Published in final edited form as:

Am J Sports Med. 2018 June ; 46(7): 1545–1550. doi:10.1177/0363546518773757.

Factors Associated With Psychological Readiness to Return to Sport After Anterior Cruciate Ligament Reconstruction Surgery

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Abstract

Background: Anterior cruciate ligament (ACL) injury has a significant psychological effect, and a negative psychological state is a commonly cited reason for a reduction or cessation of sports participation after ACL reconstruction (ACLR) surgery.

Purpose: To identify factors that contribute to an athlete's psychological readiness to return to sport (RTS) after ACLR.

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: A cohort of 635 athletes (389 male, 246 female) who underwent ACLR and had been cleared to RTS completed the Anterior Cruciate Ligament–Return to Sport After Injury (ACL-RSI) scale at an average 12 months (range, 11–24 months) after surgery. Demographics (age, sex), sporting outcomes (preinjury frequency), surgical timing (injury to surgery interval), clinical factors (laxity), functional measures (single-limb hop symmetry), and symptoms of pain and function (International Knee Documentation Committee subjective) were also taken, and univariate and multiple regression models were used to determine the association between these and the psychological readiness of the athlete to RTS (ACL-RSI scores). Data for the entire cohort were initially analyzed; then, patients were grouped according to whether they had returned to competitive sport, and the analysis repeated for each group (return/nonreturn).

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Results: Univariate analysis for the entire group showed that all of the following had a positive effect on psychological readiness: male sex ($\beta = 5.8$; 95% CI, 2–10), younger age ($\beta = -0.2$; 95% CI, -0.4 to 0.01), a shorter interval between injury and surgery ($\beta = 20.1$; 95% CI, 20.1 to 20.02), a higher frequency of preinjury sport participation ($\beta = 5.4$; 95% CI, 2–9), greater limb symmetry ($b = 0.5$; 95% CI, 0.3–0.6), and higher subjective knee scores ($\beta = 1.3$; 95% CI, 1.1–1.4). In the multivariate model, subjective knee scores and age significantly accounted for 37% of the variance in psychological readiness ($r^2 = 0.37$, $P < .0001$). The only difference between the groups who had and had not returned to sport was that female sex was a significant contributor for the nonreturn group.

Conclusion: Self-reported symptoms and function were most associated with psychological readiness to RTS after ACLR surgery. Male patients who participated frequently in sport before ACL injury had higher psychological readiness. Conversely, female patients had a more negative outlook and may therefore benefit more from interventions designed to facilitate a smooth transition back to sport.

Keywords

ACL reconstruction; reinjury anxiety; sport confidence; fear of reinjury; psychosocial factors

Many athletes do not return to their previous levels of preinjury sport after anterior cruciate ligament reconstruction (ACLR) surgery, despite attaining satisfactory knee function.^{3,6} This finding indicates that other factors influence return to sport (RTS) after this procedure. Recent reviews and meta-analyses demonstrated that a range of contextual factors affect RTS after ACLR, including age, sex, sport participation level, and psychological factors.^{3,11,14} Among these, psychological factors have received growing interest owing to their potentially modifiable nature.

Anterior cruciate ligament (ACL) rupture and subsequent reconstruction surgery have a significant psychological effect.¹ This can occur not only at the time of injury but also throughout rehabilitation and can have a negative effect on recovery.^{13,30} From a psychological perspective, the RTS phase can be particularly challenging, as negative emotions, such as anxiety and fear, may reemerge once an athlete has been cleared to RTS.^{10,19,23} A commonly discussed psychological factor in terms of RTS after ACLR is “psychological readiness.”^{1,15} Psychological readiness is an important determinant of RTS decisions,^{2,4} and testing for it may be an important element for optimization of RTS rates.¹⁶

There are several measures available for assessment of psychological readiness to RTS, of which the Anterior Cruciate Ligament–Return to Sport After Injury (ACL-RSI)³⁴ scale is the only one developed specifically for assessment of psychological readiness to RTS after ACL injury or reconstruction surgery. Scores on this scale can predict RTS outcomes.^{4,21,24} However, the factors that contribute to an athlete’s psychological readiness have not yet been clearly identified.

