

# Psychological Responses During Latter Rehabilitation and Return to Sport After Anterior Cruciate Ligament Reconstruction Surgery

Hayley C. Russell, PhD\*; Elizabeth A. Arendt, MD†; Diane M. Wiese-Bjornstal, PhD‡

\*Department of Health and Exercise Science, Gustavus Adolphus College, Saint Peter, MN; †Department of Orthopaedics, University of Minnesota, Minneapolis; ‡School of Kinesiology, University of Minnesota, Minneapolis

**Context:** Despite positive physical outcomes of anterior cruciate ligament reconstruction (ACLR), many athletes do not return to sport afterward.

**Objective:** To determine if there were differences between athletes who returned to play and those who did not return to sport after ACLR in patterns of psychological responses to injury over the latter course of rehabilitation and return to sport.

**Design:** Case-control study.

**Setting:** Comprehensive orthopedic medical center referrals.

**Patients or Other Participants:** Thirty-nine recreational and competitive athletes (13 to 58 years, 21 males) with a first ACL tear were observed over the course of the study.

**Main Outcome Measure(s):** Return to sport.

**Results:** Fifty-two percent of participants returned to play by 9 months post-ACLR. Those who returned showed a linear

decrease in reinjury anxiety from 4 to 9 months post-ACLR, whereas those who did not return showed a linear decrease from 4 to 6 months post-ACLR and then a leveling off from 6 to 9 months. Those who returned showed linear and quadratic effects on perceived limitations of ability with a decrease from 4 to 9 months post-ACLR that accelerated over time, whereas nonreturners showed a linear decrease over time. No significant differences were found between returners and nonreturners in knee self-efficacy, perceived percent recovery, and psychological distress.

**Conclusions:** Our results suggest that reinjury anxiety and perceived limitations of ability are psychological constructs on which returners and nonreturners differ and therefore may be points of intervention to increase the likelihood of return to sport.

**Key Words:** fear of reinjury, knee self-efficacy

## Key Points

- Approximately 50% of athletes had not returned to play 9 months after anterior cruciate ligament reconstruction (post-ACLR).
- Reinjury anxiety and perceived limitations of ability exhibited different trajectories during the latter part of rehabilitation among athletes who had and those who had not returned to play at 9 months post-ACLR.
- Athletes' psychological states generally improve from 4 to 9 months post-ACLR; however, for athletes who have not returned to play by 9 months post-ACLR, their reinjury anxiety and perceived limitations of ability stop showing improvement between 6 and 9 months.

Anterior cruciate ligament (ACL) tears are a common and costly injury for athletes that often require surgical repair.<sup>1</sup> Physical outcomes of ACL reconstruction (ACLR) surgery are overwhelmingly positive. Athletes perform well on tests of joint stability, strength, and range of motion after surgery, with approximately 90% of athletes achieving normal or near normal functioning.<sup>2,3</sup> Statistics on return to sport, however, are far less positive. Researchers have found that athletes who suffer ACL injuries and undergo subsequent ACLR often do not return to sport or return at a lower level.<sup>2-6</sup> A recent systematic review suggests that the rate of return to sport following ACLR is 63.4%, with 36.6% of athletes who do return to sport unable to perform at their previous level of play.<sup>7</sup>

Increasing attention has been paid to psychological responses to injury that may influence athletes' readiness to return to sport

following ACLR.<sup>2-9</sup> The integrated model of psychological response to sport injury and the rehabilitation process recognizes 3 domains of psychological responses in injured athletes: (1) cognitive appraisal, (2) emotional or affective response, and (3) behavioral response, all of which are influenced by personal and situational factors.<sup>10</sup> According to the model, these dynamically changing psychological responses to injury can influence physical and psychological outcomes, including return to sport. Psychological factors are consistently found as being predictive of return to sport status following ACLR.<sup>7,9,11</sup> Generally, athletes report greater psychological barriers than physical barriers to returning to play.<sup>12</sup>

Addressing the discrepancy between athletes who achieve success in physical rehabilitation outcomes and those who return to sport is an important issue for 2 reasons: (1) athletes who undergo ACLR primarily intend to return to sport, and

(2) athletes who retire from sport due to injury report lower quality of life and life satisfaction after retirement than athletes who retire for other reasons.<sup>8,13,14</sup> As a result, researchers have shifted their focus from an exclusively biomedical view of ACLR and return to sport to a view that includes a concurrent examination of the influences of psychological responses post-ACLR.<sup>3,7,8,11,12,15,16</sup> This research, however, has limitations; researchers have mostly examined psychological responses related to return to sport retrospectively, cross-sectionally, or only early in rehabilitation.<sup>4,5,12,17,18</sup>

