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Psychological and Functional Outcomes in Athletes Post-ACL Reconstruction: A Narrative Review of the Impact of Symptomatic and Non-Symptomatic Recovery

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Abstract
ACL injuries make it difficult for athletes to resume sports without surgery because they cause joint swelling, muscle weakness, altered movement, and decreased functional performance. Even though the most common surgery for ACL-injured athletes who want to return to competitive sports is anterior cruciate ligament reconstruction (ACLR), less than half of them recover within the first year following surgery, and about 25% of those who do experience another knee injury. Physical activity, which is part of the non-surgical treatment, is impacted by psychological outcomes such as lack of confidence and fear of re-injury. ACL injury patients have also reported poor subjective knee function, asymmetric hop performance, landing mechanics similar to those at risk for ACL injury, insufficient and asymmetric quadriceps strength, and an increased chance of a second ACL injury. Investigating the effects of both symptomatic and non-symptomatic recovery following ACL reconstruction in athletes is the aim of this study. Boolean operators and MeSH key headings were used to electronically search the PubMed, Scopus, Web of Science, and Google Scholar databases in order to find relevant articles from the previous 15 years.

Keywords ACL reconstruction, symptomatic athletes, psychological outcomes, functional performance, return to sports, kinesiophobia, resilience and fear-avoidance beliefs.

INTRODUCTION

A common traumatic event that usually happens during sports activities is an anterior cruciate ligament (ACL) injury, which frequently results in an inability to resume the same level of activity as before the injury. Anterior cruciate ligament (ACL) injuries are common among athletes and are frequently severe enough to keep them from returning to their previous level of play. Adolescent and female athletes, as well as those who participate in pivoting and cutting sports, are at a higher risk of suffering an ACL tear. According to earlier studies, high school female athletes may sustain an ACL injury at a rate of one injury out of every 60. [1]

Compared to practice sessions, competitions are where ACL injuries occur most frequently. These two environments have very different conditions. Because they practice more and try out new tactics more frequently, athletes are more likely to sustain injuries. Nonetheless, competitions put more strain on the body and mind, which probably explains why the current research indicates a higher rate of injuries

sustained during games. For both male and female participants, noncontact injuries were the most prevalent kind. In particular, noncontact injuries accounted for about 70% of female injuries, which was significantly higher than both the frequency of noncontact injuries in males and the prevalence of all other injury types in females..[2]

About 90% of ACL injury patients in the US eventually have anterior cruciate ligament reconstruction (ACLR), making it the most popular treatment option for ACL injuries.[1] Although the majority of patients who undergo ACL reconstruction (ACLR) eventually resume their athletic activities, this outcome is influenced by a number of factors. These include the risk of further knee injuries, as well as physical factors like knee condition, psychological obstacles like fear of re-injury, the particular sport, and social obligations like work and family. According to numerous studies, women who suffer from ACLR frequently report lower rates of returning to sports than men do. This trend is evident for both returning to a pre-injury athletic level and a competitive level. [3]

According to studies, many athletes find it difficult to resume competitive sports following ACL reconstruction. 66% of athletes hadn't returned by 12 months after surgery, and only 44% ever did, according to Ardern et al. This was primarily because of fear of re-injury. Similar return-to-play rates were noted in the Multicenter Orthopedic Outcomes Network (MOON) study, where half of the athletes who chose not to return cited fear of re-injury as the reason. Therefore, the authors of the MOON study suggested that psychological factors may be more important—yet frequently disregarded—in allowing athletes to return to their sport. Kinesiophobia, or a fear of movement, has a major impact on injury recovery by impeding rehabilitation and lowering physical activity levels. Despite its significance, decisions about returning to activity frequently overlook this patient-reported fear in favor of more objective physical measurements. Inadequate and asymmetrical quadriceps strength, unbalanced hop performance, landing mechanics linked to ACL injury risk, a higher likelihood of a second ACL injury, and subjective reports of poor knee function are among the other troubling deficiencies seen in patients with elevated kinesiophobia. [4]

Because they are unable to fully regain their pre-injury physical capabilities, many athletes who suffer an ACL injury find it difficult to return to their previous level of athletic performance. Lower-extremity function must fully recover in order to perform well and avoid re-injury. Consequently, choosing the best recovery strategy and determining when it is safe for an athlete to resume their sport are significant challenges in ACL rehabilitation.[5]

The purpose of this narrative review is to compile the most recent findings regarding the effects of both symptomatic and non-symptomatic recovery in athletes following ACL reconstruction. Comparing the effects of symptomatic and non-symptomatic recovery in athletes following ACL reconstruction is the study's goal.

