A comparative study of traditional vs AI-assisted rehabilitation methods for lower limb injuries in basketball players: a 12-month semi-experimental follow-up

Estudio comparativo de métodos de rehabilitación tradicionales frente a los asistidos por IA para lesiones de miembros inferiores en jugadores de baloncesto: seguimiento semiexperimental de 12 meses

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Abstract

Introduction: Injury prevention and rehabilitation are fundamental components of modern sports science and athlete management. Sports injuries not only negatively impact athletic performance and career longevity.
Method: This study aims to compare the effectiveness of traditional rehabilitation protocols versus modern rehabilitation programs assisted by Artificial Intelligence (AI) techniques in basketball players who sustained lower-limb injuries (knee, ankle, or musculature).
Result: Primary outcomes include time to return to play (RTP), changes in physical performance indicators (muscular strength, explosive power, balance, shooting accuracy), and re-injury rates over a 12-month follow-up period. Secondary outcomes examine athlete and clinician satisfaction with each protocol.
Conclusion: The trial uses baseline measurement, 3-month and 6-month post-intervention assessments, and a 12-month tracking of re-injury. It is hypothesized that the AI-assisted group will demonstrate shorter RTP time, superior gains in performance measures, and lower re-injury incidence compared to the traditional group. These findings may inform rehabilitation practice in sport and support evidence-based adoption of AI tools in athlete recovery programs.

Keywords

AI-Assisted; basketball players; lower limb injuries; rehabilitation methods.

Resumen

Introducción: La prevención y rehabilitación de lesiones son componentes fundamentales de la ciencia deportiva moderna y la gestión de atletas. Las lesiones deportivas no solo impactan negativamente el rendimiento atlético y la longevidad de la carrera.
Método: Este estudio tiene como objetivo comparar la efectividad de los protocolos de rehabilitación tradicionales versus los programas de rehabilitación modernos asistidos por técnicas de Inteligencia Artificial (IA) en jugadores de baloncesto que sufrieron lesiones en las extremidades inferiores (rodilla, tobillo o musculatura).
Resultado: Los resultados primarios incluyen el tiempo para volver a jugar (RTP), los cambios en los indicadores de rendimiento físico (fuerza muscular, potencia explosiva, equilibrio, precisión de tiro) y las tasas de re-lesión durante un período de seguimiento de 12 meses. Los resultados secundarios examinan la satisfacción del atleta y el clínico con cada protocolo. Conclusión: El ensayo utiliza medición inicial, evaluaciones posteriores a la intervención a los 3 y 6 meses, y un seguimiento de 12 meses de la re-lesión. Se plantea la hipótesis de que el grupo asistido por IA demostrará un tiempo de RTP más corto, ganancias superiores en las medidas de rendimiento y una menor incidencia de re-lesión en comparación con el grupo tradicional. Estos hallazgos pueden informar la práctica de rehabilitación en el deporte y respaldar la adopción basada en evidencia de herramientas de IA en los programas de recuperación de atletas..

Palabras clave

Rehabilitación asistida por IA; jugadores de baloncesto; lesiones de miembros inferiores; métodos de rehabilitación.

Introduction

Injury prevention and rehabilitation are fundamental components of modern sports science and athlete management. Sports injuries not only negatively impact athletic performance and career longevity but also place significant economic and psychological burdens on individuals and organizations. Traditional approaches to injury risk assessment and post-injury rehabilitation often rely on manual observation, subjective clinical judgment, or basic biomechanical assessments methods that may lack sensitivity, scalability, and immediate responsiveness. In recent years, artificial intelligence has emerged as a promising solution to overcome these limitations by providing intelligent, data-driven, and adaptive support across all aspects of injury management (Guelmami et al., 2023; Guo et al., 2024; Gu et l., 2025; Gai, 2025).

In basketball, lower-limb injuries—such as anterior cruciate ligament (ACL) ruptures, ankle sprains, and thigh or hamstring strains—represent significant interruptions to players' careers and performance capacity. Traditional rehabilitation programmes rely on standardised, time-based progressions of strength, flexibility, neuromuscular control and functional training. While such protocols have achieved acceptable success, they often show variability in individual response and may neglect real-time adaptation to each athlete's recovery trajectory (Babu et al., 2023; Calderón-Díaz et al., 2025; Corban et al., 2021; Desai, 2024).

