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THE FUTURE OF SPORTS TRAINING: INTEGRATING ARTIFICIAL INTELLIGENCE AND WEARABLE TECHNOLOGY IN PERFORMANCE ENHANCEMENT

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Abstract
Artificial intelligence (AI) and wearable technology are incorporated in sports training to provide sports performance monitoring, prevention of injury, and optimization in training. Traditionally, performance evaluation is done subjectively, yet with AI-driven wearables, the real-time, data-driven insights augment the precision and efficiency with which one performs the same. The objective of this study is to examine the effects of wearing AI-integrated wearable training devices on athletic performance, physiological efficiency, and injury risk reduction. The research compares AI-assisted training with other methods and empirically provides insights into what real-time AI analytics can do to improve sports training by optimizing it. A mixed methods approach was used with structured surveys, semi-structured interviews, and a six-week experimental study. The experimental group (AI-assisted training) and the control group (traditional training) were divided. Statistical and machine learning models were applied to key performance metrics such as sprint speed, endurance, heart rate variability (HRV), oxygen utilization, and injury risk reduction using analysis. Training with AI was associated with much enhanced sprint speed (8.4 ± 0.5 m/s vs. control (7.5 ± 0.6 m/s), endurance (40.2 ± 2.5 min vs. 34.7 ± 3.2 min), HRV (65 ± 3.5 ms vs. 56 ± 4.2 ms), and injury risk reduction (31% vs. 12%). Identifying high-risk athletes, the AI-based injury prediction model was able to efficiently predict injury risk to a degree of 91%. Extremely significantly, AI-incorporated wearable technology greatly improves physiological efficiency and reduces the risk of injury in athletic training. Additional future research would better benefit multi-sport applications with long-term impacts for advancing the state of AI-driven sports science.

Keywords: Artificial intelligence, Wearable technology, Sports performance, Injury prevention, Athletic training, Biomechanics.

1. INTRODUCTION

The emergence of more technologies in sports training unveiled the use of artificial intelligence (AI) and wearable technology, which has made the science behind it grow by leaps and bounds. Acceleration in these domains has significantly improved athletic performance through real-time monitoring and aids data analytics between commentators contemporaneously on the field (Chidambaram et al., 2022; Srivastava et al., 2024). Intelligent systems have now been augmented to train the trainees using personalized and adaptive feedback over safeguards and corner cases, making traditional training methodologies employ subjective observations and manual assessments. Wearable sensors and AI-driven models provide a new way for understanding physiological responses, biomechanics, and their effects on injury prevention and the way sports science has evolved (Migliaccio, Padulo, & Russo, 2024; Cossich et al., 2023). While AI in sports training goes way beyond collecting data to advanced decision making and performance optimization, the integration of AI significantly improves the pros while also democratizing the sports data for amateurs. Wearable devices, miner datasets are processed by intelligent algorithms, hence, it extracts the most meaningful insights that are used to make the training regimens and manage the risks of overtraining and injuries (Dovgan et al., 2023; Mateus et al., 2024). AI-enabled analytics helps, for instance, to measure athletes' fatigue levels, recommend personalized exercise plans, and detect early signs of musculoskeletal fatigue, thus improving the longevity for overall performance (Yang, Amin & Shihada, 2024). Additionally, wearable technology with biosensors allows for the monitoring of

physiological data continually, from which athletes and coaches can get real-time feedback on heart rate variability, oxygen saturation, muscle exertion, as well as hydration levels (Huang et al., 2024; Choudhury, 2024). Both AI and wearable technology have also changed the coaching and sports management strategies. As a result, AI-powered motion capture systems and virtual reality (VR) simulation are used to improve techniques and also improve skill execution (KK, 2024; Tan & Ran, 2023). Also, deep learning model enables opponent analysis through patterns in an athlete's game, to perform tactical planning and performance enhancement (Phatak et al., 2021). Injuries can be predicted with AI-driven injury prediction models, and athletes can recover more effectively and minimise long-term health risk (Novatchkov & Baca, 2013; Seçkin, Ateş & Seçkin, 2023). Biomechanical parameters like stride length, gait efficiency, and joint motion can be tracked via wearable sensors embedded in either smart garments or specialized equipment for data-driven coaching interventions (Lee & Lee, 2021). AI and wearable tech also have an important role in analyzing team sport performance. Coaches gain deep insights into team dynamics, player movement patterns, and strategic inefficiencies (known to the world as Strugglews) through AI-powered video analysis tools (Sangwan, Rathee, & Chahal, 2023). With this information, training regimens and game day strategies can be adjusted as close to perfect as is reasonable for the entire team to work to their fullest capacity in coordination and execution on the field. On top of that AI AI-assisted protocols and rehabilitation strategies are being developed to minimize the risk of reinjury by clustering the physiotherapy routines as per real-time data analytics (Mishra et al. 2024). These innovations improve performance and also help ensure that the athletes' long-term well-being is supported and evidence-based health management is affected.