Method

Search Strategy and Databases - The literature search is carried out from 2015 to 2024 in the following scientific databases: Pubmed, Google scholar PRISMA guidelines followed.

To carry out the searches in the scientific database, the keywords ACL reconstruction, psychological readiness, functional recovery, return to sport, symptomatic recovery, non-symptomatic recovery, neuromuscular training, kinesiophobia.

Inclusion & Exclusion Criteria

Articles from 2015 to 2024 Inclusion: RCTs, cohort, case-control, and systematic reviews on ACLR in athletes.

Exclusion: Studies focusing on non-athletes or incomplete rehabilitation protocols.

S.no.	Authors, Year	Objectives	Study design	Methods	Result
1.	Johanna M. Hoch et al. 2024[6]	The purpose of this study was to examine differences in health-related quality of life (HRQL) and psychological outcomes in people with a history of ACLR who were categorized as symptomatic or non-symptomatic by application of the Englund criteria	Cross-sectional, survey	Participants at least one-year after ACLR were recruited for the study and completed the Tegner Activity Scale, the Brief Resilience Scale (BRS), the modified Disablement in the Physically Active Scale (mDPA), and the Fear-Avoidance Belief Questionnaire (FABQ) at one time-point. Descriptive statistics were summarized using median [interquartile range] and differences between groups were examined using separate Mann-Whitney U tests.	Participants with symptomatic knees had a significantly higher BMI (24.8 [6.4]) than the non-symptomatic group (21.2 [4.3], p=0.013). Participants in the symptomatic group had worse HRQL on the physical subscale (12.5 [16.3] vs. 0.0 [2.5], p<0.001) and mental subscale (2.0 [1] vs. 0.0 [1], p=0.031), higher scores on the FABQ-Sport (14.5 [11] vs. 0.0 [6], p<0.001) and FABQ-Physical Activity (20 [24] vs. 1 [4], p<0.001) and less resilience (3.7[0.42] vs. 4.0 [0.83],

					p=0.028)) compared to those participants in the non-symptomatic group. There were no differences in current physical activity (p=0.285) or change in physical activity (p=0.124) levels between the two groups.
2.	Shelby E. Baez et al. 2020 [7]	The purpose of this study was to examine the association of patient-based, specifically psychological, and functional outcomes with return to sport and physical activity.	Modified cross-sectional design	Forty participants, a minimum of 1-year post-ACLR, reported to the laboratory for one-testing session. Participants completed a series of patient-based and functional outcome assessments. Participants were also instructed to wear a pedometer for 1 week to monitor their daily steps.	pedometer for 1 week to monitor their daily steps. Results Twenty-five participants (62%) did not return to sport and 29 participants (72%) did not average 10,000 steps per day. Individuals with elevated levels of self-reported kinesiophobia were 17% less likely to return to sport. Self-reported knee self-efficacy and knee-related quality of life

