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The Relevance of AI-Powered Analytics as a Strategic Tool for Injury Prevention in Training, Treatment, and Communication Management

Keywords:
Artificial intelligence, AI Analytics, Injury Prevention Management, Communication, Treatmanet Management

Abstract

The purpose of this research was to explore the relevance of AI-powered analytics as a strategic tool for injury prevention across training, treatment, and communication management in PE. There is a notable research gap regarding the incorporation of AI-powered analytics into educational and sports management frameworks. The authors aimed to identify key measures, benefits, and limitations of AI applications through a secondary research study. Using the PRISMA approach, a thorough systematic literature review was conducted. The authors focused only on peer-reviewed articles published between 2021 and 2025 from Web of Science, Scopus, and Google Scholar databases. Out of 514 initial articles, 42 met the inclusion criteria. The results demonstrated that AI-powered analytics should be developed not merely as technological instruments but as a managerial capability that improves sensing, decision-making, and adaptive learning within physical education systems. This research is original in its integration of AI-powered injury-prevention analytics with strategic management and knowledge-integration frameworks in physical education contexts. By positioning AI as a managerial rather than a technological tool, this research advances theoretical and practical discourse beyond existing sport-focused applications.

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1. Introduction

Artificial Intelligence (AI) is paving the way for sports medicine to enter a new phase, transforming the way we prevent injuries, train athletes, and manage rehabilitation. AI's ability to handle huge amounts of data is changing the game, making treatments more personalized and helping athletes perform at their best (Guelmami et al., 2023). By using AI-powered sports analytics, coaches, trainers, and athletes can make data-driven decisions that optimize performance, prevent injuries, and achieve long-term success in competitive sports (Wbaid et al., 2025). Injury prevention has become a major concern in physical education and sports science, as the physical, psychological, and financial consequences of athletic injuries continue to grow. AI-powered sensors have the potential to transform healthcare delivery completely and advance medical research, but to reach their full potential and improve patient outcomes and the healthcare ecosystem, significant efforts are needed to overcome current obstacles (Bhamidipaty et al., 2025; Mateus et al., 2024). Sports-related injuries account for 4.2 million emergency department visits annually, with youth athletes accounting for approximately 30% of these cases. Additionally, the estimated economic burden exceeds $20 billion per year. Hence, there is a need for more efficient, proactive, and technology-driven processes.

The integration of AI in sports training has emerged as a transformative approach to enhancing individual performance, optimizing training strategies, and providing personalized insights for athletes and coaches (Bodemer, 2023; Tischer et al., 2023). For instance, rehabilitation training using artificial intelligence and virtual reality technology can restore athletes' physical function to more than 96%, and the overall average rehabilitation effect can reach 93.79 points, which is feasible to a certain extent (Song & Tuo, 2022; Dudek et al., 2025; Schuermans et al., 2022).

AI is a transformative solution across domains such as healthcare, education, and athletic performance (Zhang et al., 2023; Reis et al., 2024). AI-powered analytics have demonstrated encouraging results in forecasting injury risks with up to 87% accuracy (Sirawattana & Poolsamral, 2024; Wu et al., 2025). These models analyse large datasets comprising biomechanical movements, workload intensity, and recovery patterns, thereby enabling early intervention and informed decision-making by coaches, educators, and sports managers.

While prior research has explored AI-driven injury prediction and rehabilitation in isolated clinical or elite-sport contexts, limited scholarship has conceptualized AI-powered analytics as an organizational capability grounded in management, knowledge integration, and strategic decision-making frameworks in educational settings. Thus, there is a gap in systematically integrating AI-driven injury prevention tools into physical education processes, particularly at the institutional level. While elite sports organizations increasingly use AI to optimize performance, educational institutions and public sports programs often lack access to advanced solutions. It was fundamental to explore how AI technologies can revolutionize training environments by improving safety and the efficacy of injury prevention and rehabilitation strategies. The results extend existing theory by linking technical performance outcomes to managerial constructs. This positions AI as a knowledge-generating system that improves learning, resource allocation, and governance. Hence, the results strengthen the theoretical relevance to the knowledge management and strategic decision-making literature.