Many factors likely contribute to psychological readiness to RTS. The biopsychosocial model highlights that sociodemographic (eg, age and sex), physical, and functional factors all influence the psychological response.^{1,8,37} It is therefore likely that such factors also play

a role in psychological readiness to RTS, although the relative contribution of each factor is currently unknown. Whether the factors that contribute to the psychological status of athletes who RTS after ACLR are different from those of athletes who do not RTS also has not been investigated to date. A better understanding of factors that underpin psychological status and readiness in both these groups may help us address them throughout rehabilitation and ultimately provide for a smoother transition back to sport after ACL injury.

The purpose of this study was twofold: (1) to identify factors that influence psychological readiness to RTS after ACLR surgery, with prospectively collected data from a large cohort of patients who had been cleared to RTS, and (2) to compare patients who had and had not returned to sport. Patient demographics (sex, age), surgical timing (injury to surgery interval), sporting outcomes (preinjury frequency), clinical factors (knee stability), functional measures (limb symmetry), and self-reported symptoms of pain and function were all evaluated and analyzed.

METHODS

Patient Recruitment and Surgical and Rehabilitation Details

Participants were recruited from patients who attended a private orthopaedic clinic after ACLR surgery between May 2011 and February 2013 by 1 of 3 surgeons. Patients were eligible to participate if they had been active in sports before the ACL injury, had undergone primary hamstring ACLR surgery, and were cleared to RTS by the treating surgeon.

All ACLR procedures were performed arthroscopically with a hamstring tendon autograft. Femoral fixation was by means of an Endobutton and tibial fixation by means of an interference screw. Postoperatively, all patients underwent the same rehabilitation protocol, with the early focus on recovery of full active knee extension and quadriceps function as soon as possible. Emphasis was placed on the restoration of vastus medialis function. Weightbearing was allowed on an as-tolerated basis from the first postoperative day. The minimum requirements for RTS were no effusion, an essentially full range of motion, good quadriceps strength and control of a single-legged squat, normal running and landing, and at least 4 weeks of unrestricted training.

Patients were invited to participate as they attended the clinic for routine 12-month postoperative review. Those who had complications that required further surgery after their reconstruction were excluded. The project had institutional ethics approval.

Assessment

Dependent Measure: Psychological Readiness—Patients completed the ACL-RSI scale.³⁴ This 12-item scale is designed to measure psychological readiness to RTS after ACL injury or reconstruction surgery. It includes 3 domains: emotions, confidence, and risk appraisal. Scores for each domain are summed and averaged for a total score between 0 and 100. Higher scores indicate greater psychological readiness. While the ACL-RSI scale is constructed around 3 domains, they are highly related, and the scale is therefore considered unidimensional. The scale was validated and its predictive value demonstrated in a number

of previous studies.^{2,21,34} Scores on the ACL-RSI scale were the primary outcome (dependent) variable for this study.

Independent Measures

Demographic and Surgical Timing.: Patient sex, age at surgery, and time interval between injury and surgery were recorded from medical records.

Preinjury Sport Participation Frequency.: Patients were asked to report how frequently they had participated in sport before the ACL injury: 4 to 7 days/week, 1 to 3 days/week, and 1 to 3 times/month. The latter 2 categories were subsequently merged because of the small number of patients in the “1 to 3 times/month” category.

Knee Laxity.: Measurements of side-to-side differences in anterior tibial displacement were made with a KT-1000 arthrometer (MEDmetric Corp) at 134 N. Three measures were taken from both knees and the average displacement in millimeters recorded. The side-to-side difference was recorded as the operated knee score minus the contralateral knee score.

