studies underline the implications of AI technologies beyond their predictive capabilities. For example, the integration of analysis promoted by AI in routine training facilitated the development of individualized training regimes that adapt to the needs and responses of each athlete (Johnson et al., 2019). This personalized approach can lead to more efficient and effective lesion prediction strategies, ultimately improving sports performance while safeguarding the well-being of the players. The transformative potential of AI in predicting lesions in sports medicine is substantial, but it relies on a synergistic partnership between technologists and sports scientists. Desai (2024) highlights the growing need for interdisciplinary collaboration to effectively leverage AI capabilities, thereby expanding the limits of injury prevention strategies. This partnership is essential for addressing complex biomechanical standards and physiological data that are critical in predicting injury risk. The integration of AI systems into existing sports science structures is hindered by numerous obstacles, including data privacy concerns and the requirement for substantial and well-annotated datasets to train algorithms effectively (Desai, 2024).

One of the fundamental methodologies used in this domain involves the application of predictive modeling techniques, where AI algorithms analyze historical lesion data, along with physiological and biomechanical variables. For example, Zou (2025) highlights the effectiveness of neural networks in forecasting potential injuries when analyzing stress distributions in an athlete's musculoskeletal system during training. The ability to model and simulate different training loads and their impact on the athlete's body enables the optimization of training regimes that are explicitly tailored to the individual's physical abilities.

The effectiveness of AI applications in injury forecasting is increasingly supported by empirical evidence, but additional validation is essential. Longitudinal studies that examine the predictive power of AI in different sports and physical activities would provide critical information about the generalization of existing models. According to Tsilimigkras et al. (2024), AI's role in the decision-making continuum of sports surgery is crucial for adapting rehabilitation protocols. Fostering collaboration in this area, guided by AI analytics, can enhance both athletic performance and its long-term sustainability. (Tsilimigkras et al. 2024).

Martins et al. (2024) also classify the predictive models based on the incorporation of contextual factors that influence the risk of injuries. Studies that utilize GPS data and accelerometers to quantify training loads within the framework of AI have revealed significant correlations between training intensity and the risk of injury. This indicates that the AI is not only used to predict injuries based on historical events but also allows monitoring and real-time intervention strategies. The automatic learning models, combined with wearable technological data, employ an integrated approach to understanding the triggers of lesions, thereby improving the decision-making process for coaching staff and sports scientists.

The use of automatic learning techniques not only enhances the granularity of intuitions derived from the load data but also facilitates the identification of models that may be indicative of imminent injuries. For example, the implementation of ensemble learning methods, as highlighted by Amendolara et al. (2023), allows the integration of multiple models to improve the robustness of the forecast. These techniques can better explain individual variability in physiological responses, potentially leading to strategies for preventing the most adapted injuries. In addition, Amendolara et al. (2023) emphasize the importance of selecting characteristics in refining the relationship between the load indicators. By prioritizing the most relevant external and internal load variables through techniques such as eliminating recursive characteristics and random scoring of forest importance, researchers can reduce noise in predictive models. This leads to the identification of specific training loads that can prepare athletes for injuries, thus making both theoretical understanding and practical applications in Sports Sciences.

The integration of AI technologies into sports injury prevention strategies marks a significant paradigm shift in the realm of athlete health and services. As evidenced through a systematic review of existing literature, AI applications enhance the ability to monitor, predict, and mitigate injury risks, thereby fostering a safer competitive environment. Numerous studies illustrate how machine learning algorithms, predictive analytics, and advanced data collection techniques can inform coaches and sports scientists about athletes' physical conditions and performance metrics, enabling timely interventions that can prevent injuries (Huang, 2024; Mishra et al., 2024).

The effectiveness of these automatic learning approaches in predicting injuries has been emphasized by various empirical studies that demonstrate superior predictive performance compared to traditional methods. Noteworthy progress has been reported in frameworks that incorporate learning methods from ensembles, which aggregate forecasts from multiple models to improve robustness and accuracy. In addition, the application of cross-validation techniques allows the generalization of predictive models across different sporting contexts and populations, thereby highlighting the merit of these advanced methodological structures (Leckey et al., 2024).

Musat et al. (2024) conducted a systematic review aimed at critically evaluating the existing literature to clarify the multifaceted roles of AI technologies in advancing injury prevention methods in competitive sports. By focusing on peer-reviewed articles, conference presentations, and case studies, this review aims to highlight significant findings related to the application of AI in injury risk assessment, athlete monitoring, and the provision of real-time feedback. A primary goal of this systematic review is to compile insights on how AI tools were employed to analyze player biomechanics, training regimens, and recovery protocols, thereby aiding decision-making processes for coaches and medical teams.

CONCLUSION

AI applications in injury prevention show tremendous potential. Several intertwined challenges need to be addressed, including data privacy, the need for interdisciplinary collaboration, the development of AI models, and the requirement for model interpretability. Continuous research is necessary to develop strategies that overcome these barriers, ensuring that AI technologies can be effectively integrated into injury prevention structures to enhance safety and reduce incidents across various fields. An examination of artificial intelligence applications in the prevention of injuries across various fields reveals a compelling landscape of methodologies, results, and implications. A multitude of studies highlight the effectiveness of AI-based solutions, highlighting the progress of predictive analysis, real-time surveillance, and personalized interventions. For example, in sports, automatic learning algorithms have demonstrated considerable potential in predicting the risk of injury by analyzing players' biomechanics, workload, and historical injury data. These methodologies not only facilitate early intervention but also allow tailor-made training schemes to minimize the occurrences of injuries. The results of these applications suggest a paradigm shift in the way athletes train and recover, ultimately enhancing sports performance while reducing the risk of injury.

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Corresponding author:
Dr. Yordan Popov
G. S. Rakovski National Defence College,
Sofia, Bulgaria
E-mail: yordan_stoilov_popov@abv.bg

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