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Mini Review

Artificial Intelligence in Sports Medicine: A Mini- Review

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Abstract

Artificial intelligence (AI) is rapidly transforming the field of sports medicine, offering new tools for injury prediction, diagnosis, treatment, and rehabilitation. This review explores the current applications of AI in sports medicine, highlighting the advancements in machine learning algorithms, wearable technology, and data analytics. The paper also discusses the challenges and future possibilities of AI integration in sports related healthcare.

Introduction

Sports medicine focuses on improving athletic performance, preventing injuries, and maintaining athletes' physical health. Historically, the expertise of physicians, physiotherapists, and other healthcare professionals has been essential in diagnosing and treating sports-related injuries. However, the emergence of artificial intelligence (AI) is revolutionizing sports medicine by introducing advanced solutions for predicting, diagnosing, treating, and rehabilitating injuries [1]. AI integrates various technologies, such as machine learning, deep learning, and natural language processing, to analyse extensive datasets, identify patterns, and make data-driven decisions. These technologies are particularly beneficial in sports medicine, where timely and accurate decisions are crucial for an athlete's health and career [2].

The incorporation of AI in sports medicine is fuelled by developments in wearable technology, advanced data analytics, and enhanced medical imaging techniques. AI algorithms can evaluate an athlete's biomechanical data to forecast injury risks, offer personalized feedback, and create tailored rehabilitation programs [1,2]. Additionally, AI improves the precision of medical imaging, facilitating accurate injury diagnoses [3]. Despite its enormous potential using AI in sports medicine presents challenges, including data privacy issues, integration with existing healthcare systems, and ethical concerns. Overcoming these challenges is essential to fully leverage the advantages of AI in this field.

This review explores the applications of AI in sports medicine, underscores the technological advancements driving this integration, and addresses the future directions and challenges of implementing AI in sports healthcare. As AI progresses, it promises to transform sports medicine, ultimately enhancing the health and performance of athletes globally. Table 1 summarizes the recently published studies on the role ofTable 1ial intelligence in sports medicine.

Table 1: Summary of recent publications on Artificial Intelligence in Sports Medicine.

Publication	Authors	Year	Focus	Journal
Applications of convolutional neural networks in medical image analysis	Lindsey et al.	2018	Utilizing CNNs to interpret medical images and diagnose fractures and soft tissue injuries	Radiology
Deep learning with electronic health records (EHRs)	Rajkomar et al.	2018	Applying NLP to EHRs for pattern identification and faster, more accurate injury diagnoses	NPJ Digital Medicine
Machine learning in personalized rehabilitation	Bauer et al.	2019	Designing customized rehabilitation programs with machine learning for optimal recovery	Journal of Rehabilitation Research and Development
Enhancing engagement and effectiveness in rehabilitation using VR and AI	Levac et al.	2019	Combining VR with AI to create immersive and effective rehabilitation experiences	Rehabilitation Research and Practice
Data analytics for performance optimization in sports	Morgans et al.	2014	Using AI to analyse performance data and develop targeted training programs	Journal of Sports Sciences

Applications of AI in Sports Medicine

Injury Prediction and Prevention

- **Machine Learning Models:** AI algorithms can analyse large datasets to identify patterns and predict injury risks. Machine learning models have been developed to predict anterior cruciate ligament (ACL) injuries by analysing biomechanical data and athlete movement patterns.

Jauhiainen S et al [4] used 3-D motion sensing and data collected from more than 700 female handball and football players to predict the risk of ACL injuries and concluded that their analysis led to a statistically significant predictive value.

- **Wearable Technologies:** It consists of devices equipped with sensors which can collect real-time data on an athlete's movements, providing insights into potential injury risks. These wearables, combined with AI, can offer personalized feedback to prevent injuries [5].

Huhn et al [6] performed a scoping review on 179 studies (10,835,733 participants) to study the impact of wearable gadgets on health care and concluded that wearable can yield crucial data to forecast major health trends in athletes. They also studied the prediction of COVID-19 infection by wearables.

Injury Diagnosis

- **Medical Imaging:** AI has shown great promise in the interpretation of X-rays, CT and MRI scans. Deep learning algorithms can assist in diagnosing injuries with high accuracy. For instance, Convolutional Neural Networks (CNNs) have been used to detect fractures and soft tissue injuries [7, 8].