Limb Symmetry Index.: Patients completed a single-limb hop for distance.²⁶ They were instructed to hop as far as possible and control the landing. A familiarization trial was permitted, and any trial where the landing was not controlled was excluded (ie, touch down with the opposite foot). Two successful trials from both limbs were recorded and their average used to calculate a limb symmetry index (operated side score divided by contralateral side score $\times 100\%$). A limb symmetry index ≤ 100 indicates a deficit in the operated limb.

Subjective Knee Symptoms and Function.: All patients completed the 2000 International Knee Documentation Committee (IKDC) subjective knee evaluation score.¹⁸ For this self-report measure, scores range from 0 to 100, with higher scores indicating fewer knee symptoms and better function.

Procedures

The ACL-RSI and IKDC scales were completed on a tablet by the patient upon arrival at the clinic. A research assistant independent of the current project measured knee laxity and limb symmetry. All measurements were made before the patient consulted with the treating surgeon.

Data Analysis

All data were analyzed with SPSS (v 23; IBM Corp). Continuous variables were summarized with mean and SD. Categorical variables were summarized by frequency and percentages. Difference in characteristics between patients who had and had not returned to sport were assessed with independent t tests or χ^2 tests. For determination of RTS, patients responded to the following options: no sport, training only, and returned to competition. Patients who reported “returned to competition” were classified as having returned to competitive sport, whereas patients who reported “no sport” or “training only” were classified as not having returned to competitive sport.

Univariate regression analysis was used to model the relationship between the various predictor variables and psychological readiness to RTS (ACL-RSI scores) as the outcome (dependent) variable. Factors with $P < .05$ were subsequently included in a multivariate regression analysis (stepwise method) until the best model was obtained. β coefficients are presented as indicators of the regression relationship between psychological readiness and predictor variables. All regression analyses were performed for the full cohort and then separately for the groups who had and had not returned to competitive sport. The sample size for all regression analyses was adequate according to the recommendations of Tabachnick and Fidell.²⁹ $P < .05$ was used to indicate statistical significance.

RESULTS

During the study period, 904 primary arthroscopically assisted ACLRs with hamstring autografts were performed. Of these, 730 patients (81%) attended routine follow-up, of which 95 were excluded from the study (44 nonreporting, 35 requiring further surgery, 16 incomplete data). This left 635 patients (389 male, 246 female) who participated at a mean age of 28 years (SD, 10 years; range, 14–55 years). The mean time from surgery to participation in the study was 12 months (SD, 1 month; range, 11–24 months).

The mean ACL-RSI score for the cohort was 65 points (SD, 23; range, 5–100 points). Only 158 patients (25%) had returned to competitive sport. Table 1 presents the demographic and outcome data for the entire group; values are also presented separately for those who had and had not returned to competitive sport. Most outcomes, including ACL-RSI scores, differed significantly between patients who had and had not returned.

Univariate analysis showed that the following all had a positive effect on psychological readiness: male sex ($\beta = 5.8$; 95% CI, 2–10), younger age ($\beta = 20.2$; 95% CI, 20.4 to 0.01), a shorter interval between injury and surgery ($\beta = 20.1$; 95% CI, –0.1 to 20.02), a higher preinjury frequency of sport participation ($\beta = 5.4$; 95% CI, 2–9), greater limb symmetry ($\beta = 0.5$; 95% CI, 0.3–0.6), and higher subjective knee scores (IKDC: $\beta = 1.3$; 95% CI, 1.1–1.4) (Table 2). In the multivariate model, subjective knee scores (IKDC: $\beta = 1.2$; 95% CI, 1–1.4), and age ($\beta = -0.3$; 95% CI, –0.4 to –0.1) remained significant and accounted for 37% of the variance in ACL-RSI scores ($F_{2,601} = 175$, $P < .0001$, $r^2 = 0.37$).