To address the limitations of previous research, the purpose of this study was to explore if there are differences between athletes who returned to play by 9 months post-ACLR and athletes who did not return to sport at 9 months post-ACLR in patterns of psychological responses to injury over the latter course of rehabilitation and return to sport. Most athletes recovering from ACLR have their physical symptoms (eg, pain, limitation of range of motion, and swelling) resolved by 4 months post-ACLR and are transitioning to more sport-specific training, and most athletes are cleared for unrestricted activity by 9 months post-ACLR.<sup>9,19,20</sup> Therefore, the *latter course* of rehabilitation was defined as 4 to 9 months post-ACLR. We hypothesized that patterns of psychological responses to injury would differ over the latter course of ACLR between those who had returned to play at 9 months post-ACLR and those who had not returned.

## METHODS

### Participants

Participants who met inclusion criteria were identified by staff at a comprehensive orthopaedic medicine clinic and were contacted by the primary investigator. The following inclusion criteria were used: over 13 years of age, the ACL tear was the primary injury and the participant's first, and the individual was active in sport or physical activity before the injury and intended to return to sport post-ACLR. After a preliminary screening to confirm that participants met the inclusion criteria, 39 participants (21 male and 18 female) were recruited for the study. Participants ranged in age from 13 to 58 years ( $M_{age} = 28.44$  years,  $SD = 12.77$ ). Twenty participants indicated that they considered themselves to be recreational athletes, and 19 identified as competitive athletes.

### Procedure

Institutional review board approval was obtained before data collection. Informed consent was obtained at the time of recruitment for the study and was mailed to the primary investigator. For participants under the age of 18, parental consent and participant assent were both obtained. The present study used a repeated measures design. Participants were asked to complete questionnaires at 4, 6, and 9 months post-ACLR. These time points correspond with important time points in the ACL rehabilitation protocol. Specifically, by 4 months post-ACLR, issues with range of motion, pain, and swelling should be resolved. At this point, athletes can typically begin light jogging and increase gradually to more sport-specific training. Six months post-ACLR is considered the early end of the return to unrestricted activity, where athletes may be able to return to sport if they meet required physical outcomes. By 9 months post-ACLR, most athletes are expected to meet the physical requirements of returning to

unrestricted activity.<sup>9,19,20</sup> This design allowed for examining differences in patterns of psychological responses between 9-month returners and nonreturners. Questionnaires were administered using Qualtrics software of the Qualtrics Research Suite (2014). Psychological measures were selected based on the predictions of the integrated model of the psychological response to the sport injury and rehabilitation process and a comprehensive literature review.<sup>10</sup>

## Measures

**Cognitive Appraisal.** The Knee Self-Efficacy Scale (K-SES) is a 22-item self-report questionnaire that asks participants to rate how certain they are right now that they can perform specific physical activities.<sup>21</sup> All items are scored on a 0–10 Likert scale, with 0 indicating *not at all* and 10 indicating *certain*. Participants were asked to “mark the number that best represents how certain you are about the activity right now despite pain/discomfort.” For example: “How certain are you that you can participate on the same activity level as before your injury?” A higher score on this inventory indicates higher knee self-efficacy.<sup>21</sup> For the purpose of the present study, only 2 of the 4 K-SES subscales (physical activities and knee function in the future) were used. A sample item from the physical activities subscale is, “How certain are you that you can jump sideways from one leg to the other?” while a sample item from the knee function in the future subscale is, “How certain are you that you will not have new knee injuries?” The other 2 subscales were less relevant for the time points selected. The K-SES has been found to have good content and face validity.<sup>21</sup>

One item from the Emotional Responses of Athletes to Injury Questionnaire was used to assess perceived percent of recovery.<sup>22</sup> The single item used in this study asked participants to self-report on a scale of 0% to 100%, in increments of 10, what percent of recovery they thought they had achieved to date relative to their preinjury status. Smith and colleagues reported that this measure has high face validity as a direct measure of perceived recovery, and they used it as an individual item to assess perceptions of recovery in their 1990 study.<sup>22</sup>