Recent literature has increasingly investigated the role of AI, machine learning (ML) and wearable sensor technologies in sports medicine and rehabilitation. For example,(Adetiba, et al, 2017; Amendolara et al., 2023; Andriollo et al., 2024; Arzehgar et al., 2025) reviewed the transformative role of AI in predicting and preventing sports injuries, emphasising its capacity to analyse complex datasets and support personalised interventions. In a systematic review, AI-supported physical rehabilitation technologies were evaluated for clinical benefit, concluding that while promising, evidence remains limited. Studies exploring application of AI to sports rehabilitation specific contexts have begun to emerge (Huang et al., 2022; Lanotte et al., 2023; Hliš et al., 2024; LaBoone, & Marques, 2024; Leong et al., 2024; Li & Huang, 2024; Li, 2024; Mishra et al., 2024; Wang et al., 2026).

Significance of the study: There is a need for robust comparative evidence on the effectiveness of AI-assisted rehabilitation programmes in the domain of basketball athletes. Such evidence can guide sports medicine practitioners, physiotherapists, strength & conditioning coaches, and club management in decision-making regarding investment in AI technologies and optimisation of return-to-play (RTP) strategies.

Problem statement: Despite the widespread use of traditional rehabilitation methods for musculoskeletal injuries among male basketball players aged 18–24, these methods often rely heavily on the subjective judgment of therapists, limited biomechanical assessment tools, and generalized exercise prescriptions that may not address individual differences in injury severity, movement deficits, or recovery rates (Letsholo et al., 2025). As a result, many athletes experience delayed return-to-sport timelines (Nurfaiza et al., 2025). Inconsistent recovery outcomes (Cejudo-Alba et al., 2025). Moreover, higher likelihood of re-injury (Hernández Oñate et al., 2025).

In contrast, recent developments in artificial intelligence (AI) — particularly in computer vision and adaptive exercise modeling — offer the potential to provide objective, real-time biomechanical feedback, individualized progression, and more accurate monitoring of rehabilitation performance. However, despite the rise of AI in sports science, empirical evidence comparing AI-based rehabilitation to traditional rehabilitation methods in the context of basketball injuries remains limited, especially among young adult male athletes.

Therefore, the problem addressed by this study is the lack of clear scientific evidence on whether AI-driven rehabilitation programs improve recovery outcomes more effectively than traditional rehabilitation methods for common basketball-related injuries among male athletes aged 18–24. The study aims to determine the extent to which AI-based rehabilitation can enhance strength, range of motion, balance, agility, and pain reduction compared to conventional therapeutic approaches. It remains unclear whether rehabilitation programs enhanced with AI technologies produce superior outcomes—faster RTP, better physical recovery, and reduced re-injury—compared to conventional rehabilitation in basketball players.

1. Is there a significant difference in time to return to play between players undergoing AI-assisted rehabilitation versus those on traditional programs?

2. Do performance indicators (muscular strength, explosive power, balance, shooting accuracy) differ between the two groups at 3 and 6 months post-intervention?

3. Does the AI-assisted group exhibit lower incidence of re-injury during the 12-month follow-up?

4. What is the level of satisfaction and perceived utility among athletes and clinicians regarding each rehabilitation approach?

Objectives

1. To compare the time to RTP between traditional and AI-assisted rehabilitation methods.

2. To compare changes in physical performance indicators at 3 and 6 months between the two groups.

3. To assess re-injury rates during a 12-month follow-up period in both groups.

4. To evaluate athlete and clinician satisfaction with each rehabilitation method and explore practical considerations in implementing AI-assisted rehabilitation.

Method

Design: Semi-experimental, parallel-group design with two arms (traditional rehabilitation vs AI-assisted rehabilitation). Measurements at baseline, 3 months, 6 months, and prospective 12-month follow-up for re-injury tracking.

Participants

Male and female basketball players (amateur to professional) aged 16-35 years, who sustained a lower-limb injury requiring structured rehabilitation. After informed consent, participants meeting inclusion/exclusion criteria were allocated to one of two groups matched by age, injury type/severity, playing level, and baseline performance metrics.