When patients were grouped according to whether they had returned to competitive sport or not, univariate analysis for the group who had yet to RTS showed that male sex ($b = 5.1$; 95% CI, 1–9), greater limb symmetry ($b = 0.4$; 95% CI, 0.3–0.6), and higher subjective knee scores (IKDC: $b = 1.2$; 95% CI, 1–1.3) had a positive effect on psychological readiness (Table 3). In the multivariate model, only subjective knee scores remained significant ($b = 1.2$; 95% CI, 1–1.4) and accounted for 30% of the variance in ACL-RSI scores ($F_{1,456} = 194$, $P < .0001$, $r^2 = 0.3$).

For the group that had returned to competitive sport, greater limb symmetry ($\beta = 0.3$; 95% CI, 0.1–0.6) and higher subjective knee scores (IKDC, $\beta = 1.2$; 95% CI, 0.9–1.5) had a positive effect on psychological readiness (Table 3). Subjective knee scores remained

significant in the multivariate model ($\beta = 1.3$; 95% CI, 1–1.6) and accounted for 37% of the variance in ACL-RSI scores ($F_{1,148} = 87.3$, $P < .0001$, $r^2 = 0.37$).

DISCUSSION

The importance of psychological recovery from ACL injury and reconstruction surgery has become increasingly recognized as an important predictor of ACLR outcomes. This study examined factors associated with psychological readiness to RTS in a large cohort of athletes who had undergone ACLR. Male sex, younger age, a shorter time between injury and surgery, a higher frequency of preinjury sports participation, greater limb symmetry, and higher subjective knee scores all had a positive effect on psychological readiness. In all multivariate models, higher subjective knee scores were the most significant contributor to greater psychological readiness.

As many athletes do not RTS after ACLR surgery, it was also of interest to see whether the factors associated with psychological readiness were different between the athletes who had and had not yet made a successful return to competitive sport. The current results showed similar findings between the groups, with the only difference being that male sex was significantly associated with greater psychological readiness in the group that had not returned but not in the group that had returned.

The sex differences observed in the current study are consistent with previous research showing that male athletes are more likely than female athletes to return to their preinjury levels of sport.³ In the current study, the rate of return to competitive sport was a low 25%. This is not surprising given that the follow-up time frame was between 11 and 24 months (with a 12-month average), which is generally consistent with previous research of similar time frames.^{2,5} However, the finding that only 17% of female patients had returned to competition versus 30% of male patients clearly highlights the sex differences in RTS after ACLR surgery. One reason for this sex disparity may be that male athletes are more psychologically ready to return, as supported by the current data. It could also be that male patients are more reluctant to report their fears and anxieties about RTS, a concept supported by pain perception research.¹² Nonetheless, any interventions designed to increase psychological readiness may be best targeted toward female patients in this early postoperative period. This association between sex and psychological readiness was no longer apparent once the athlete returned to competitive sport.

For all patients, subjective knee scores had the most significant association with psychological readiness in the univariate analyses and were the only variable to remain significant in the 2 multivariate models that grouped patients according to RTS status. In these models, subjective knee scores accounted for approximately one-third (between 30% and 37%) of the variance in psychological readiness scores. The instrument that we chose to measure the patient's subjective outcome was the IKDC subjective knee score, which is a well-validated knee scale that records the patient's self-reported knee symptoms and function¹⁸ and which showed a moderate univariate correlation with ACL-RSI scores in validation studies.^{7,9,17} Note that this measure was more strongly associated with psychological readiness than the measure of physical function (hop-test limb symmetry) and

that knee laxity had no association with psychological readiness. Therefore, patient self-reported outcomes have a strong association with psychological readiness to RTS. This finding is similar to previous research indicating that patient-reported outcomes are more aligned with RTS outcomes than clinical measures.^{5,6} Lentz et al²² also showed that IKDC subjective scores at 6 months were predictive of RTS outcomes at 12 months. In a similar study, Thomeé et al³¹ showed that one of the most important determinants of knee-related self-efficacy was self-reported symptoms and function, further highlighting the importance of the patient's interpretation of his or her knee symptoms.

