

High-risk Movement Patterns in Athletes Returning after ACL Reconstruction: A Systematic Evidence Review

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ABSTRACT

Introduction: Despite advances in surgical techniques and rehabilitation, athletes who return to sport after Anterior Cruciate Ligament Reconstruction (ACLR) remain vulnerable to a second ACL injury. Increasing attention has been directed toward subtle biomechanical and neuromuscular deficits that may persist at return to sport but are not routinely captured by standard clinical criteria.

Aim: To systematically synthesise evidence on high-risk movement patterns observed in athletes returning to sport following ACL reconstruction.

Materials and Methods: This systematic review followed PRISMA 2020 guidelines. A comprehensive literature search was conducted in PubMed, Scopus, ScienceDirect, Web of Science, and BMJ Open Sports and Exercise Medicine for studies published between January 2000 and March 2025. Eligible studies involved athletes post-ACLR and reported Aim movement-based outcomes, including biomechanical, kinematic, kinetic, or neuromuscular measures assessed at or near return to sport. Due to methodological variability across studies, findings were synthesised narratively.

Results: Forty-three studies were included in the qualitative analysis. Across a range of dynamic tasks such as landing, cutting, hopping, and sport-specific movements, athletes commonly demonstrated persistent movement deficits. These included increased frontal-plane knee motion, reduced knee flexion strategies, inter-limb asymmetries, altered joint loading, and impaired neuromuscular control. Notably, several studies reported these high-risk patterns even in athletes who satisfied conventional return-to-sport benchmarks.

Conclusion: Evidence consistently indicates that movement-related risk factors may persist at return to sport after ACL reconstruction. Reliance on time-based or performance-based criteria alone may be insufficient. Integrating movement-quality and biomechanical assessment into return-to-sport decision-making could enhance reinjury prevention strategies.

Keywords: Anterior cruciate ligament, Biomechanics, Movement quality, Neuromuscular control, Return to sport, Secondary injury.

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