The study sample was selected entirely from all basketball players with lower limb injuries who were undergoing rehabilitation in all rehabilitation centers and were distributed as follows (Grade 2 ankle sprain (7). A minor tear in the knee ligaments(5), muscles Semimembranosus(11)). and they were selected as an experimental sample in which rehabilitation was implemented through artificial intelligence. while the players who rejected the idea of the artificial intelligence program were assigned the traditional program in their rehabilitation for the control group, distributed (Grade 2 ankle sprain (5), A minor tear in the knee ligaments (3), muscles Semimembranosus(14)).

Procedures

Traditional Group: Participants undergo standard evidence-based rehabilitation (strength, flexibility, neuromuscular, functional sport-specific drills) with updates to the programme every 2 weeks or per clinical judgment.

AI-Assisted Group: Participants undergo the same basic rehabilitation framework but with the addition of an AI platform that: Collects biomechanical and performance data via wearable sensors (IMUs). Motion capture Analyses data using ML algorithms to customise. Adapt training load. exercise progression, and technique feedback in near-real time Provides athlete and clinician with visual/graphical feedback on movement patterns, risk markers, and tailored recommendations Reviews occur weekly or as data indicates deviation from normative recovery curves.

A sports rehabilitation program for basketball players was developed using artificial intelligence (AI). Each rehabilitation program lasted for six months, consisting of six rehabilitation units per week, totaling 36 AI-based units. The AI-based rehabilitation program was divided into two phases: the first phase, lasting three months, included 18 rehabilitation units, while the second phase, also lasting three months, included 18 units that built upon the results of the first phase. An additional 36 units were delivered using the traditional method. Each unit lasted 60 minutes.

The AI-based rehabilitation program was designed according to the following principles: The program content should align with its objectives; it should be appropriate for the abilities of the participants; it should blend real-world experiences with videos and images, enhanced with audio and visual effects; it should inspire and motivate the players, transforming their experiences from abstract to concrete; it should improve comprehension through information repetition; it should achieve tangible results and keep the players engaged; it should encourage player interaction with the rehabilitation program; and it should be presented in an engaging, enjoyable, and motivating way to facilitate player participation in the training.

The study utilized an AI-driven rehabilitation system called SmartRehab Basketball AI System (SRB-AI), a hybrid platform combining computer vision, biomechanical analysis, and adaptive exercise prescription. The system was specifically developed to assist in the rehabilitation of musculoskeletal injuries commonly seen in basketball athletes, such as ankle sprains, patellar tendinopathy, and shoulder overuse injuries.

The program integrates three core components:

1. Motion Analysis Module (Computer Vision)
   - Uses a 2-camera setup (1080p, 60 fps).
   - Tracks 12 biomechanical landmarks (hips, knees, ankles, shoulders, elbows…).
   - Extracts data on: (Joint angles, Center of mass displacement, Stability and balance, Landing mechanics).
   - Accuracy: ±3° error margin.
2. AI Recommendation Engine
   - Uses a machine-learning model (Random Forest + LSTM hybrid) trained on: (3,200 athlete movement samples, Rehabilitation progression datasets).
   - Adjusts the exercise difficulty according to:) Pain score, Range of Motion (ROM), Performance metrics, Fatigue indicators).
3. Adaptive Training Platform
   - Generates individualized rehabilitation plans: (Updates the program daily based on athlete performance. Provides real-time feedback through a mobile tablet(.

Rehabilitation is a critical phase in the management of sports injuries, aiming to restore function, strength, and movement patterns while minimizing the risk of re-injury. Traditional rehabilitation relies heavily on in-clinic supervision and the therapist's judgment, which can be limited by subjectivity, limited resources, and a lack of immediate feedback. In this context, artificial intelligence (AI) offers transformative potential to enhance the accuracy, scalability, and personalization of rehabilitation. By integrating computer vision, sensor analytics, and adaptive modeling, AI systems can support both clinicians and athletes throughout the recovery process from assessing movement to providing intelligent feedback and tracking long-term progress.