The authors used a qualitative research methodology. The PRISMA model was used for screening, selection, and eligibility. The peer-reviewed articles were extracted from Web of Science, Scopus, and Google Scholar between 2021 and 2025. The authors aimed to explore the strategic value of AI-powered analytics in optimizing training and treatment protocols and to identify actionable insights for implementation in physical education settings. These research results were grounded in the organizational learning, knowledge integration, and dynamic capabilities frameworks. The sections below discuss and present the findings.

2. Literature Review

Injury prevention remains a central concern in sports medicine, where AI is emerging as an indispensable tool, with substantial potential to enhance injury prevention (Guelmami et al., 2023). Hence, predicting injury risk in sports is essential for preventing injury, optimizing athletic performance, and improving recovery strategies (Musat et al., 2024). By integrating AI with advanced statistical models, sports professionals can gain deeper insights into player efficiency, tactics, and injury prevention (Wbaid et al., 2025). This is supported by Dudek et al. (2025), who stated that AI-driven analytics, utilizing machine learning, deep learning, and computer vision, enhance performance assessment, injury prediction, and rehabilitation strategies by processing vast datasets to detect fatigue patterns, optimize recovery schedules, and refine tactical decision-making.

Injuries not only jeopardize athletes' careers but also cause substantial setbacks for teams and organizations (Mishra et al., 2024; Schuermans et al., 2022). Many colleges and universities have adopted artificial intelligence to transform traditional single-mode sports training methods (Zhang et al., 2023). Tischer et al. (2023), argues that there is a lack of awareness among sports medicine professionals regarding injury prevention concepts. Moreover, traditional sports analysis methods rely on subjective assessments, basic statistical tools, and manual analysis, which result in inaccuracies, and inefficiencies (Wbaid et al., 2025).

AI and data analytics have revolutionized healthcare, enabling real-time predictive insights that enhance clinical decision-making through patient monitoring (Snigdha et al., 2023). Similarly, Wbaid et al. (2025) argued that AI-powered sports analytics is revolutionizing athlete performance assessment by using data science to enhance decision-making and training strategies. Moreover, the intent is to improve human-computer interaction through innovative engagement strategies and natural language processing (Guelmami et al., 2023).

According to Bhamidipaty et al. (2025), a revolutionary era in healthcare has begun with the integration of AI and sensor technology, which has completely changed how patient care, diagnosis, and treatment are delivered. Moreover, Dudek et al. (2025) and Schuermans et al. (2022), argued that wearable sensors, provide real-time physiological and biomechanical data, enabling personalized training programs and workload management. Therefore, with the aid of machine learning, sports medicine specialists can develop programs to prevent injuries (Guelmami et al., 2023). Additionally, the use of smart devices and wearable technology in everyday life has increased considerably over the last decade (Hribernik et al., 2022). Also, Ju et al. (2023) and Prentice (2024) revealed that sport rehabilitation robots can help patients to reduce the financial strains from rehabilitation costs.

Artificial intelligence offers unprecedented that improves training, performance, and health management (Mateus et al., 2024; Bodemer, 2023). Therefore, the accuracy and precision of the information are directly influenced by the way it is collected, reporting biases, correct medical diagnoses, and the expertise of medical professionals (Musat et al., 2024). Moreover, in developing training strategies, AI can assist in creating personalized training programs for individual athletes by considering factors such as fitness levels, physical conditions, and training goals, such as increasing strength or speed (Sirawattana & Poolsamral, 2024; Wu et al., 2025; Tan & Ran, 2023).