**Affective Responses.** The ReInjury Anxiety Inventory (RIAI) was used to measure reinjury anxiety. This measure was developed specifically for use with injured athletes.<sup>23</sup> It has 2 subscales, rehabilitation and return to sport, with only the 15-item return to sport subscale being used for this study. All items are on a 4-point Likert scale, with answers ranging from 0, indicating *not at all*, to 3, indicating *very much so*. Participants were asked to “read each statement and circle the appropriate number to indicate how you feel right now, at this moment.”<sup>23</sup> For example: “I am worried about reentry into competition making my body feel tense.” A higher score on this subscale of the RIAI is indicative of higher reinjury anxiety at the moment of return to sport, with scores ranging from 0 to 45.<sup>23</sup> The creators reported that the RIAI shows sound psychometric properties, including good internal consistencies (reinjury anxiety surrounding rehabilitation [ $\alpha = .98$ ]; reinjury anxiety surrounding return to sport [ $\alpha = -.96$ ]).<sup>23</sup>

Psychological distress was measured using the Patient Health Questionnaire-4 (PHQ-4).<sup>24</sup> When completing this measure, participants indicate on a scale of 0 to 3 how often symptoms of anxiety and depression have bothered them in the last 2 weeks. A sample item on this inventory is *not being*

able to stop or control worrying. A higher score indicates a higher degree of psychological distress, with scores ranging from 0 to 12.<sup>24</sup> In clinical practice, a cumulative score of 3 or higher indicates that the patient requires additional psychological evaluation. The PHQ-4 has been found to have good construct validity, showing strong correlations with other well-established inventories assessing anxiety and depression. Authors report that the internal reliability is good ( $\alpha > .80$ ). Factorial validity is also good, with 84% of the variance explained by the 2 factors of depression and anxiety.<sup>24</sup>

**Recovery Outcomes.** Return to sport was determined using a single author-developed item, whereby participants were asked if they had or had not returned to their preinjury level of sport or physical activity. This information was used to divide participants into the following 2 groups: (1) those who self-reported that they had returned to play at the same level of participation as before injury (returners) at 9 months and (2) those who self-reported that they had not returned to play at the same level of participation as before injury (nonreturners).

To supplement outcomes of return to sport status, perceived physical disablement was assessed only at 9 months using the Disablement in the Physically Active Scale.<sup>25,26</sup> The Disablement in the Physically Active Scale is a multidimensional assessment based on the disablement model developed by Vela and Denegar.<sup>25</sup> This scale assesses perceived disablement across the following 4 domains: impairments, functional limitations, disability, and quality of life.<sup>26</sup> It is a 16-item scale in which participants rate their problems within the past 24 hours, with the perceived disablement items on a scale of 1 to 5 (1 indicates that the patient has *no problem* with the listed item, and 5 indicates that the person is *severely impacted* by the listed item). A sample item is, “Do I have impacted muscle function? Ex. Decreased range/ease of motion, flexibility, and/or increase stiffness.”<sup>26</sup> Scores range from 16 to 80, with a higher score indicating higher perceived physical disablement. This scale has been found to have good reliability ( $\alpha = .91$ ) and validity, showing an inverse relationship with global functioning.<sup>26</sup>

Athletes also completed a demographic questionnaire at the 4-month assessment that included their age, competitive level, current injury, surgery date, mechanism of injury, sport they intended to return to playing, and estimated return to sport date.

## Data Analysis

Statistical analyses were conducted using SPSS (version 22.0; IBM Corp). Descriptive statistics (means and SDs) were calculated for all demographic, psychological, and return to sport variables. Internal consistency reliability was determined using Cronbach  $\alpha$  for all multi-item variables at each of the 3 assessment periods. Harmonic mean substitution was used for participants with only 1 missing item. Participants who were missing more than 1 item on a subscale or did not answer the single-item questionnaire were excluded from analysis.

Because we were interested in specific patterns of psychological responses across time, return to sport (our outcome variable) was analyzed by exploring the full 3 (time: 4, 6, and 9 months post-ACLR) by 2 (return status: returners and nonreturners) table of means using a series of a priori planned

**Table 1. Demographic Characteristics of Returners and Nonreturners**

	Age, y (SD)	Gender		Competitive Level	
		Male	Female	Competitive	Recreational
Returners	25.10 (11.22)	11	9	11	9
Nonreturners	31.16 (12.79)	10	9	8	11

comparisons. We conducted polynomial contrasts for linear and quadratic effects for returners and nonreturners on each of the 5 repeated cognitive and affective psychological measures (10 planned comparisons).<sup>27</sup> If both the linear and quadratic effects were significant, there was a general change in psychological distress over time, but the change either accelerated or decelerated (ie, rebounded or leveled off) between 6 and 9 months post-ACLR.