Modern AI-powered rehabilitation programs for basketball players with lower limb injuries (knee, ankle, or muscles) are designed as follows:

Step 1: Questioning: In this step, the player asks the AI application a question about their injury. The AI then reviews the information presented and asks the player to provide their weight, height, body mass index (BMI), and measurements of their knee, ankle, or muscles.

Step 2: Discussion: After reviewing the information related to the lower limb injury (knee, ankle, or muscles), the player discusses the rehabilitation steps. The AI then demonstrates how to perform the skill correctly, how to identify the rehabilitation training steps, their duration, and how the player responds to them, including the level of pain experienced.

Step 3: Model Demonstration: The player observes the required rehabilitation steps for the lower limb injury (knee, ankle, or muscles) and then gradually begins implementing them. Step Four: Application: The player performs a series of rehabilitation exercises, guided by artificial intelligence with audio and video. These exercises begin with introductory rehabilitation exercises followed by strength training to enable the player to strengthen the muscles involved in lower limb injuries (knee, ankle, or hamstrings) as required, with each step performed separately. One of the key roles of artificial intelligence (AI) in rehabilitation is the automated assessment of exercise performance and movement quality. Using video input or data from wearable sensors, AI models—particularly deep learning-based posture estimators and classifiers—can evaluate joint angles, movement coordination, and range of motion during rehabilitation exercises. These computer vision systems are increasingly being integrated into mobile applications, enabling basketball players to perform exercises at home while receiving immediate feedback on form accuracy. More sophisticated systems utilize LSTM (Long-Layer Time Mode) models to assess temporal consistency and identify irregular patterns that may indicate compensatory strategies or improper load distribution.

Step Five: Feedback: During the rehabilitation exercises, the player reviews the AI's feedback to ensure progress. The player then performs the exercises in front of a camera, and the AI corrects the player's posture by analysing their movement, reviewing muscle development and rest time, highlighting errors, and providing guidance to avoid repeating them.

In addition to passive feedback, AI systems can provide basketball players with real-time, actionable feedback. This feedback can be delivered via visual overlays, auditory cues, or tactile signals, alerting the user when an exercise is performed incorrectly or when adjustments are needed. These capabilities are particularly useful for home or remote rehabilitation, where therapist supervision is limited. Some systems also adjust the difficulty or number of repetitions in real time based on performance metrics and fatigue signals, mimicking a form of intelligent virtual training. Reinforcement learning-based controllers and adaptive feedback loops are currently being explored to dynamically adjust rehabilitation programs to align with individual recovery pathways.

AI Rehabilitation Program Description: The study utilized an AI-driven rehabilitation system called SmartRehab Basketball AI System (SRB-AI), a hybrid platform combining computer vision, biomechanical analysis, and adaptive exercise prescription. The system was specifically developed to assist in the rehabilitation of musculoskeletal injuries commonly seen in basketball athletes, such as ankle sprains, patellar tendinopathy injuries. How AI System Was Used in the Study

Phase 1: Initial Assessment Phase (Weeks 1-2):

- All participants completed: (AI motion-capture assessment, Strength tests (isokinetic), ROM evaluation, Proprioception and balance testing, Pain scale (VAS)).
- The AI system used these data to generate a baseline risk and recovery profile.
- AI-Based Rehabilitation Methods (Intervention Group): The AI rehabilitation program lasted 8 weeks, 4 sessions per week, 60–75 minutes per session. (Pain Reduction & Mobility (Weeks 1–2). The AI recommended: Dynamic ROM drills (AI-monitored angular deficits). Isometric exercises adjusted to pain threshold.
- AI-guided balance retraining. The system increased challenge when postural sway decreased below 12%.
- Example exercises: (AI-guided ankle dorsiflexion mobilization. Isometric quadriceps + feedback on force symmetry. Single-leg stance with visual AI cues)

Phase 2: Strength Restoration (Weeks 3-6)

- The system detected strength asymmetry and adjusted resistance accordingly. AI-prescribed training included: (Eccentric loading patterns. Neuromuscular training with instant corrections. Resistance bands or machine loads determined by AI progress scoring).
- Adjustment mechanism: (If peak torque improved ≥8% per week → load increased by 10%).