					accounted for 27.1% of the variance of average daily step counts.
3.	Susanne Beischer et al. 2019[8]	To investigate psychological readiness to return to sport, knee-related self-efficacy, and motivation among adolescent (15-20 years old) and adult (21-30 years old) athletes after ACL reconstruction. A further aim was to compare athletes (15-30 years old) who had recovered their muscle function and returned to sport with athletes who had not	Case-control study	Data were extracted from a rehabilitation-specific register 8 and 12 months after ACL reconstruction. Athletes previously involved in knee-strenuous sport who had undergone primary ACL reconstruction were included. Data comprised psychological patient-reported outcomes and results from 5 tests of muscle function. Comparisons were performed between age groups, between athletes who had and had not recovered their muscle function, and between patients who had returned to sport and not	Enhanced self-efficacy was reported at both follow-ups by adolescents and by athletes who had recovered their muscle function. Athletes who had recovered their muscle function reported higher (P = .0007) motivation to achieve their goals. Subgroup analyses on patient sex revealed findings similar to those in the main analyses for females but not for males. Moreover, adolescent and adult athletes who had returned to sport reported significantly higher levels on the Knee Self-Efficacy Scale and the ACL–Return to Sport

					After Injury scale at both follow-ups.
4.	Mark V. Paterno et al. 2017 [1]	The purpose of this study was to determine whether fear was related to functional performance measures and risk of second ACL injury after ACLR and return to sport (RTS)	Prospective cohort study.	: A total of 40 patients cleared to RTS after ACLR completed the Tampa Scale of Kinesiophobia (TSK-11), hop testing, and quadriceps strength testing, bilaterally. Patients were tracked for 12 months after RTS to identify the incidence of second ACL injury. Chi-square analyses determined whether patients with high fear (TSK-11, ≥17) were more likely to have lower levels of activity, greater asymmetry on functional testing, and higher reinjury rates.	: Patients with greater fear on the TSK-11 (≥17) at RTS were 4 times (odds ratio [OR], 3.73; 95% CI, 0.98-14.23) more likely to report lower levels of activity, 7 times (OR, 7.1; 95% CI, 1.5-33.0) more likely to have a hop limb symmetry lower than 95%, and 6 times (OR, 6.0; 95% CI, 1.3-27.8) more likely to have quadriceps strength symmetry lower than 90%. Patients who went on to suffer an ipsilateral second ACL injury had a greater TSK-11 score at the time of RTS (mean, 19.8 ± 4.0) than those who did not suffer a second ACL injury (mean,

					16.4 ± 3.6) (P = 0.03). Patients with a TSK-11 score of 19 or greater at the time of RTS were 13 times (relative risk, 13.0; 95% CI, 2.1-81.0) more likely to suffer a second ACL tear within 24 months after RTS
5.	Melissa A. Christino et al. 2016[4]	The purpose of this study was to demonstrate relationships between self-esteem, health locus of control, and psychological distress with objective clinical outcomes, patient-oriented outcomes, and return to sport.	Cross-sectional study	Twenty-seven patients who were 6 to 24 months post–computer-assisted ACL reconstruction by a single surgeon consented to participate in the study (52% response rate). Participants had a 1-time visit with a physician consisting of: a physical examination, a single-leg hop test, KT-1000 arthrometer measurements, and survey completion. Psychological measures included the Multidimensional Health Locus of Control Scale, Rosenberg Self-	The majority (89%) of the patients identified themselves as athletes, and of these, 65% reported returning to sports at a competitive level. Sport returners were found to have higher levels of self-esteem (P ¼ .002) and higher reported KOOS-QOL scores (P ¼ .02). Self-esteem was significantly associated with IKDC scores (r ¼ 0.46, P < .05), KOOS-QOL scores (r ¼ 0.45, P < .05), and

				Esteem Scale, and Brief Profile of Mood States. Outcome measures included the Tegner activity scale, International Knee Documentation Committee (IKDC) Subjective Knee Score, Knee injury and Osteoarthritis Outcome Score–Quality of Life subscale (KOOS-QOL), and Short Form–36 (SF-36). Patient charts were also reviewed for pertinent operative details	SF-36 subscales of general health (r ¼ 0.45, P < .05) and physical functioning (r ¼ 0.42, P < .05). Internal locus of control was significantly correlated with performance on single-leg hop test (r ¼ 0.4, P < .05). Objective knee stability measurements did not correlate with subjective outcomes.
6.	Clare L. Ardern et al 2015[9]	To investigate return-to-sport rates at 2 years after surgery in athletes who had not returned to their preinjury level sport at 1 year after ACL reconstruction	Case series	A consecutive cohort of competitive- and recreational-level athletes was recruited prospectively before undergoing ACL reconstruction at a private orthopaedic clinic. Participants were followed up at 1 and 2 years after surgery with a sports activity questionnaire that collected information regarding returning to sport, sports participation, and	A group of 122 competitive- and recreational-level athletes who had not returned to their preinjury level sport at 1 year after ACL reconstruction participated. Ninety-one percent of the athletes returned to some form of sport after surgery. At 2 years after surgery, 66% were playing