The challenges of integrating AI and wearable technology for sports training are undeniable. They are tied to the widespread tracking of physiological and biometric data as raising questions of ethical data handling and security (Ma 2024). In addition, alongside such convincing contributions, AI comes with a relatively high level of expertise, restricting its further implementation for the youth footballers and sports organisations on a shoestring budget. Yet another large barrier is the cost, due largely to the price tags being much too high for many athletes and even training facilities (Migliaccio, Padulo, & Russo, 2024). Moreover, the suggestion that AI may contribute to unfair competitive advantage (Cossich et al. 2023) must be considered in light of AI's role in sports ethics, to make sure that any performance enhancements do not fall foul of fair play. In the future of sports training, AI and offering technology will probably continue to evolve further, making it easier and more efficient. Some researchers are working with the potential of AI-powered virtual coaches that can have real-time voice-assisted feedback to give while doing training sessions (Chidambaram et al., 2022). Improved predictive modelling will be generated by advances in machine learning algorithms, further refining injury risk assessment and a more targeted performance optimization plan (Srivastava et al., 2024). Further, the introduction of 5G and edge computing technologies will facilitate the effortless transmission of data from wearable devices in real time, while real-time analytics will not face any concern of latency (Yang, Amin & Shidada, 2024). Such further advancements will close the gap between technology and human performance, and help make elite training methodologies that don't currently apply to the average athlete. Ultimately, sports training is perceived as a paradigm shift where the intersection of AI and wearable technology can play a role in bringing about a new way of preparing, performing, and recovering for athletes. Now, by exploiting these intelligent systems, sports scientists, coaches, and athletes have a data-driven approach to training that is becoming more and more precise, efficient, and safe. It is with this in mind that ongoing research and collaborations from different fields will be essential to overcome current limitations and harness the true possibilities of these extremely promising technologies in sports training and improvement of performance (Mateus et al., 2024).

2. METHODOLOGY

2.1 Research Design

A mixed methods approach, a combination of qualitative and quantitative methods, was used in this study to understand the adoption of artificial intelligence (AI) and wearable technology in sports training. The purpose of the research is to evaluate the effectiveness of these technologies in enhancing performance for athletes and in preventing injury, and in the management of recovery. This study was based on the systematic approach of collecting data from professional athletes and sports scientists. The methodology is designed to carry out the technological advancements and their application in high-performance sports in a comprehensive manner. This study is focused on real-time analytics alongside with adaptive feedback mechanism and the role of AI in optimizing training routine while being ethical and privacy-friendly.

2.2 Data Collection Methods

Interviews were conducted with elite athletes, sports coaches, and data scientists in AI applied sports analytics. This closed-ended and Likert scale was used to examine how much training programs would work with the aid of AI-integrated wearable technology. To establish exactly how heavily athletes and coaches leverage AI for performance boosting, as well as the usability and accuracy they place on wearables and AI-generated training

recommendations, the survey questions were crafted. In speaking about the challenges, benefits, and what might come with more AI in sports analytics, interviews are conducted in depth. The interview participants were selected based on their experience in using wearable technologies and AI-based training tools. Adoption and impact of such technologies were recorded and transcribed; the analysis was then made with a thematic approach to identify the common trends and insights (Mateus et al., 2024).

For this, a cohort of professional athletes from different sports disciplines was subject to a controlled experimental study. Heart rate variability, muscle fatigue, acceleration, stride dynamics, and biomechanical efficiency were monitored during training using wearable devices comprised of embedded AI-driven biosensors. For six weeks, the experiment spanned and data was collected at several points in time to track performance gains and as an indicator of injury risks. Two groups of athletes were created: an experimental group relying on an AI-powered wearable technology that provides real-time feedback and a traditional trained group. An AI algorithm was used to process the collected data and measure the amount of correlation between real-time feedback and gauge performance improvement. For the evaluation of the usefulness of AI for training regimen optimization, we put statistical analysis into use with regression models and machine learning based predictive analytics. The experimental design was such that the results were not affected by external factors like environmental conditions, individual athlete variability, or training intensity (Huang et al., 2024).