## RESULTS

Table 1 shows demographic data for both returners and nonreturners. At 9 months postsurgery, 51.3% (20/39) of participants had returned to play. There were no significant differences between returners ( $M_{\text{age}} = 25.10$  years,  $SD = 11.22$ ) and nonreturners ( $M_{\text{age}} = 31.16$  years,  $SD = 12.79$ ) in terms of age ( $t_{37} = -0.58$ ,  $P = .75$ ), competitive status ( $\chi^2(1, N = 39) = 0.65$ ,  $P = .42$ ), or gender ( $\chi^2(1, N = 39) = -0.02$ ,  $P = .88$ ). Returners reported significantly lower perceived disablement than nonreturners ( $t_{34} = -4.85$ ,  $P < .001$ ) at 9 months post-ACLR.

Means on psychological variables for returners and nonreturners are presented in Table 2. All multi-item measures were determined to have acceptable internal consistencies. Cronbach  $\alpha$  at 4 months post-ACLR was  $\alpha = .88$  for the RIAI,  $\alpha = .70$  for the K-SES, and  $\alpha = .69$  for the PHQ-4.

### Reinjury Anxiety

Results indicated that returners demonstrated a consistent linear decrease in reinjury anxiety over time ( $F_{1,18} = 146.03$ ,  $P < .001$ ,  $\eta^2 = .89$ ; no quadratic effect:  $F_{1,18} = 3.47$ ,  $P = .08$ ,  $\eta^2 = .16$ ). Nonreturners, however, revealed a significant linear decrease in reinjury anxiety ( $F_{1,15} = 40.45$ ,  $P < .001$ ,  $\eta^2 = .74$ ) that leveled off over time, as indicated by a significant quadratic effect ( $F_{1,15} = 35.56$ ,  $P < .001$ ,  $\eta^2 = .72$ ).

### Knee Self-Efficacy

There was no change in knee self-efficacy over time for either returners (linear:  $F_{1,19} = 2.73$ ,  $P = .12$ ,  $\eta^2 = .13$ ; quadratic effect:  $F_{1,19} = 0.006$ ,  $P = .94$ ,  $\eta^2 = .00$ ) or nonreturners (linear:  $F_{1,15} = 3.38$ ,  $P = .09$ ,  $\eta^2 = .18$ ; quadratic:  $F_{1,15} = 1.14$ ,  $P = .25$ ,  $\eta^2 = .09$ ).

### Psychological Distress

In terms of psychological distress (PHQ-4), both returners (linear:  $F_{1,19} = 187.87$ ,  $P \leq .001$ ,  $\eta^2 = .91$ ; quadratic:  $F_{1,15} = 14.95$ ,  $P < .001$ ,  $\eta^2 = .44$ ) and nonreturners (linear:  $F_{1,15} = 69.63$ ,  $P < .001$ ,  $\eta^2 = .82$ ; quadratic:  $F_{1,15} = 19.14$ ,  $P = .001$ ,  $\eta^2 = .56$ ) showed significant improvement that plateaued over time.



**Table 2. Means and SDs Comparing Returners and Nonreturners on All Psychological Measures at 4, 6, and 9 Months Post–Anterior Cruciate Ligament Reconstruction**

Measure	Return Status	4 Months Postsurgery	6 Months Postsurgery	9 Months Postsurgery
RIAI	Returners	28.25 (8.31) <sup>a</sup>	15.90 (8.09) <sup>a</sup>	8.95 (5.62) <sup>a</sup>
	Nonreturners	34.53 (8.72) <sup>a,b</sup>	15.60 (10.79) <sup>a</sup>	19.53 (11.04) <sup>a,c</sup>
K-SES	Returners	6.74 (1.76)	6.35 (1.31)	6.00 (1.13)
	Nonreturners	5.73 (1.62)	5.62 (1.53)	6.58 (1.32)
PHQ-4	Returners	4.95 (1.54) <sup>a</sup>	1.20 (2.26) <sup>a</sup>	0.35 (0.67) <sup>a</sup>
	Nonreturners	5.56 (1.50) <sup>a</sup>	1.06 (2.11) <sup>a</sup>	1.38 (1.59) <sup>a,d</sup>
Perceived limitations of ability	Returners	6.40 (0.88) <sup>a</sup>	5.30 (0.73) <sup>a</sup>	1.30 (0.50) <sup>a</sup>
	Nonreturners	9.44 (0.26) <sup>a,c</sup>	6.38 (0.95) <sup>a,c</sup>	6.19 (0.79) <sup>a,c</sup>
Perceived percent recovery	Returners	65.5 (17.0) <sup>a</sup>	96.67 (5.77) <sup>a</sup>	94.29 (5.07) <sup>a</sup>
	Nonreturners	54.7 (17.7) <sup>a</sup>	87.50 (10.56) <sup>a,d</sup>	82.11 (7.13) <sup>a,c</sup>