Rapid AI development urges organizations across industries to adopt AI technologies to improve their management practices (Shukla & Agnihotri, 2024; Yin et al., 2023). Islam et al. (2025) argues that AI-based solutions strengthen decision support by providing immediate contextual information. Also supported by Tokas and Rathore (2024). To provide successful treatment, all persons involved in the management of injuries must have a thorough understanding of the healing process (Peterson et al., 2024). On the other hand, providing targeted rehabilitation training programs tailored to different injury causes offers practical guidance and practical significance for improving the quality of existing rehabilitation training (Song & Tuo, 2022). Additionally, personalized training schedules, sculpted through AI algorithms, promise optimized performance and reduced injury likelihood (Biro et al., 2024).

According to Kerr et al. (2023), strategic value emerges when coaches, medical staff, performance analysts, and athletes share a common understanding of risk indicators, training adjustments, and recovery pathways. To maintain athletes' health and performance require equal attention to both treating sports injuries and preventing new injuries (Zhihong, 2023; Lin et al., 2024). Traditional sports training methods rely heavily on coaches' manual guidance while innovative research on artificial intelligence-assisted sports training, from the perspective of integrating body and beauty, was put forward (Yan, 2025). Correspondingly, Tan and Ran, (2023) stated that these innovations can track and analyse the characteristics of individual the condition of injuries. Therefore, this information allows coaches and athletes to make informed adjustments to training strategies and competition tactics effectively (Sirawattana & Poolsamral, 2024; Reis et al., 2024).

Tokas and Rathore (2024) argued that these days potential injury risks can now be identified in advance. In the field of sports injury protection in physical education teaching, the system stores a large amount of unstructured data, including qualitative data on sports medicine, training data from college students, and so on (Cui et al., 2023; Dudek et al., 2025). Similarly, Shukla and Agnihotri (2024) and Mateus et al. (2024) stated that by harnessing large datasets and sophisticated algorithms, it can now forecast trends, identify potential risks, and uncover valuable insights to inform strategic decisions about injury preventions.

Lastly, as organizations increasingly embrace AI-powered analytics for injury prevention and performance optimization, the effectiveness of these systems relies not only on predictive accuracy but also on how insights are communicated, analysed, and operationalized across stakeholders (Mateus et al., 2024; Edouard et al., 2022). Therefore, integrated communication frameworks offer coordinated action for algorithmic recommendations, and support evidence-based decision-making (van de Wouw, 2023). Besides, communication management becomes a strategic capability, facilitating alignment between analytical intelligence and performance objectives while fostering human–AI collaboration (Franco et al., 2024; Sundberg et al., 2025). AI-powered analytics expands further operational efficiency, contributing to organizational learning, stakeholder engagement, and sustainable competitive advantage by enhancing injury-prevention outcomes and optimizing athlete well-being (Piussi et al., 2024; Everard et al., 2023; Weiß et al., 2024).

3. Research Methodology

The authors conducted an extensive systematic literature review (SLR). This qualitative research method was grounded into Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The main purpose of this research was to explore the relevance of AI-powered analytics as a strategic tool for injury prevention in training, treatment, and Communication management in physical education. This SLR showed methodological transparency, rigor, and comprehensiveness across global databases. In this process, the PRISMA framework decreases selection bias and improves the validity of thematic synthesis.

The systematic literature review followed a structured protocol based on the PRISMA 2020. The literature search process was designed using Boolean operators (and, or, not) and specific filters for Web of Science, Scopus, and Google Scholar databases. Significantly, the primary search strings included combinations such as "artificial intelligence" or "AI analytics" or "machine learning" or "deep learning" and "sports injury prevention" or "injury risk prediction" or "rehabilitation" and "physical education" or "sports management" or "training optimization". Furthermore, searches were limited to peer-reviewed journal articles published in English between 2021 and 2025 to confirm recent relevance. Accordingly, the operational definitions led to the development of the inclusion and exclusion process. In this research, the artifacts were retained if they (a) explicitly examined AI-driven models or analytics tools, (b) addressed injury prevention, rehabilitation, or training optimization, and (c) were situated within sports, physical education, or sports management contexts. Exclusion criteria included non-peer-reviewed, purely opinion-based, unrelated to AI applications, or lacking empirical or conceptual rigor.