				psychological responses. An independent physical therapist evaluated physical function at 1 year using hop tests and the International Knee Documentation Committee knee examination form and subjective knee evaluation.	sport, with 41% playing their preinjury level of sport and 25% playing a lower level of sport. Having a previous ACL reconstruction to either knee, poorer hop-test symmetry and subjective knee function, and more negative psychological responses were associated with not playing the preinjury level sport at 2 years.

Discussion

One of the most common and serious knee injuries in sports is an ACL tear. Although anterior cruciate ligament reconstruction (ACLR) is still the preferred procedure for athletes hoping to resume competitive play, the outcomes are frequently quite variable and unexpectedly worse than previously thought. The results are inconsistent and lower than expected.

Although surgical techniques for ACL reconstruction have improved, returning patients to their previous levels of activity is the real test of the procedure's effectiveness, not just a robust graft. Due to residual deficits in strength and neuromuscular control, as well as the emergence of compensatory movement patterns, many patients—athletes in particular—find it difficult to return to their full pre-injury function. Improving rehabilitation and lowering long-term complications require addressing these enduring problems. In order to maximize recovery and avoid issues in the future, we need to focus on overcoming these multifaceted functional hurdles.

After ACL reconstruction, quadriceps and hamstring weakness frequently endures despite organized rehabilitation. Particularly vulnerable to arthrogenic muscle inhibition, which results in decreased activation and muscle loss, are the quadriceps. Since the quadriceps are essential for regulating tibial translation, this weakness directly jeopardizes the knee's dynamic stability. These deficiencies have a significant effect on neuromuscular control, the body's unconscious motor reactions that stabilize the joint, in addition to isolated strength. When performing dynamic tasks like jumping and cutting, patients frequently show altered muscle activation and impaired proprioception, or the sense of joint position. Reduced knee flexion angles, increased knee valgus moments, and changed ground reaction forces are some of the ways that these neuromuscular control deficiencies can show up. These conditions impair

functional performance and raise joint loading.

Prolonged strength and neuromuscular deficiencies frequently result in observable disparities between the injured and uninjured limbs, not only in terms of strength but also in terms of power, endurance, and general movement quality. During functional activities, people frequently develop altered biomechanics and use compensatory strategies to prevent discomfort, protect the healing graft, or overcome perceived weakness. A secondary ACL injury in the contralateral knee may result from these compensations, which may permit a return to activity but may also put undue strain on the uninjured limb. Moreover, osteoarthritis, patellofemoral pain, and other chronic joint diseases in the reconstructed knee may be exacerbated by these changed movement patterns.

We must consider more than just symptoms when evaluating ACL recovery. Pain, instability, stiffness, or anxiety are still experienced by symptomatic athletes, which negatively affects their quality of life and makes it more difficult for them to recover to their pre-injury levels. Their unease and lack of confidence obviously affect how well they perform. Athletes without symptoms, on the other hand, may report a full return to competition and believe their knee is healed; however, they may still have subtle, underlying neuromuscular deficits and biomechanical asymmetries. Despite the fact that these minor problems don't hurt right away, they greatly raise the possibility of further injuries, such as another ACL tear in either knee.

An athlete's capacity to resume sports and general well-being are significantly influenced by the psychological aspects of their recovery from anterior cruciate ligament reconstruction (ACLR).