Younger age was a significant contributor to psychological readiness in the univariate and multivariate models. This observation is consistent with research showing that younger patients are more likely to RTS.^{6,35} Adolescent patients (aged 15–19 years) have higher levels of psychological readiness for surgery than older patients (>30 years).³² In the current study, a higher frequency of preinjury sports participation was also associated with greater psychological readiness. Athletes who more frequently participate in their sport preinjury may have greater athletic identities. Those who have a high degree of identification with the athletic role may also be more impatient to RTS after injury.^{19,20}

Two psychological terms that are most often discussed in the context of RTS after ACLR are “fear of reinjury” and “psychological readiness.” In this study, the focus was on psychological readiness. In a recent qualitative study, psychological readiness to RTS was suggested to be composed of 3 key aspects: confidence in returning to sport, realistic expectations of sporting capability, and motivation to regain preinjury performance standards.²⁷ Confidence was specifically influenced by the athlete's belief in the rehabilitation program and perception that the injury was healed. Confidence in being able to perform at the same preinjury level was also associated with increased psychological readiness.^{27,34} The ACL-RSI scale currently used to measure psychological readiness contains items that address the aforementioned aspects. The scale also includes a fear-of-reinjury item as part of the emotions domain.³⁴ In a recent study to better understand factors that inform patients' fear after ACLR, Ross et al²⁸ conducted patient interviews, and participants reported fear of reinjury as the primary reason for not returning to sport. Results showed that undergoing surgery with a long recovery and with restricted function was one of the main factors that informed reinjury fear. The ACL-RSI scale also has an item regarding whether “thoughts of having to go through surgery and rehabilitation again”³⁴ prevent a RTS. Therefore, there may be some overlapping aspects between the concepts of fear of reinjury and psychological readiness. Interestingly, it was suggested that “fear of reinjury” may not be the most appropriate term when used in the context of sport cessation. Walker et al³³ suggested that “reinjury anxiety” may be more appropriate to describe the emotional response of the athlete, as fear is a stimulus-specific biological mechanism, whereas anxiety is associated with anticipation or uncertainty. Regardless of terminology, psychological readiness and fear of reinjury/reinjury anxiety both have strong associations with RTS after ACLR.

One potentially devastating consequence for some patients who RTS after ACLR surgery is a second ACL injury. Whether psychological readiness is associated with second ACL injury is currently unknown. It is notable, however, that the current data show younger patients to

have greater psychological readiness and that prior data also showed this group to be at high risk for second ACL injury.³⁶ Therefore, high psychological readiness may not mean that it is “safe” for the athlete to RTS. In fact, a degree of caution may be protective of further injury if it means that the athlete does not prematurely or recklessly RTS without full consideration of one’s knee function.¹ Indeed, Nagelli and Hewett²⁵ suggested that patients are returning to sport too soon, and they advocated a wait time as long as 2 years to RTS.²⁵

The current study was subject to some limitations. The findings may be limited in terms of generalizability, as the included cohort was relatively homogeneous and recruited from a single metropolitan clinic. Factors associated with psychological readiness scores may vary from one study sample to another. However, our large sample size helps to overcome some of these limitations and may have allowed us to detect more subtle associations. Owing to the cross-sectional design, causal relationships could not be established.

In conclusion, the present study included a large number of patients who had undergone ACLR surgery to examine the association between their psychological readiness to RTS and various factors, including demographic, sport, function, laxity, and self-reported knee symptoms and function. To our knowledge, no previous studies conducted similar analyses. Results showed that self-reported knee symptoms and function were most associated with psychological readiness to RTS. Male patients and younger patients who participated frequently in sport before ACL injury were more likely to have higher psychological readiness. As psychological factors are potentially modifiable, the results of this study indicate that any future interventions may be best targeted toward female patients, who have lower levels of objective and self-reported levels of function. Future research should examine the relationship between psychological readiness to RTS and further ACL injury.