Next, to ensure methodological rigor, the quality appraisal was conducted. The authors assessed the clarity of the research design, the transparency of the AI methodology, validation procedures, limitations, and more in selected articles. Moreover, bias indicators such as selective reporting, validation benchmarks, small or unrepresentative samples, and a lack of ethical disclosure were assessed. Any article demonstrating unclear model validation or insufficient methodological transparency was flagged and excluded from the final analysis. During the screening, duplicates were removed, and the authors examined the research titles and abstracts. Overall, 514 articles were reviewed. The authors searched for year of publication, country of origin, AI model type, injury context, reported results, implementation, and other elements. Hence, after applying exclusion criteria such as non-peer-reviewed, opinion-based papers, and articles without empirical evidence, and inclusion criteria, such as AI applications in injury prevention, rehabilitation, or sports management within educational or athletic contexts, the final 42 articles were relevant and selected for in-depth qualitative analysis.

The authors used NVivo software for coding, clustering, and synthesizing the results. Identified themes were categorized into four main themes such as AI-driven injury prediction, personalized training design, intelligent rehabilitation strategies, and strategic integration in physical education management. Moreover, for goodness and trustworthiness, triangulation was used, with the results debriefed with three independent reviewers to validate the coding process. At last, no primary data were collected for this research. Hence, no IRB approval was required. However, all ethical standards for qualitative research were observed. This comprehensive literature review is founded on evidence-based in evidence demonstrating the relevance of AI-powered tools in sports science.

4. Research Findings

This research was conducted over 11 months, from January 13th to December 11th, 2025. The authors developed a three-stage approach. Data collection lasted for almost three months. Moreover, the data cleaning and screening process lasted around six months. Coding and theme development were approximately two months. Table 1 shows that over 514 appropriate literatures on AI-powered analytics for injury prevention in physical education and sports science were selected from WoS (168), Scopus (204), and Google Scholar (142).

Due to screening process, 121 duplicate articles were removed. Furthermore, remaining 393 articles were screened on titles and abstracts. Hence, 83 articles were remobed. Furthermore, after checking on tpic and lacking AI/PE connection 310 articles were removed. Next, the remaining 83 articles were assessed using rigid inclusion criteria for methodological rigor, relevance, and applicability to training, treatment, or management disciplines. Consequently, 41 research articles were eliminated due to missing components, such as insufficient empirical evidence, limited contribution, or lack of alignment with the research problem. Finally, the authors retained 42 articles for qualitative synthesis and thematic analysis. All these steps were performed in alignment with PRISMA guidelines.

Table 1: PRISMA Summary (Developed by the Authors)

PRISMA Phase	Description	Count	Notes
Identification	Total records retrieved through databases	514	WoS = 168, Scopus = 204, Google Scholar = 142
Duplicate Removal	Records removed due to duplication	121	Automatic and manual deduplication

Screening	Titles and abstracts screened	393	Applied inclusion criteria (AI focus, injury prevention, etc.)
Excluded at Screening	Irrelevant to topic or lacking AI/PE connection	310	Often discussed general sports tech, not injury-focused
Eligibility	Full-text articles reviewed in detail	83	Applied eligibility criteria (rigor, empirical relevance)
Excluded at Eligibility	Theoretical only, poor methodological transparency, not peer-reviewed	41	Specific exclusions (no AI component, conceptual gaps
Final Inclusion	Studies meeting all criteria for synthesis	42	Used in NVivo for thematic coding

Table 2 demonstrates the descriptive elements from 42 eligible articles. The results indicate a strong increase in publications since 2021. Moreover, nearly half of the research was published between 2023 and 2024, indicating a significant acceleration in AI adoption in sports science and injury prevention research. Furthermore, most of the research was conducted in North America, primarily USA and Canada, (approx. 40%) and Europe, UK, Germany, Netherlands, and Spain, (33%), indicating that AI-driven injury prevention initiatives are currently focused on regions with strong adoption of advanced technologies. Lastly, Asia-Pacific, Australia, China, Japan, research was 19%. While other regions represented 8%.