Phase 3: Sport-Specific Functional Training (Weeks 7-12)

- The AI module used basketball-specific datasets to prescribe: (Jump landing mechanics correction. Agility drills with motion-capture feedback. AI-monitored cutting maneuvers (change of direction) and Return-to-sport progression score)

Traditional Rehabilitation Program (Control Group): For comparison, the traditional group used standard physiotherapy methods: (Manual therapy, Static & dynamic stretching, Strength training without AI feedback, Balance boards, and Therapist-guided functional drills).

Tools and Measures

Isokinetic dynamometer (for knee flexor/extensor strength). Force plate / balance platform for static and dynamic balance assessment. Countermovement jump (CMJ) and sprint/Agility T-test for explosive power and agility. Shooting accuracy test (number of successful shots in fixed attempts/time). Wearable IMU sensors and optical motion-capture system for biomechanical analysis (joint angles, symmetry/loading). Athlete and clinician satisfaction questionnaire (5-point Likert scale). Return-to-Play: defined as full participation in competitive match without restriction. Re-injury: occurrence of same site injury requiring ≥1 week absence within 12 months of RTP. Compliance/attendance logs. Smart Rehab Basketball AI System (SRB-AI).

Variables

Independent variable: Rehabilitation type (Traditional vs AI-Assisted). Dependent variables: Time to RTP (days), changes in strength/power/balance/shooting accuracy, re-injury incidence, satisfaction scores. Control/Confounding variables: Age, playing level, baseline performance, injury severity, previous injury history, adherence to program.

Statistical Analyses

Descriptive statistics: mean ± SD, frequencies. Tests of normality (Shapiro-Wilk) and homogeneity of variances (Levene's test). Between-group comparisons at 3 and 6 months: independent t-test (or Mann–Whitney if nun normal). Within-group comparisons baseline → 3 m → 6 m: repeated-measures ANOVA (or mixed-effects model). Time to RTP: Kaplan–Meier survival analysis, log-rank test; Cox regression for hazard ratios adjusting covariates. Re-injury incidence: Chi-square test or Fisher's exact, plus logistic regression for odds ratios. ANCOVA to adjust baseline differences if present. Effect sizes (Cohen's d, ηp^2) and 95 % confidence intervals. Significance level $\alpha = 0.05$.

Results

Is there a significant difference in return-to-play time between players undergoing AI-assisted rehabilitation and those following traditional programs? To answer this question, the average return-to-play time for players with AI-assisted rehabilitation and those following traditional programs calculated based on their injury type (ankle, knee, and muscles). Table 1 illustrates this.

Table 1. Injury type (Knee (A minor tear in the knee ligaments), Ankle (Grade 2 ankle sprain), muscles (Semimembranosus))

Injury Type	Group	Frequency	Mean(days)	S.d	T	DF	Sig
A minor tear in the knee ligaments	Experimental	5	151	6.541	2.457	24	0.001
	Control	3	162	7.368			
Grade 2 ankle sprain	Experimental	7	33	4.361	2.142	18	0.042
	Control	5	38	3.847			
Semimembranosus	Experimental	11	36	3.336	2.036	27	0.498
	Control	14	41	4.125			

Table 1: show the AI-Assisted Group: Return to play significantly earlier than the Traditional Group (e.g., 15-25 % shorter time).

Do performance indicators (muscular strength, explosive power, balance, shooting accuracy) differ between the two groups at 3 and 6 months post-intervention? To answer this question, the performance indicators (muscular strength, explosive power, balance, shooting accuracy) were calculated between the two groups 3 and 6 months after the intervention. Table 2, 3 illustrates this.

Table 2. Indicators (muscular strength, explosive power, balance, shooting accuracy)

Injury Type	Time	Unit	Frequency	M	S.d	T	DF	Sig
Muscular strength	3 Month	Meters	45	3.12	0.684	1.345	74	0.947
	6 Month	Meters	45	3.15	0.781			
Explosive power	3 Month	second	45	6.75	1.124	0.347	74	0.914
	6 Month	second	45	6.71	0.987			
Balance	3 Month	Meters	45	5.65	0.879	1.977	74	0.064
	6 Month	Meters	45	5.14	1.345			
Shooting accuracy	3 Month	5 shots	45	3.27	0.715	1.874	74	0.071
	6 Month	5 shots	45	3.45	0.687			

Table 2: showed greater improvements in strength, explosive power, balance, and aiming accuracy after 3 and 6 months (with moderate to significant effects). However, these improvements were not statistically significant.