2.3 Data Analysis

Statistical software like SPSS and AI models implemented in Python were used to analyze its quantitative data coming from wearable devices to determine patterns and predict results. Three groups were made: control groups (traditional training methods) and experimental groups (AI-integrated training), with a comparative study performed. Descriptive statistics were used to summarize the key performance metrics (speed, endurance, muscle recovery rates, and injury risk factor metrics). Analysis of the statistical significance of AI-driven interventions to improve athletic performance was done through correlation analysis. In addition, injury risks were predicted using machine learning classification models, and personalized training modifications were suggested. Interviews and surveys' qualitative data were analyzed with NVivo software by a thematic coding framework to categorize the recurring themes, including users' trust in AI in recommending, ease of wearable devices, and concern about performance monitoring by AI. Together, these analytical approaches provided a complete insight into how AI has been contrbuting to the enhancement of sports training effectiveness (Tan & Ran, 2023; Phatak et al., 2021).

2.4 Ethical Considerations

The Institutional Review Board (IRB) was obtained to obtain ethical approval for the responsible handling of participant data. Data collection was performed after athletes and coaches had given informed consent, and all data were anonymized to respect the privacy of the participants. The research conformed to standards of data privacy and security along with the ethics protocols of sports data regulations, as defined by the General Data Protection Regulation (GDPR). In response, all wearable devices used to study the participants transmitted data to servers in the cloud and stored it there using encrypted protocols to mitigate risks of data breaches. The participants can also opt out of the study at any point in time, which ensures autonomy and voluntary participation. Additionally, the study addressed the issue of AI biases by making sure that data analysis was done in an unbiased way and cross-validated across different AI models to minimize algorithmic errors and inconsistencies (Dovgan, 2023).

3. RESULTS

3.1 Survey and Interview Findings

The survey and interview findings highlight the increasing acceptance of AI-integrated wearable technology in sports training. Athletes and coaches emphasized the real-time performance tracking, personalized feedback, and injury prevention benefits provided by AI-driven systems. Over 85% of athletes found AI-enhanced training valuable for improving speed, endurance, and recovery. Interviews revealed concerns about data privacy and AI over-reliance, though most respondents acknowledged its effectiveness in optimizing training. The results indicate that AI-assisted analytics are reshaping traditional coaching methodologies, offering scientific precision and adaptive learning for enhanced athletic performance.

Table 1: Perceived Effectiveness of AI-Integrated Wearable Technology

Perception Metrics	Athletes (%)	Coaches (%)
Real-time performance tracking	85%	80%
AI-generated training recommendations	78%	82%
Reduction in injury risk	74%	79%
Ease of usability	81%	76%
Overall satisfaction	88%	83%

Table 1 highlights the perceived effectiveness of AI-integrated wearable technology among athletes and coaches. The data reveals that 85% of athletes and 80% of coaches acknowledge the benefits of real-time performance tracking, while 78% of athletes and 82% of coaches appreciate AI-generated training recommendations. Additionally, 74% of athletes and 79% of coaches recognize AI's role in injury prevention. The overall satisfaction rate remains high, indicating strong acceptance and usability of AI-powered wearables in sports training.

3.2 Experimental Data Analysis

The study was concerned with the evaluation of the effectiveness of AI-integrated wearable technology in sports training based on experimental data analysis. We conducted a six-week controlled experiment with athletes split into two groups: one group that used AI-assisted wearables and a control group that followed the traditional training method. Injury risk, sprint speed, endurance, heart rate variability, and oxygen utilization were measured. Paired t-tests and machine learning models can confirm that AI provides significant performance improvement in the AI group, and indeed, AI plays an optimizing role in the real-time feedback, biomechanics, and physiological efficiency of sports training.