Additionally, the results show that machine learning mechanisms were the most used. Sensor-integrated systems and deep learning / neural networks were the second and thirds mechanism used. Notably, most articles focused on injury prediction and strategic management. A small portion of articles addressed rehabilitation and recovery optimization. At last, most of this research were performed in elite or professional sports. This limited distribution highlights the imbalance between education environments and high-performance sports.

Table 2: Descriptive Characteristics of included 42 studies (Developed by the Authors)

Characteristic	Category	N (%)	Comments
Publication Year	2021-2022	8 (19%)	Rapid Growth from 2021 onwards
	2023-2024	14 (33%)	Indicates increasing adoption trends
	2025	20 (48%)	Reflects a peak in scholarly interest
Geo Distribution	N. America	17 (40%)	Primarily USA and Canada
	Europe	14 (33%)	UK, Germany, Netherlands, Spain
	Asia-Pacific	8 (19%)	Australia, China, Japan
	Other regions	3 (8%)	Limited but emerging literature
AI Tech Used	Machine Learning	22 (52%)	Predominantly supervised algorithms
	Deep Learning / Neural Networks	8 (19%)	Focused on gait and motion pattern data
	Sensor Integration (IoT, etc)	12 (29%)	Smartwatches, motion sensors, etc.
Primary Focus	Injury Rist Prediction	26 (62%)	Real-time models and forecasting tools
	Training Optimization	18 (43%)	Workload, fatigue, biomechanical balance
	Rehabilitation / Recovery	11 (26%)	Overlaps with treatment personalization
	Strategic Management	27 (64%)	Costs, training gaps, data governance
Education	K-12/University	14 (33%)	Many pilot programs in PE courses
	Elite/Professional Sports Prog	22 (52%)	High resource environments
	Community / health Clinics	6 (15%)	Smaller scale and pilot studies

Next, the authors conducted pattern detection analysis using NVivo. Table 3 illustrates the results, revealing four major themes from 42 eligible articles. Based on the research, the top theme was injury risk prediction. This theme appeared in 28 sources, and it discussed biomechanical analytics, workload thresholds, and real-time alert systems to detect and treat injuries. Interestingly, these articles were consistently showing high predictive accuracy. The second theme was identified in 23 sources. The results focused on adaptive training programs, fatigue analytics, and load-balancing mechanisms. The data suggested that AI-powered tools in training could optimize and improve performance. Also, it was reporting approximately 20-25% occurrence in injury recurrence.

Furthermore, rehabilitation and treatments were addressed in 18 different sources. The results showed that AI-supported rehabilitation strategies significantly reduced recovery time. Accordingly, these results are achieved through personalization and feedback-based treatment routes. Finally, strategic integration and management were more like a cross-cutting theme but must be recognized. 27 different articles identified and explored this condition. Moreover, in the results organizational and operational limitations were addressed, especially connected with AI adoption. Literacy gaps, privacy concerns and resource constraints were sub-themes strongly mentioned.

Table 3: Thematic Categories and Subthemes from NVivo Analysis (Developed by the Authors)

Major Themes	Subthemes	N	Insights
Injury Risk Prediction	• Biomechanical Pattern Detection • Workload Threshold Monitoring • Real-time Alert Systems	28	AI identifies risks with high accuracy (80-92%) using gait, EMG, HRV data
Optimized Training & Performance	• Adaptive Programming • Fatigue Analytics • Load Balancing	23	Models shown to improve efficiency by 20-25%
Treatment & Rehabilitation	• Personalized Recovery Paths • AI-Physiotherapy Integration • Feedback Loops	18	Reduced rebab time by 25-30% compared to conventional methods, dynamic plan adjustment
Strategic Integration & Management	• Curriculum and Program Design • Digital Literacy & Faculty Training • Privacy Challenges • Financial/Recourse Barriers	27	Common barriers, lack of skills, cost of AI deployment, data protection issues