Abbreviations: K-SES, Knee Self-Efficacy Scale; PHQ-4, Patient Health Questionnaire-4; RIAI, Reinjury Anxiety Inventory.

<sup>a</sup> Significant difference across time,  $P < .05$ .

<sup>b</sup> Significant difference between groups,  $P < .05$ .

<sup>c</sup> Significant difference between groups,  $P < .001$ .

<sup>d</sup> Significant difference between groups,  $P < .01$ .

### Perceived Limitations of Ability

Regarding perceived limitations of ability, returners showed a significant decrease (linear:  $F_{1,19} = 18.45$ ,  $P < .001$ ,  $\eta^2 = .49$ ) that accelerated over time (quadratic:  $F_{1,15} = 5.03$ ,  $P = .03$ ,  $\eta^2 = .21$ ). For nonreturners, however, the significant linear decrease ( $F_{1,15} = 13.78$ ,  $P = .001$ ,  $\eta^2 = .56$ ) was sustained over time (quadratic:  $F_{1,15} = 1.82$ ,  $P = .20$ ,  $\eta^2 = .11$ ).

### Perceived Percent Recovery

Finally, for perceived percent recovery, neither a linear nor a quadratic effect was found for returners or nonreturners.

## DISCUSSION

The purpose of the present study was to determine if there were differences between athletes who returned to play post-ACLR and athletes who did not return to sport post-ACLR in their trajectory of psychological responses to injury over the latter course of rehabilitation and return to sport. We found that the 2 groups differed in their patterns of psychological responses on 2 psychological measures (reinjury anxiety and perceived limitations of ability) but did not differ on their patterns of knee self-efficacy, psychological distress, and perceived percent recovery.

These findings both support and deviate from the findings of previous research on the relationship between psychological responses and return to sport post-ACLR. Consistent with previous research, approximately half of the participants in this study returned to play by 9 months postsurgery.<sup>2,4</sup> Researchers have consistently established that the most common reasons for not returning to play post-ACL rehabilitation are a fear of reinjury and continued knee symptoms.<sup>3,7,11,16,28</sup>

Our results revealed no significant pattern of change in knee self-efficacy over the latter course of ACL rehabilitation in returners and nonreturners. This finding contrasts with that of Thomeé and colleagues, who found a significant increase in knee self-efficacy from preoperatively to 12 months postoperatively in patients who had undergone ACLR.<sup>29</sup> Differences in methodology might explain these discrepant findings. Whereas the present study used only the most relevant K-SES subscales—namely, physical activity and future knee function—Thomeé et al included activities of

daily living in their assessment of changes in knee self-efficacy.<sup>29</sup> The activities of daily living subscale was excluded in this study because we would expect function in activities of daily living to be high at 4 months post-ACLR, but it may partially account for the difference in results between these 2 studies. The level of knee self-efficacy reported in the 2 subscales used in the present study was already high at 4 months; thus, there may have been little room for it to improve throughout rehabilitation. Moreover, measures of knee self-efficacy in the study by Thomeé et al were taken preoperatively and at 12 months postoperatively.<sup>29</sup> In the present study, knee self-efficacy was measured at 4, 6, and 9 months postoperatively. The difference between preoperative and 12-month postoperative knee self-efficacy could be meaningfully different based on the different times of assessment in these 2 studies.