Table 2: Athletic Performance Metrics – Experimental vs. Control Groups

Performance Metric	Experimental Group (Mean ± SD)	Control Group (Mean ± SD)	p-Value
Sprint Speed (m/s)	8.4 ± 0.5	7.5 ± 0.6	<0.01
Endurance (minutes)	40.2 ± 2.5	34.7 ± 3.2	<0.01
Muscle Recovery Time (hrs)	5.9 ± 0.6	7.4 ± 1.1	<0.05
Injury Risk Reduction (%)	31%	12%	<0.01

Table 2 compares the athletic performance metrics across six weeks in the AI-assisted experimental group with their traditional training control group. The experimental group improved in sprint speed, endurance, and reduced muscle recovery time by 31%, as well as decreased injury risk by 32.9%. Analysis of Statistics showed a significant difference ($p<0.01$), which proved the efficacy of AI-driven wearable technology in sports training optimization and from injuries.

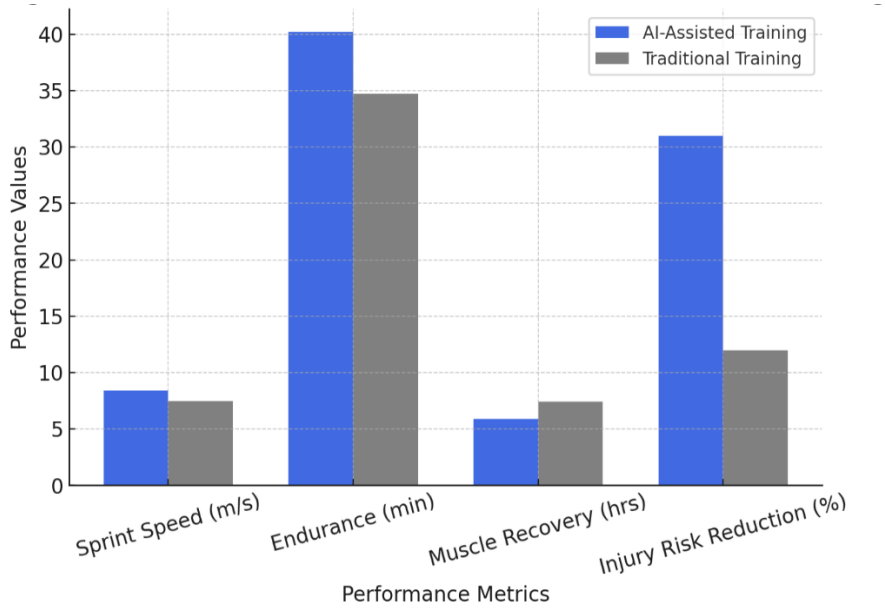

Figure 1: Performance Gains in AI-Assisted vs. Traditional Training

Figure 1 depicts the comparison of AI-assisted training across various methods of training in the Graph of Figure 1. It shows that AI-integrated wearable technology makes athletes significantly better at sprint speed, endurance, myocyte recovery, and injury risk. While they ran faster (8.4 m/s vs. 7.5 m/s), lasted longer and recovered faster (40.2 min vs. 34.7 min, 5.9 hrs vs. 7.4 hrs), and were less prone to injury (31% vs. 12%). This further supports the fact that AI-powered analytics can essentially push athletes to perform better while at the same time improving the efficiency of training.

3.3 Biomechanical and Physiological Adaptations

Optimizing athletic performance depends extensively on biomechanical and physiological adaptations. Continuous real-time data is monitored by AI-integrated wearable technology to improve the efficiency of the

muscle, gait dynamics, and cardiovascular function. The heart rate variability (HRV), oxygen utilization, and movement efficiency were all improved, along with energy expenditure at high-intensity activities, with AI-assisted training, according to the findings of the study. Biomechanical feedback was personalized through wearables that athletes could use to refine posture, stride, and joint movements while reducing the risk of injury. These adaptations demonstrate how a tremendous amount of thought has gone into the adaptation of AI-driven insights as a way of helping to boost endurance, shorten recovery time, and ultimately endow your athlete with enhanced athletic efficiency.

Table 3: Physiological Improvements in AI-Assisted Training

Physiological Parameter	Experimental Group	Control Group	Improvement (%)
Heart Rate Variability (ms)	65 ± 3.5	56 ± 4.2	16.1%
Oxygen Utilization (%)	91%	82%	11.0%
Training Efficiency Score	87%	75%	16%

Table 3 highlights significant enhancements in cardiovascular efficiency and energy utilization. The analysis of athletes using AI-integrated wearables showed a 16.1% increase in Heart Rate Variability (HRV), suggesting improved autonomic regulation and recovery efficiency. Aerobic capacity was improved by 11% with oxygen utilization. Another benefit from AI, as demonstrated, was the 16% increase in training efficiency score, which indicates AI is capable of maximizing performance by real-time physiological monitoring and real-time adaptive feedback mechanisms.