5. Discussion

In this research, given the variability in research design, sample size, AI model architecture, validation techniques, and outcome measurements, a statistical meta-analysis was not appropriate. Instead, a structured narrative synthesis method was used. Notably, the reported quantitative results were directly extracted from each study and categorized by comparable performance extents such as injury prediction accuracy, training efficiency gains, and recovery time reduction. Also, where articles reported different statistical indicators, such as AUC, F1-score, and sensitivity/specificity, results were standardized descriptively by reporting ranges and central tendencies, such as minimum–maximum values and approximate means when calculable. Additionally, no weighted averaging was conducted due to inconsistent methodological reporting in existing research. Thus, predictive accuracy and rehabilitation improvements should be interpreted as descriptive synthesis ranges rather than effect sizes. This method reduced overgeneralization and maintained methodological rigor in SLR.

These research results were grounded in the organizational learning, knowledge integration, and dynamic capabilities framework, which improves the relevance of AI-powered analytics in physical education management. From the organizational learning perspective, AI systems function as continuous feedback mechanisms that transform raw and performance data into actionable knowledge. This process supports two types of learning, first, single-loop learning, which entails minor training adjustments, and second, double-loop learning, which involves modifying training policies and safety standards (Argyris & Schön, 1978). The knowledge integration framework emphasized that AI analytics facilitate coordination among coaches, physiotherapists, administrators, and data specialists within a unified decision-support system that improves evidence-based planning and shared understanding (Grant, 1996). Furthermore, the dynamic capabilities framework emphasizes how AI analytics improve an organization's capacity to identify injury risks and adapt treatment and management practices in response to changing conditions (Teece, Pisano, & Shuen, 1997; Teece, 2007).

This qualitative research results allowed the authors to highlight several key analytical extents from available data. At first, Table 4 showed that 87% of reports indicate high predictive accuracy in detecting injury risks, especially when using AI tools, also supported in the findings by Wbaid et al. (2025), Guelmami et al. (2023) and Mishra et al. (2024). In their research, they demonstrated how AI systems are trained to provide EMG, gait analysis, and heart rate variability, and how they outperform traditional tools. Hence, this type of accuracy significantly supports and validates AI tools for predictive injury prevention. This is supposed to be applied not only within the professional or elite athletes, but also in education setting for long-term applications, planning, and engagement.

While AI-powered analytics offer significant possibilities for injury prevention, their effectiveness relies on strategic management, institutional readiness, and governance. Recognizing patterns and correlations in these data can signal potential harm, and AI can pinpoint patterns and links that may elude human observation (Guelmami et al., 2023). These conditions cannot be ignored, as it develops are communication stream between various moving variables.

Table 4 presents evidence to argue the relevance of AI applications in injury prevention, rehabilitation, and strategic communication management. Moreover, Wbaid et al. (2025) argued that AI tools improve performance assessment accuracy, reduce injury occurrences by identifying risk factors in advance, and enhance game strategy through AI-driven insights. Moreover, Snigdha et al. (2023) stated that combining wearable sensors, electronic health records (EHRs), and cloud computing, the system offers customized recommendations and real-time health status updates. Besides Bhamidipaty et al. (2025), in their works address AI-powered sensors in a range of healthcare disciplines. While Mishra et al. (2024) highlight the role of AI-driven analysis in advancing sports medicine by offering a blueprint for coaches, sports medicine professionals, and athletes alike to navigate the complexities of injury prevention and management.

Next, Table 4 reports the gains in rehabilitation efficiency. According to the literature analysis, AI-powered tools improved the rehab process connecting these results to the research by Cui et al., (2023). They demonstrate AI's power to modify recovery plans in real time via progress dashboards. Hence, these applications offer faster return-to-play decisions and lower resource dependency. Additionally, from the reports it was revealed a significant improvement in training personalization and fatigue management while using AI tools. At last, this suggests that AI-powered tools not only assist performance monitoring but managing training volumes.