Lindsey et al [8] focused on using deep learning to improve the detection of fractures on radiographs. They developed a deep neural network that was trained on a large dataset of radiographs elucidated by well-trained orthopedic surgeons. The results showed that the model significantly improved the accuracy of fracture detection when used by clinicians, reducing the rate of misinterpretation.

- **Natural Language Processing (NLP):** AI can also analyze electronic health records (EHRs) to identify patterns and assist in pre-emptive prediction of risk of sports' injuries. NLP algorithms can extract relevant information from unstructured clinical notes, aiding in faster and more accurate diagnoses [9].

Treatment and Rehabilitation

- **Personalized Rehabilitation Programs:** AI can design customized rehabilitation programs based on an athlete's specific injury and recovery progress. Machine learning algorithms can adjust these programs in real-time, ensuring optimal recovery.

Matijevich et al [10] assessed the practicality of utilizing wearables to predict tibial bone force during running. To estimate tibial force, they used an impact metric known as the ground reaction force vertical average loading rate (VALR). This study showcased the promising potential of integrating wearables, musculoskeletal bioinformatics, and machine learning to create precise algorithms to monitor musculoskeletal loading in real-world scenarios.

- **Virtual Reality (VR) and AI:** VR combined with AI can provide immersive rehabilitation experiences, enhancing engagement and effectiveness. These technologies can simulate real-world scenarios to help athletes regain their skills safely [11].

Lal et al [12] conducted a systematic review to assess the effectiveness of tele-consultations and virtual reality in enhancing athletic performance. They concluded that future health policies should integrate these digital tools to improve overall performance. With the availability of such technology, physical therapists and sportsmen can communicate remotely using data collected from smart watches and accelerometers.

Performance Optimization

- **Data Analytics:** AI can analyse performance data to provide insights into an athlete's strengths and weaknesses. Coaches can use this information to develop targeted training programs.

Midoglu et al [13] developed an extensive soccer athlete dataset 'SoccerMon', featuring exhaustive metric data gathered from two women's soccer teams in 2 years' time. This included 33,849 subjective reports &10,075 objective reports, amounting to six billion GPS position measurements. Such extensive data can help in predicting at risk positions for athletes on the playing field and

eventually help in preventing sports related injuries.

- **Predictive Analytics:** By analysing historical performance data, AI can predict future performance trends and potential improvements, helping athletes reach their full potential [14].

Pappalardo et al [15] presented their large collection of soccer logs which included on field events such as goals, passes, fouls from each match for a total of 7 league matches to help in evaluation of individual playing patterns and at-risk behaviour to prevent soccer related lower limb injuries. Such data can be analyzed by physical therapists of the team to improve individual athletic performance and avoid injury prone positions on field.

Potential Challenges

Although AI has the potential to transform sports medicine, numerous challenges must be overcome [16]:

- **Data Privacy and Security:** Protecting the security of athletes' data is crucial. Strong measures are required to safeguard such sensitive information.
- **System Integration:** Integrating AI tools with current healthcare systems is complex and demands substantial investment.
- **Ethical Issues:** The use of AI in sports medicine brings up ethical concerns, especially regarding data ownership and responsibility in decision-making.
- **Adoption in Clinical Practice:** Medical professionals might be reluctant to use AI tools due to a lack of familiarity or trust in the technology.
- **Education and Training:** Sports medicine practitioners need appropriate training to use AI tools effectively.
- **Accuracy and Reliability:** Ensuring that AI systems perform accurately and reliably in diverse real-world scenarios is essential.
- **Regulatory Compliance:** Obtaining approval from regulatory authorities for AI-based medical tools can be a lengthy and intricate process.
- **Liability Concerns:** Establishing accountability in cases of AI errors or incorrect diagnoses can be challenging.

Conclusion

AI is poised to significantly impact sports medicine by enhancing injury prediction, diagnosis, treatment, and performance optimization. As technology continues to evolve, it is crucial to address the associated challenges in harnessing the full potential of AI in sports healthcare. Future studies should focus on developing standardized protocols for AI implementation in sports medicine, ensuring that these technologies are accessible and beneficial to all athletes.

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Conflict of Interest

No conflict of interest.

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