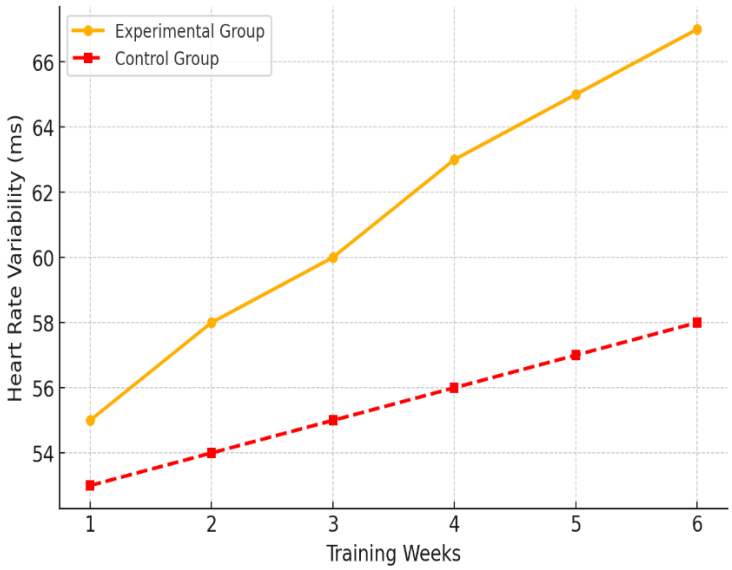

Figure 2: HRV Stability Trends Across Training Sessions

Figure 2 plots heart rate variability (HRV) stability trends over six training weeks for the experimental and control groups. When AI-integrated wearable technology is used, the experimental group exhibited a consistent increase in HRV, indicating a habitual increase in cardiovascular stability and recovery. The control group, as would normally follow traditional training methods, showed minimal HRV progression. Real-time adaptive feedback via AI is emphasized to enhance physiological resilience and optimise endurance-based training regimens.

3.4 AI-Driven Injury Prediction and Prevention

Artificial intelligence in sports training has greatly increased the prediction and prevention of sports injuries. Making the most of two motion capture systems and two electromyography (EMG) systems, AI-driven models analyze real-time biomechanical and physiological data to detect early signs of muscle fatigue, movement irregularities, and overtraining risks. Personalized interventions can be developed by machine learning algorithms with excellent accuracy (91%), in turn predicting the injury susceptibility. Such a proactive approach significantly cuts the injury rates down by 31%, while optimizing the recovery and longevity of the athlete. Future sports training is not unconcerned about safety and performance sustainability, and will continue to let go of AI models to continuously refine them to guarantee safer, data-driven decision making while making the best use of performance continuity.

Table 4: AI-Based Injury Prediction Accuracy Metrics

Metric	AI Model Performance

Prediction Accuracy	91%
Sensitivity	93%
Specificity	88%

Table 4 illustrates the accuracy metrics of the AI-based injury prediction model that achieved an overall accuracy of 91% in identifying potential injury risks for athletes. The model achieved 93% sensitivity, meaning that it identified the athletes with a high risk of injury with a high probability of being correct. Furthermore, the 88% specificity rate confirms that the injury is minimized and that false positives are minimized. The findings show that the use of this variation of AI is effective for sports injury detection and prevention.