While some reports highlight the significant role of AI tools in injury prevention and communication management, the role of AI is still conditional (Tischer et al., 2023). The results revealed a gap between institutional adoption and professional sports. Moreover, AI was reported as a strategic integration tool for resource planning, upskilling, and more. According to Tan & Ran (2023) and Zhang et al. (2024), there is a potential in AI-powered tools, but their operationalization in physical education and sports medicine is still limited.

Moreover, Bodemer (2023) explored the scientific foundations of AI-enhanced sports training, discussing the personalization and customization of individual training, performance analysis, and feedback using AI-powered tools, injury prevention and risk assessment through AI models, user experience and interface design considerations, ethical implications and data privacy, case studies and empirical evidence, challenges, and recommendations for further research. Moreover, Song and Tuo (2022) noted that applying AI and virtual reality technologies to the current stage of rehabilitation training can effectively enhance the rehabilitation outcomes of track and field athletes.

Additionally, the literature reported concerns about data governance, privacy, and algorithmic transparency. Higher concerns related to wearables and their monitoring systems. The issues such as legal compliance, autonomy, and more must be taken into consideration while managing and communicating using the data from Ai-tools. Additionally, it can be argued that AI-powered analytics offer transformative opportunities for injury prevention, performance management, and communication in physical education and sports medicine. However, efficiency will require calculated measures from management strategy, data ethics, two-way communication, and evidence-based implementation.

Table 4: Analytical Summary of Key Metrics and Results (Developed by the Authors)

Analytical Dimension	Indicator/metrics	Mean Value	Interpretation
Injury Prediction Accuracy	ML (Machine Learning)prediction accuracy (AUC, F1-score)	36 out of 42	Highest accuracy achieved when using multimodal data (motion, EMG, HRV
Rehabilitation Efficiency	Time to recovery compared to control/standard protocol	14 out of 42	AI-adaptive treatment plans shortened rehab time
Training Optimization	Training workload accuracy, fatigue detection, etc.	11 out of 42	Better detection and injury avoidance through predictive adjustment
Wearable AI Sensor Usage	% of studies using AI-integrated wearables	12 out of 42	Mostly smart insoles, GPS+AI for micro-motion data, IMUs
Contextual Implementation	Studies focused on physical education vs elite sport	14 out of 42	Highlights the gap in AI use within institutional PE settings
Managerial Integration strategy	Inclusion of strategic, financial, or policy guidance	27 out of 42	Few detailed roadmap-style models, many flagged budget/resource barriers
Privacy Concerns	Mentions of data governance, consent, algorithmic fairness	19 out of 42	Growing concerns around wearable surveillance and autonomy
AI Methods Used	ML (SVM, regression), DL (CNN, RNN), hybrid models	22 out of 42	Random Forest was most widely used ML technique due to interpretability
Validated Against Ground Truth	Empirical validation using physiotherapy benchmarks	17 out of 42	Not all studies validated their AI models, limiting generalizability

Table 5 summarizes the systematic literature analysis into actionable strategic recommendations. Table 5 shows that AI-driven tools can significantly improve early injury detection, training load optimization, and rehabilitation efficiency. This, this offers measurable improvements in predictive accuracy and lowered recovery time. This suggests that AI contributes not only to better health results but also to increased functional efficiency and cost savings. Yet the results highlight the need for institutional readiness to ensure sustainable adoption of AI as a strategic tool. Overall, the empirical evidence reveals that AI-led analytics are not only relevant but necessary as strategic tools for creating safer, adaptive, and performance-oriented mechanisms for injury prevention and rehabilitation.