This study was grounded in Wiese-Bjornstal et al's integrated model of psychological responses to the sport injury and rehabilitation process, wherein cognitive appraisals, affective responses, and behavioral responses interact reciprocally to influence recovery outcomes.<sup>10</sup> A unique aspect of the present study was the assessment of cognitions about recovery as potential contributors to return to sport outcomes. Cognitive-behavioral models, such as Wiese-Bjornstal et al's model, suggest that cognitions are central to influencing feelings and behaviors and, ultimately, rehabilitation outcomes.<sup>10</sup> Cognitions have emerged in qualitative research as being associated with rehabilitation outcomes post-ACLR.<sup>28</sup> In the present study, perceptions of physical activity ability limitations differed in their patterns over time between returners and nonreturners. Consistent with the integrated model, athletes who returned to play revealed an accelerated decrease in perceived limitations of ability, whereas those who did not return to sport revealed a linear decline, indicating that cognitive appraisals appear to influence behavioral and recovery outcomes.<sup>10</sup> This finding fits with previous qualitative findings, wherein athletes who did not return to sport post-ACLR cited cognitions related to perceived continued knee-related symptoms and limitations of functional ability as reasons why they have not recovered or returned to play.<sup>13</sup> This is the first study, however, to examine patterns in this construct prospectively or longitudinally. As 6 months post-ACLR is the beginning of sport-specific training in ACL rehabilitation, it is

interesting to observe the stark decline in perceived limitations of ability over this period for returners.<sup>13,19,20</sup> Based on the previous literature, we would not expect to see actual differences in limitations of ability.<sup>3,4</sup> Thus, these perceptions of limitations may be a constraining factor in returning to play.

Our finding that reinjury anxiety patterns differed between returners and nonreturners is consistent with previous research.<sup>4,6,7,9</sup> Reinjury anxiety early in rehabilitation is predictive of return to sport, and athletes have retrospectively reported it as a common explanation for why they do not return to sport.<sup>12,28</sup> A unique contribution of the present findings, however, is the prospective examination of levels of reinjury anxiety and rehabilitation outcomes as a pattern across the latter course of ACL rehabilitation.

The differences of the patterns in the reduction of reinjury anxiety over time might be explained by the nature of ACL rehabilitation goals at different times post-ACLR. Specifically, in the months immediately following ACLR, some degree of reinjury anxiety is adaptive, preventing activities that might put patients at risk of reinjuring their knee.<sup>5</sup> By 6 months post-surgery, however, ACL rehabilitation involves increased exposure to sport-specific training.<sup>13,19,20</sup> For individuals high in reinjury anxiety, sport-specific training may activate their fear response and possibly lead to avoidance behavior, such as not returning to play.

This study had a somewhat unique participant population, which may account for some of the differences between the results of the present study and those from previous research. The population in this study included both competitive and recreational athletes and athletes from a large age range. Many previous studies used a more homogeneous sample, focusing specifically on competitive athletes, recreational athletes, athletes from a specific age group, or athletes from a specific sport.<sup>3,5,14</sup> Although no differences were found between returners and nonreturners in terms of age or competitive status, the results may differ from previous research because of the participant population in the present study.

## Limitations

The present study extends the current literature by using a prospective longitudinal design to examine patterns of psychological responses relative to rehabilitation outcomes post-ACLR. Despite what it adds to the literature, this study is limited in several ways. The first notable limitation was the relatively small sample size ( $n = 39$ ) in this study. A small sample size increases the likelihood of missing a significant result when one is present (type II error). The second limitation of this study was the use of incomplete measures. Although we selected limited subscales for each study to reduce participant burden, this limits our ability to compare our results to those from previous research, and we may have missed interesting or important findings from the additional subscales. Finally, because a standard ACLR protocol involves return to play between 9 and 12 months postoperatively, this study is limited by only following participants until 9 months postoperatively.<sup>30</sup> Subsequent research should assess the trajectory of psychological responses to ACLR to at least 12 months postoperatively.

## Future Research Recommendations

Future research could build on the results of this study by addressing some of the limitations, including the sample

size and incomplete measures. Moreover, randomized controlled interventions could determine if intervening between 4 and 6 months postoperatively with psychoeducational strategies could identify athletes at risk of poor rehabilitation outcomes (eg, those with consistently high reinjury anxiety and perceived limitations of ability) and determine if there are effective strategies for intervention in the recovery process—ideally, preventing disablement and encouraging return to sport.

## Implications for Practice

Ideally, based on the results of this study, athletic trainers would be able to identify athletes at risk of not returning to play after ACLR through repeated physical and psychological measures at key time points throughout rehabilitation. Practitioners may expect to see continued psychological distress at 4 months post-ACLR but should be looking for continued reductions over the rest of rehabilitation, particularly in reinjury anxiety and perceptions of recovery. If athletic trainers observe that an athlete does not show continued improvement in reinjury anxiety after 4 months post-ACLR or if their improvement in perceived limitations of ability is slow, this might be a good opportunity to intervene with strategies to reduce reinjury anxiety and reframe or address limitations of ability. This could be done through psychoeducational techniques or a referral to a sport psychologist.