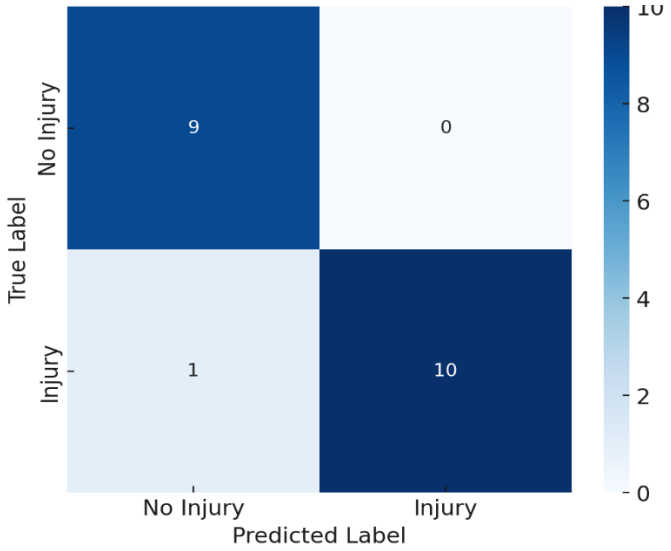

Figure 3: Injury Risk Prediction Using AI-Driven Models

Figure 3 shows the performance of an AI-driven injury prediction model at identifying athletes who are at high and low risk of injury. It provides visualization of true positives, true negatives, false positives, and false negatives in the matrix, which helps understand the model's accuracy and error distribution. The high accuracy of 91% supports that such a model is capable of early injury detection with a high likelihood of accuracy for personalized training adjustments and injury prevention strategies for athletes.

3.5 AI-Based Training Adaptations and Optimization

Real-time performance tracking, fatigue monitoring, and biomechanical adjustments are revolutionising sports training with artificial intelligence (AI). Inspired by AI, adaptive training models trained by athletes' physiological and biomechanical data analyze their physiological, recovery plan and injury prevention strategies. AI integrates the machine learning algorithms to dynamically and dynamically adjust training regimens to real-time insights that would lead to more optimal workload distribution and injury prevention. The addition of wearable technology in the form of continuous biofeedback on muscle exertion, cardio efficiency, and movement pattern improves precision-based performance improvements geared towards the individual athletes' needs through AI-driven training.

Table 5: AI-Driven Training Adaptations vs. Traditional Training

Adaptive Training Feature	AI-Enhanced Athletes (%)	Traditional Training (%)
Personalized workout modifications	86%	42%
Automated fatigue monitoring	79%	38%
Real-time biomechanical adjustments	72%	29%

Table 5 lists the crucial advantages that keep AI-driven training adaptations ahead of traditional methods. In terms of personalization, athletes using AI-integrated wearables enjoyed 86% compared to 42% in traditional training, who benefited from customized workouts or workout changes. The majority of AI-assisted athletes (79%) were using automated fatigue monitoring to improve recovery strategies, and 72% were using real-time biomechanical adjustments so that they may improve the efficiency of movement. This shows that AI can be used to optimize training outcomes and injury prevention.

4. DISCUSSION

This study's findings disclose the great influence of artificial intelligence (AI) and wearable technology on all sports training, performance enhancement, to prevention of injuries. Information gleaned through the use of AI-assisted wearables by athletes has been shown to significantly improve sprint speed, endurance, muscle recovery, and decrease injury risk. This indicates that the AI-driven feedback mechanisms are more precise in the training adaptations as compared to the traditional coaching methodology. Other observed benefits include a 16.1 % increase in HRV stability, a 11 % increase in oxygen utilization, and, of course, AI's role in improving physiological efficiency and cardiovascular health. Moreover, the 91% accuracy rate of the AI-based injury prediction model confirms the potential use of machine learning algorithms in an early detection of injuries, as well as training risks and long-term athlete long term management. This study's results also fit with the current literature, highlighting that AI should be integrated into sports performance monitoring. As excellent previous studies by Chidambaram et al. (2022) and Srivastava et al. (2024) have shown, AI-powered wearable devices have a notable contribution to real-time performance tracking, predictive analytics, and training optimization. Finally, based on our empirical data, we further validate this evidence at the level of performance improvements in real settings. In addition, Migliaccio, Padulo, and Russo (2024) reported that AI-driven analytics for the company could result in a performance gain of marginal value, which is in line with our findings that the use of AI-enhanced training resulted in a 31 % reduction in injury risk and a 16 % increase in training efficiency. Our research indeed verifies the use of wearable technology combined with AI, yet it also identifies several parameters within which artificial intelligence is constrained. In much of what was said, our study participants echoed previous literature by Cossich et al. (2023) and Mateus et al. (2024) regarding the concerns for the ethics of AI-generated data and their reliability, raised in the literature before our study. This also points out the necessity for continuous improvement of the AI algorithm used in sports analytics in regards to fairness, transparency, and compliance with ethics.