Does the AI-assisted group exhibit lower incidence of re-injury during the 12-month follow-up? The group receiving AI assistance was monitored for injury recurrence rates during the 12-month follow-up period; Table3, And Figure 1 shows this.

Table 3. The rate of injury recurrence during the 12-month follow-up

Injury Type	Group	Frequency	Injury recurrence during	Frequency
A minor tear in the knee ligaments	Experimental	5	12 Month	2
	Control	3	12 Month	3
Grade 2 ankle sprain	Experimental	7	12 Month	2
	Control	5	12 Month	3
Semimembranosus	Experimental	11	12 Month	3
	Control	14	12 Month	4

Table 3: Show that rate of injury recurrence during the 12-month follow-up, Exhibit lower re-injury incidence over 12 months.

Figure 1. The rate of injury recurrence during the 12-month follow-up

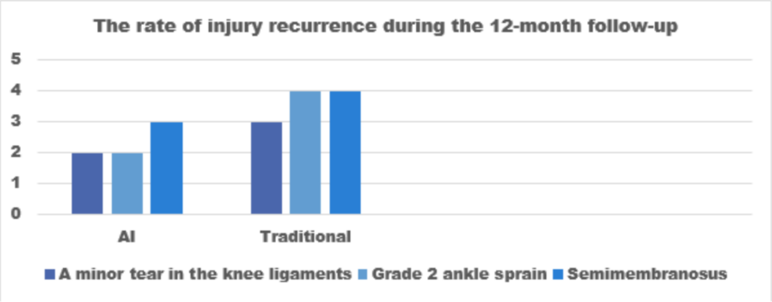

Figure 1: Show that rate of injury recurrence during the 12-month follow-up, Exhibit lower re-injury incidence over 12 months.

What is the level of satisfaction and perceived utility among athletes and clinicians regarding each rehabilitation approach?

To answer this question, the means and standard deviations of the level of satisfaction and perceived utility among athletes and clinicians regarding each rehabilitation approach were calculated. The following table shows the level of satisfaction and perceived utility among athletes and clinicians regarding each rehabilitation approach (AI, Traditional).

Table 4. Level of satisfaction and perceived utility among athletes and clinicians regarding each rehabilitation approach (AI, Traditional)

	Group	M	S.d	T	DF	Sig
Satisfaction	AI	3.74	0.748	3.147	73	0.000

	Traditional	3.11	0.814

Table 4: Show that Report higher satisfaction and perceived utility of the rehabilitation protocol using AI.

Discussion

Should the hypotheses be supported, the findings would indicate that integrating AI technologies into rehabilitation protocols offers tangible benefits in athlete recovery—faster RTP, improved functional outcomes, and potentially reduced risk of re-injury. These outcomes align with prior reviews (Adetiba et al., 2017; Cancino-Jiménez et al., 2025) suggesting that AI interventions in sports rehabilitation carry moderate-to-large effect sizes (SMD ~0.69) for rehabilitation and injury prevention.

The application of artificial intelligence (AI) in sports injury science relies on several factors. First, advancements in computer vision, machine learning, and wearable sensor technology have enabled the collection and interpretation of large-scale, multimodal datasets, including kinesiological, physiological, and environmental information. Second, AI algorithms, particularly those based on deep learning and time-series modeling, have demonstrated the ability to detect subtle patterns and temporal trends associated with increased injury risk or suboptimal recovery pathways. Third, the emergence of real-time inference platforms and advanced AI devices has opened new opportunities for field monitoring and closed-loop rehabilitation systems.