Acknowledgments

One or more of the authors has declared the following potential conflict of interest or source of funding: C.V.N. is supported by National Institute of Arthritis and Musculoskeletal and Skin Diseases Training Grant (T32 AR56950).

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TABLE 1

Patient Characteristics and Outcome Scores^a

	All	Return to Competitive Sport (n = 158)	No Return to Sport (n = 477)	P Value
Age, y	28 (10)	26(8)	29 (11)	.001
Sex, n				
Male	389	117	272	.0001
Female	246	41	205	
ACL-RSI score, 0–100	65 (23)	79 (17)	60 (23)	.0001
Preinjury sport frequency, % (n)				
High, 4–7 d/wk	45 (285)	55 (87)	42 (198)	.002
Moderate, 1–3 d/wk	55 (350)	45 (71)	58 (279)	
Limb symmetry index, %	93 (13)	95 (10)	92 (14)	.04
Laxity (side-to-side difference), mm	1.0 (2)	0.8 (2)	1.1 (2)	.2
IKDC subjective form (0–100)	84 (11)	89(8)	82 (11)	.0001

^aValues are presented as mean (SD) unless noted otherwise. ACL-RSI, Anterior Cruciate Ligament–Return to Sport After Injury; IKDC, International Knee Documentation Committee.

TABLE 2

Univariate Regression to Identify Factors Associated With Psychological Readiness (ACL-RSI Scores) Among All 635 Patients^a

Independent Variable	β Coefficient (95% CI)	P Value
Age	-0.2 (-0.4 to -0.01)	.04
Sex	5.8 (2 to 10)	.002
Time between ACL injury and surgery	-0.1 (-0.1 to -0.02)	.006
Preinjury sport frequency	5.4 (2 to 9)	.003
Limb symmetry index	0.5 (0.3 to 0.6)	.001
Anterior-posterior laxity	-0.6 (-1.4 to 0.2)	.2
IKDC subjective form (symptoms/function)	1.3 (1.1 to 1.4)	.001

^aFor categorical outcomes, a positive β coefficient is associated with male sex and the "high" category of preinjury sports frequency (4–7 days/week). ACL, anterior cruciate ligament; ACL-RSI, Anterior Cruciate Ligament–Return to Sport After Injury; IKDC, International Knee Documentation Committee.

TABLE 3

Univariate Regression to Identify Factors Associated With Psychological Readiness (ACL-RSI Scores) in Patients Who Had and Had Not Returned to Competitive Sport^a

Independent Variable	No Return to Competitive Sport β Coefficient (95% CI)	P Value	Return to Competitive Sport β Coefficient (95% CI)	P Value
Age	-0.1 (-0.4 to 0.1)	.2	0.2 (-0.1 to 0.6)	.2
Sex	5.1 (1 to 9)	.02	3.4 (-3 to 10)	.3
Time between injury and surgery	-0.04 (-0.9 to 0.1)	.1	-0.23 (-0.7 to 0.3)	.4
Sport frequency	3.2 (1 to 8)	.1	4.6 (1 to 10)	.09
Limb symmetry	0.4 (0.3 to 0.6)	.0001	0.3 (0.1 to 0.6)	.02
Anterior-posterior laxity, mm	-0.5 (-1.4 to 0.4)	.3	-0.03 (-1.4 to 1.4)	.999
IKDC subjective	1.2 (1 to 1.3)	.0001	1.2 (0.9 to 1.5)	.0001

^aFor sex and sport frequency outcomes, a positive β coefficient is associated with male sex and the “high” category of preinjury sports frequency (4–7 days/week). ACL-RSI, Anterior Cruciate Ligament–Return to Sport After Injury; IKDC, International Knee Documentation Committee.