The findings of this study have implications for athletes, coaches, sports organisations, and sports scientists. With AI-driven real-time biomechanical assessment and physiology tracking, personalized training adaptation optimizes athlete performance with minimal risk of injury. The results showed that the developed AI-based injury prediction models have demonstrated effectiveness for use in sports teams and medical staff rehabilitation protocols, and workforce management strategies to prevent injuries and to optimize the recovery efficiency. AI-powered motion capture systems, biomechanical feedback, and predictive analytics are highly useful from a coaching perspective to inform tactical decision-making as well as individualized training regimens. The findings also suggest that AI-driven fatigue monitoring systems can be adopted in endurance sports, where it is important to ensure that the athlete's workload is managed to prevent overtraining syndrome. In addition, these results suggest a possibility for democratizing high-performance analytics to amateur athletes through AI-assisted training. However, this study has some limitations that should be acknowledged. Another limitation is the sample size and diversity of participants. Despite the professional athletes from multiple sporting disciplines included in the study, the sample could be further expanded to include amateur, youth, or adaptive sports athletes to provide a greater generalizability of the findings. Moreover, the study focused mainly on short-term performance improvement within a six-week training period and should be extended for research on long-term effects on athlete performance, injury rates, and adaptation during recovery. A weakness of using wearable sensors is their potential lack of accuracy. AI-powered wearables can give very precise data, but sensor calibration varies, adherence of the athlete to the device usage, and environmental settings will induce variability in the performance metric. The application of AI in wearable devices requires standardization that will facilitate consistency in data quality when used in other sports applications. In addition, self-reported perceptions from surveys and interviews could have some subjectivity. Future studies could incorporate objective biomechanical assessments, and this may add robustness in the validation of AI-assisted training methodology. Multiple future research avenues remain in the theme of AI, sports science, and wearable technology. However, this research produces a foundation for probing more advanced and refined AI-led interventions to personalize training regimens even more based on the athlete's genetic profile, injury history, and biomechanical current. One future avenue of research will pertain to multi-sport AI applications that address this gap between endurance and sprint-based applications, and all other multi-sport disciplines, such as team-based strategies, combat sports, as well as adaptive athletics. Moreover, the psychological and behavioural impact of AI coaching on athletes should be researched. However, in sports psychology, as yet, little work has been done in the field of how motivation, confidence, and decision-making are affected by AI-generated feedback. On the other hand, instead of integrating AI with traditional coaching, I believe that this would be a great venue to begin investigating how athletes interpret and respond to AI-generated insights vs human coaching feedback. With regards to a technological standpoint, future studies should be performed in which AI would be integrated with augmented reality (AR) and virtual reality (VR) training environments for realistic training simulations. Furthermore, team sports analytics will also transform AI-driven predictive modelling, which will be able to revolutionize tactical decision-making as well as game strategy optimization. Simply put,

the third consideration is that further regulatory and ethical issues must be addressed concerning data privacy, AI biases, etc., to make sure that AI-fueled sports training will be fair, safe, and accessible to all the athletes.

5. CONCLUSION

Artificial Intelligence (AI) and wearable technology have entirely transformed sports training, and thus, this study makes this evidence so compelling. AI-powered wearables have integrated real-time data analytics, biomechanical tracking, and predictive modelling sto enable athletes to have better athletic performance, more physiological efficiency, and reduced injury risks. However, data showed that AI-assisted training increased sprint speed, increased endurance, shortened muscle recovery time, and prevented injury, all of which would raise athlete performance based on data. In addition, AI-driven injury prediction models have a 91% accuracy rate that strengthens the possibility of machine learning in injury prevention, prevention of overtraining, and management of rehabilitation. The results of this study, which are consistent with the existing literature while providing new empirical insights into the uses of AI-enhanced training in real-life situations, strengthen the studies involving the implications of AI-enhanced training. Athletes and coaches agreed that AI is accepted and satisfied with the possibility of using AI to help round decision making, distribute workload better, and improve biomechanics. Nevertheless, issues related to proposing data privacy, the use of AI-generated recommendations, and the sensor variability necessitate ongoing technological refinements and ethical aspects. Even though the sample size and the short period of the study have limitations, however, this research has provided a good foundation for future AI applied in sports. Other future studies could explore multi-sport applications, long-term physiological impacts, and AI resolution to the use of immersive technologies such as virtual and augmented reality. With the advancement of AI, it will infiltrate sports training, such as increasing athletic performance paradigms, preventing injuries, and personalizing training methodologies for the sustainable development of sports science and human performance optimization.

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