Returners and nonreturners display different patterns of thoughts and feelings related to their injuries across the latter part of rehabilitation. Thus, athletic trainers may be able to identify athletes at risk of not returning to play earlier in the rehabilitation process, particularly if their reinjury anxiety and perceived limitations of ability do not continue to improve across the rehabilitation process. Six months post-ACLR appears to be a crucial milestone, with athletes beginning their sport-specific training, and, according to the results of this study, how their psychological characteristics at this point change (or stay the same) may determine if they return to sport by 9 months post-ACLR.<sup>13,19,20</sup>

## REFERENCES

1. Kaeding CC, Léger-St-Jean B, Magnussen RA. Epidemiology and diagnosis of anterior cruciate ligament injuries. *Clin Sports Med.* 2017;36(1):1–8. doi:10.1016/j.csm.2016.08.001
2. Ardern CL, Webster KE, Taylor NF, Feller JA. Return to sport following anterior cruciate ligament reconstruction surgery: a systematic review and meta-analysis of the state of play. *Br J Sports Med.* 2011;45(7):596–606. doi:10.1136/bjism.2010.076364
3. McCullough KA, Phelps KD, Spindler KP, et al; MOON Group. Return to high school- and college-level football after anterior cruciate ligament reconstruction. *Am J Sports Med.* 2012;40(11):2523–2529. doi:10.1177/0363546512456836
4. Kvist J, Ek A, Sporrstedt K, Good L. Fear of re-injury: a hindrance for returning to sports after anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc.* 2005;13(5):393–397. doi:10.1007/s00167-004-0591-8
5. Tripp DA, Stanish W, Ebel-Lam A, Brewer BW, Birchard, J. Fear of reinjury, negative affect and catastrophizing predicting return to sport in recreational athletes with anterior cruciate ligament injuries at 1 year postsurgery. *Rehabil Psychol.* 2007;52(1):74–81. doi:10.1037/2157-3905.1.S.38
6. Baez SE, Hoch MC, Hoch JM. Psychological factors are associated with return to pre-injury levels of sport and physical activity after ACL