Kinesiophobia, a crippling fear of movement or re-injury, is perhaps the most prevalent psychological issue after ACLR. Even if an athlete is physically cleared, this fear can have a significant impact on their decision to resume sports, frequently causing them to self-limit their performance, avoid particular movements, or withdraw entirely. Importantly, functional outcomes are directly correlated with psychological readiness, which includes mental preparedness, confidence, and effective coping mechanisms. This mental preparedness makes it easier for an athlete to trust their knee, give it their all, and perform at a higher level.

An athlete's functional output is greatly influenced by how they view the strength and stability of their knee. Lack of confidence frequently manifests as cautious, weaker movements and a reluctance to take on demanding tasks. An athlete's mental health may suffer significantly during the long and difficult recovery period following ACLR, particularly if they lose their social connections and athletic identity. As a result, anxiety and depression are prevalent at this time. Athletes who experience persistent pain or instability perform worse in terms of agility, power, and endurance. They frequently make compensatory movements out of discomfort as well as fear, which raises their likelihood of getting hurt again. They are psychologically less confident and more afraid of getting hurt again.

Even though they appear to be fully recovered and then back to competing, athletes who do not exhibit any symptoms may still have minor physical deficiencies. Their absence of symptoms, however, usually results in improved coping skills, increased self-esteem, and a more optimistic perspective, allowing them to resume competitive play.

The long-term risk of osteoarthritis is higher for both groups. But with its ongoing mechanical challenges, symptomatic recovery frequently speeds up joint deterioration, which could cut short an athletic career. A longer career and a higher quality of life are typically the results of non-symptomatic recovery, highlighting the profound influence of both physical and mental health on long-term results.

Restoring the knee's physical integrity is only one aspect of optimizing recovery after anterior cruciate

ligament reconstruction (ACLR). It categorically calls for an integrated, holistic strategy that carefully attends to the psychological as well as the physical aspects of rehabilitation. This requirement results from the significant and interconnected impact that these two factors have on an athlete's long-term health and eventual return to sport (RTS). Physical strategies include targeted neuromuscular and strength training to improve quadriceps function, dynamic stabilization, and proprioception, as well as functional and return-to-sport protocols that gradually expose athletes to sport-specific demands

The goal of gait and movement retraining, which is frequently supported by video analysis, is to enhance biomechanics such as landing mechanics and correct compensatory patterns. Importantly, to overcome mental obstacles and sustain motivation, psychological interventions such as kinesiophobia management, injury acceptance, and mental resilience training are incorporated. In order to guarantee an individualized strategy that improves general well-being and increases the possibility of a successful return to activity, this all-encompassing approach depends on a multidisciplinary team that includes physiotherapists, sports psychologists, strength coaches, and orthopedic specialists. In order to completely define successful recovery and its impact on joint health and career longevity, future efforts should prioritize customized interventions utilizing cutting-edge biomechanics and neurocognitive training in addition to long-term follow-up studies.

Conclusion

A full return to pre-injury function without any lingering impairments or increased risk of re-injury is the ultimate measure of success in the journey following ACLR, which goes well beyond surgical repair. Physical difficulties, such as chronic weakness in the quadriceps and hamstrings and deficiencies in neuromuscular control, often impede this complex recovery, resulting in changed movement patterns, heightened susceptibility to subsequent injuries, and long-term joint degradation.

The psychological barriers are equally important. An athlete's preparedness and capacity to resume sports are significantly hampered by kinesiophobia, low self-esteem, and mental health conditions like anxiety and depression. The subtle difference between symptomatic and non-symptomatic recovery emphasizes this complexity even more because hidden deficits can continue to exist without obvious symptoms, subtly raising risks in the future.

Consequently, a comprehensive, integrated, and multidisciplinary approach is necessary for the best possible ACLR rehabilitation. It must carefully blend effective psychological therapies like mental resilience training and kinesiophobia management with focused physical restoration—through neuromuscular and strength training, as well as precise gait retraining. In order to create customized programs that go beyond symptom management and instead concentrate on overall well-being and reducing long-term risks, medical professionals must work together in harmony. For all ACLR patients to experience truly sustainable functional and psychological outcomes, future research must place a high priority on long-term follow-up and customized interventions.

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