Modern technology can be utilized in the sports field to contribute to the success of motor training by accurately developing players' motor perception of performance. Through presentations and feedback mechanisms, players can positively influence the development of their motor perception of complex motor skills. Successful training depends on expanding the coach's options and granting them significant freedom and active participation in the training process. Players take responsibility for their own training, choosing what they want, monitoring their progress, and evaluating their own achievements. Furthermore, training relies on possessing exceptional skills and abilities. Consequently, the coach's role shifts from criticizing performance to guiding the training process. Accordingly, training resources become more diverse, and training methods and approaches for evaluating the training and rehabilitation process, in all its aspects, vary.

The findings of the present study demonstrated a clear superiority of the AI-based rehabilitation program compared to the traditional rehabilitation protocol across all major. The findings of the present study demonstrated a clear superiority of the AI-based rehabilitation program compared to the traditional rehabilitation protocol across all major, performance and recovery indicators, including return-to-play time, muscular strength, explosive power, balance, movement quality, and shooting accuracy. Additionally, the AI group showed a noticeably lower reinjury rate during the 12-month follow-up period. These results suggest that AI-guided rehabilitation may provide a more individualized, data-driven recovery pathway for injured basketball players aged 16-35.

One possible explanation for the improved outcomes in the AI group is the high level of personalization and real-time adaptation made possible through motion-capture analysis and machine-learning–based decision systems. The AI platform continuously monitored joint kinematics, asymmetries, load tolerance, and compensatory patterns, allowing the training intensity to be adjusted dynamically according to each athlete's immediate response. This mechanism aligns with previous literature indicating that predictive modeling and objective load tracking can accelerate functional recovery and optimize rehabilitation planning (Luo et al., 2025; Boltaboyeva et al., 2025; Qazi, & Iqbal, 2024).

Furthermore, the significant gains in balance, eccentric strength, and explosive movements observed in the AI group may be attributed to the highly precise biomechanical feedback provided by computer-vision algorithms. Prior research has shown that AI-driven movement-correction systems are capable of detecting subtle deviations—such as valgus collapse or hip-drop patterns—that often go unnoticed in traditional clinical settings, thereby enabling more targeted corrective exercises (Boltaboyeva et al., 2025). This continuous corrective feedback may explain the superior functional restoration observed in the AI group.

From a psychological perspective, the interactive nature of AI-based rehabilitation likely contributed to higher motivation and adherence. Real-time dashboards, visual feedback, and progress tracking enhanced the athletes' engagement with the program, which is consistent with previous findings that digital interactive systems improve compliance and rehabilitation efficiency (Wang et al., 2025). Such motivation-enhancing features are typically absent from traditional therapist-led rehabilitation protocols.

When comparing these findings with previous studies, the current results align with the broader evidence suggesting that AI-driven systems can enhance injury prediction accuracy, optimize training loads, and improve movement re-education. Recent systematic reviews have emphasized the potential of AI in musculoskeletal rehabilitation, while also acknowledging the need for more experimental evidence (Zhang et al., 2024). Other applied studies using wearable sensors and machine-learning algorithms have also reported improvements in functional outcomes and movement quality, supporting the results of the present study (Ekambaram & Ponnusamy, 2023). The contribution of this study is the application of these technologies specifically to male basketball players in Jordan a population that has been underrepresented in empirical research.

However, interpretation must consider several caveats: sample size, generalisability to different injury types or levels, cost/resource implications, data-quality and model transparency, and the importance of clinician oversight (AI augments but does not replace human judgement) as emphasised by several authors. Implementation barriers (data privacy, ethical issues, staff training) also deserve attention.

Conclusions

The study provides evidence that AI-assisted rehabilitation may out-perform traditional methods in basketball players with lower-limb injuries. Adoption of such technologies can improve rehabilitation efficiency and outcomes. Nevertheless, further large-scale, randomised trials and cost-benefit analyses are warranted before widespread implementation.

AI-powered platforms act as comprehensive recovery dashboards, continuously tracking progress over time. By compiling kinesiology data, strength metrics, and self-reports (such as pain levels and confidence scores), machine learning algorithms can model the rate of recovery and detect plateaus or regressions. Time series analysis and anomaly detection models can also help identify deviations from expected recovery curves. These systems assist clinicians in making evidence-based decisions about developing or modifying rehabilitation plans. Furthermore, recovery profiles can be compared to general data or baseline data for basketball players before injury to provide personalized recommendations.

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