- reconstruction. *Knee Surg Sports Traumatol Arthrosc.* 2020;28(2):495–501. doi:10.1007/s00167-019-05696-9
7. Nwachukwu BU, Adjei J, Rauck RC, et al. How much do psychological factors affect lack of return to play after anterior cruciate ligament reconstruction? A systematic review. *Orthop J Sports Med.* 2019;7(5):2325967119845313. doi:10.1177/2325967119845313
  8. Ardern CL, Kvist J, Webster KE. Psychological aspects of anterior cruciate ligament injuries. *Oper Tech Sports Med.* 2016;24(1):77–83. doi:10.1053/j.otsm.2015.09.006
  9. te Wierike SCM, van der Sluis A, van den Akker-Scheek I, Elferink-Gemser MT, Visscher C. Psychosocial factors influencing the recovery of athletes with anterior cruciate ligament injury: a systematic review. *Scand J Med Sci Sports.* 2013;23(5):527–540. doi:10.1111/sms.12010
  10. Wiese-Bjornstal DM, Smith AM, Shaffer SM, Morrey MA. An integrated model of response to sport injury: psychological and sociological dynamics. *J Appl Sport Psychol.* 1998;10(1):46–69. doi:10.1080/10413209808406377
  11. Toale JP, Hurley ET, Hughes AJ, et al. The majority of athletes fail to return to play following anterior cruciate ligament reconstruction due to reasons other than the operated knee. *Knee Surg Sports Traumatol Arthrosc.* 2021;29(11):3877–3882. doi:10.1007/s00167-020-06407-5
  12. DiSanti J, Lisee C, Erickson K, Bell D, Shingles M, Kuenze C. Perceptions of rehabilitation and return to sport among high school athletes with anterior cruciate ligament reconstruction: a qualitative research study. *J Orthop Sports Phys Ther.* 2018;48(12):951–959. doi:10.2519/jospt.2018.8277
  13. Heijne A, Axelsson K, Werner S, Biguet G. Rehabilitation and recovery after anterior cruciate ligament reconstruction: patients' experiences. *Scand J Med Sci Sports.* 2008;18(3):325–335. doi:10.1111/j.1600-0838.2007.00700.x
  14. Koch M, Klügl M, Frankewycz B, et al. Football-related injuries are the major reason for the career end of professional male football players. *Knee Surg Sports Traumatol Arthrosc.* 2021;29(11):3560–3568. doi:10.1007/s00167-021-06684-8
  15. Reider B. Return or retirement? *Am J Sports Med.* 2012;40(11):2437–2439. doi:10.1177/0363546512465849
  16. Liew BXW, Feller JA, Webster KE. Understanding the psychological mechanisms of return to sports readiness after anterior cruciate ligament reconstruction. *PLoS ONE.* 2022;17(3):e0266029. doi:10.1371/journal.pone.0266029
  17. Webster KE, Nagelli CV, Hewett TE, Feller JA. Factors associated with psychological readiness to return to sport after anterior cruciate ligament reconstruction surgery. *Am J Sports Med.* 2018;46(7):1545–1550. doi:10.1177/0363546518773757
  18. Chmielewski TL, George SZ. Fear avoidance and self-efficacy at 4 weeks after ACL reconstruction are associated with early impairment resolution and readiness for advanced rehabilitation. *Knee Surg Sports Traumatol Arthrosc.* 2019;27(2):397–404. doi:10.1007/s00167-018-5048-6
  19. Delay BS, Smolinski RJ, Wind WM, Bowman DS. Current practices and opinions in ACL reconstruction and rehabilitation: results of the survey of the American Orthopaedic Society for Sports Medicine. *Am J Knee Surg.* 2001;14(2):85–91.
  20. Stoehr A, Mayr H, Mondrasch B. Rehabilitation and return to sports. In: Siebold R, Dejour D, Zaffagnini S, eds. *Anterior Cruciate Ligament Reconstruction: A Practical Surgical Guide.* Springer; 2014:477–487.
  21. Thomeé P, Währborg P, Börjesson M, Thomeé R, Eriksson BI, Karlsson J. A new instrument for measuring self-efficacy in patients with an anterior cruciate ligament injury. *Scand J Med Sci Sports.* 2006;16(3):181–187. doi:10.1111/j.1600-0838.2005.00472.x
  22. Smith AM, Scott SG, O'Fallon MW, Young ML. Emotional responses of athletes to injury. *Mayo Clin Proc.* 1990;65(1):38–50. doi:10.1016/s0025-6196(12)62108-9
  23. Walker N, Thatcher J, Lavalley D. A preliminary development of the Re-Injury Anxiety Inventory (RIAI). *Phys Ther Sport.* 2010;11(1):23–29. doi:10.1016/j.ptsp.2009.09.003
  24. Kroenke K, Spitzer RL, Williams JB, Löwe B. An ultra-brief screening scale of anxiety and depression: the PHQ-4. *Psychosomatics.* 2009;50(6):613–621. doi:10.1176/appi.psy.50.6.613
  25. Vela LI, Denegar CR. The Disablement in the Physically Active Scale, part II: the psychometric properties of an outcomes scale for musculoskeletal injuries. *J Athl Train.* 2010;45(6):630–641. doi:10.4085/1062-6050-45.6.630
  26. Vela LI, Denegar C. Transient disablement in the physically active with musculoskeletal injuries, part I: a descriptive model. *J Athl Train.* 2010;45(6):615–629. doi:10.4085/1062-6050-45.6.615
  27. Tabachnick BG, Fidell LS. Review of univariate and bivariate statistics. In: Tabachnick BG, Fidell LS, eds. *Using Multivariate Statistics.* 6th ed. Pearson; 2013:31–59.
  28. Roos MD. The relationship between functional levels and fear-avoidance beliefs following anterior cruciate ligament reconstruction. *J Orthop Traumatol.* 2010;11(4):237–243. doi:10.1007/s10195-010-0118-7
  29. Thomeé P, Währborg P, Börjesson M, Thomeé R, Eriksson BI, Karlsson J. Self-efficacy, symptoms and physical activity in patients with an anterior cruciate ligament injury: a prospective study. *Scand J Med Sci Sports.* 2007;17(3):238–245. doi:10.1111/j.1600-0838.2006.00557.x
  30. Waldron K, Brown M, Calderon A, Feldman M. Anterior cruciate ligament rehabilitation and return to sport: how fast is too fast? *Arthrosc Sports Med Rehabil.* 2022;4(1):e175–e179. doi:10.1016/j.asmr.2021.10.027

---

Address correspondence to Hayley C. Russell, PhD, Gustavus Adolphus College, 800 West College Avenue, Saint Peter, MN 56082. Address email to hrussell@gustavus.edu.