Table 5: Strategic recommendations for Implementing AI-powered Analytics (Developed by the Authors)

Strategic Area	Key Insights from Results	Recommendations	Expected Impact
Injury Prediction & Early Detection	AI models achieved up to 92% accuracy using biometric and workload data	Adopt AI-based risk prediction platforms integrated with wearables and motion analysis tools	Reduced injury incidence, earlier intervention, personalized risk profiling

Rehabilitation Management	AI-assisted rehab programs reduced recovery time by 20-35%	Integrate adaptive recovery software with real-time feedback for therapists and athletes	Faster return-to-play improved treatment adherence and monitoring
Training Load & Fatigue Monitoring	Training optimization improved efficiency by up to 25%	Use Ai tools for real-time fatigue tracking, load balancing, and overtraining alerts	Improved training quality, reduced risk overuse injuries
Curriculum & Physical Education Integration	Only 33% of studies addressed formal PE settings	Develop pilot programs embedding AI analytics in PE classes and teacher education programs	Improved safety in school sports, increased teacher capacity
Institutional Readiness & Management	64% of studies noted gaps in infrastructure or strategic alignment	Create phased implementation plans including budget allocation, infrastructure audits, and faculty training	Sustainable adoption and scaling of AI tool in educational and sports environment
Legal Compliance	45% of studies raised privacy, consent and fairness concerns	Established governance protocols (data consent, bias audits) for student-athlete data	Ensures ethical use and builds stakeholder trust
Validation & Rigor	Only 40.5% validated AI outputs against gold-standard physiotherapy	Encourage cross-validation studies and real-world pilots with physiotherapists and trainers	Higher model reliability and institutional acceptance

To conclude, based on the data analyzed, AI-powered analytics should be developed not merely as technological instruments but as a managerial capability that improves sensing, decision-making, and adaptive learning within physical education systems. From a strategic management standpoint, AI serves as an organizational resource that facilitates dynamic capability development, such as sustaining injury risk identification, real-time training adjustments, and continuous performance optimization. Additionally, advancing the discussion to this level explains how AI contributes to knowledge creation, data-driven learning, and institutional agility for future developments in physical education.

Furthermore, an effective AI application requires organizational readiness. This process includes and demands digital infrastructure, staff competencies, governance protocols, and ethical oversight mechanisms. Therefore, without structured governance frameworks and investment in capability development, the technological benefits reported in this research cannot be sustained. Thus, positioning AI-powered analytics as a strategic management enabler supports this research's contribution to management, knowledge integration, and organizational learning discourse

6. Conclusion

In this research, the authors explored a significant gap in the literature about injury prevention, rehabilitation and communication management. There was a need to address the relevance of AI as a strategic tool in physical education management, given that its integration into educational institutions and structured education systems remains underexplored. Improvements in prediction accuracy, rehabilitation efficiency, and workload management suggest not only technological progress but also the development of sophisticated managerial capabilities that improve strategic flexibility, resource management, and long-term resilience within physical education organizations.

The authors extracted 42 peer-reviewed research articles. Using the PRISMA methodology and NVivo thematic coding, the empirical evidence supporting AI's potential to transform injury prediction, optimize training workloads, and enhance rehabilitation outcomes, with quantifiable improvements in efficiency and accuracy, was analysed. The results confirmed that AI systems can predict injuries with high accuracy, reduce rehabilitation time, and improve training precision. Moreover, these numbers validate AI's capacity to address critical limitations in current injury management frameworks, which often rely on reactive, resource-intensive interventions.

In this research, there is practical value and an opportunity for educational institutions, coaches, and healthcare professionals to implement data-driven, adaptive strategies that improve athlete safety, performance, and resource utilization. This has the potential to improve readiness, adaption and evidence-based decisions. Theoretically, these results contribute to the growing interdisciplinary discourse between artificial intelligence, sports science, and educational leadership. Hence, originality lies in bridging predictive technology with educational policy and operational planning. This offers the groundwork for future empirical research. When used effectively, AI analytics can be a proactive, data-informed too to physical well-being.

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