

Early and Repeated Psychological Assessment Reveals Individual Trajectories for Personalized ACL Reconstruction Care in Females

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Headline

Return-to-sport (RTS) guidelines recommend clinicians assess psychological readiness before clearing athletes, usually at one point late in rehabilitation. Whether late assessments reflect psychological readiness throughout rehabilitation is unknown. This study tracked psychological outcomes monthly for 6 months after ACL reconstruction (ACLR) in 5 female athletes. Few followed the expected U or A-shaped patterns; each had her unique trajectory, crossing RTS cut-offs in both directions. Monthly trends, rather than one score, may help clinicians support psychological readiness during rehabilitation.

Aim of the paper

Return-to-sport (RTS) guidelines after Anterior Cruciate Ligament Reconstruction (ACLR) recommend assessing psychological readiness before clearing athletes, but they generally anchor that assessment to a single point late in rehabilitation.^{1,2} Females report greater fear of reinjury and lower readiness scores than males,³⁻⁵ with fear of reinjury the most common reason athletes never go back.⁶ Measures such as the ACL-Return to Sport after Injury scale (ACL-RSI)⁷ are generally administered pre-operatively and 3-6 months post-operatively for RTS clearance.⁸ The identified emotional patterns include an A (low baseline, higher scores in mid-rehab, then dropped scores in late rehab), U (high baseline, dropped scores in mid-rehab, then a rise in late rehab), and zigzag (alternating improvement/worsening scores) shapes.⁹ However, there is a lack of literature that observes monthly trends that may miss maladaptive responses throughout rehabilitation in females following ACLR. We aimed to describe psychological readiness and kinesiophobia in females throughout the first 6 months after ACLR. We hypothesized that participants would present a U-shaped pattern for the ACL-RSI where scores would be high, yet below the RTS cut-off during early months, worsen during mid-rehab months, then improve beyond the RTS cut-off in late rehab months and an A-shaped pattern for the 11-item Tampa Scale for Kinesiophobia (TSK-11) with the inverse trend.

Methods

Participants

We recruited participants with a unilateral, isolated ACL injury, age 13 years or older, no previous ACL surgery, a pre-injury Tegner of 5 or higher,¹⁰ recreational to sub-elite athletes, and email access to complete the surveys. We excluded anyone with a concomitant cartilage or meniscal repair, bi-

lateral injury, or an inability to complete surveys at all time points independently. The study sample included 5 females recruited acutely after ACL injury, between 2020 and 2022, through email, clinic flyers and word of mouth.

Design

In this prospective case series, we followed participants for the first 6 months after ACLR and collected data remotely at monthly time points (1, 2, 3, 4, 5, and 6 months after surgery). The study was conducted in accordance with the Helsinki Declaration and approved by the University of Washington Institutional Review Board (study ID #00011263). All participants gave electronic consent prior to participation.

Approach

We delivered all questionnaires through REDCap (v13.7.6). Participants completed demographics and baseline questionnaires within 2-4 weeks of surgery, then monthly until 6 months. Two automated reminders were sent 2 days apart, followed by a personal email from a research assistant if a survey was still outstanding. We administered the ACL-RSI and TSK-11 at every time point. The ACL-RSI scores 12 items covering emotion, confidence in performance, and risk appraisal on a 0-100 scale; higher scores mean greater psychological readiness (RTS cut-off 65 points,^{8,11} minimal important change (MIC) 13.4 points¹²). The TSK-11 scores 11 items from 1 to 4 (range 11-44); lower scores indicate less injury-related fear (cut-off ≤ 17 points,¹³ MIC 5.6 points¹⁴). Kinesiophobia is defined as the debilitating fear of physical movement resulting from vulnerability to painful injury or reinjury.¹⁴

Statistical analysis

This case series is descriptive. We plotted each participant's ACL-RSI and TSK-11 scores across the 6 time points and described the direction and shape of change. We evaluated the change between consecutive months against the published MIC for each instrument and compared every score with the RTS cut-off. Group data are mean $\pm$ SD. No inferential statistics (p-values) were calculated.

Results

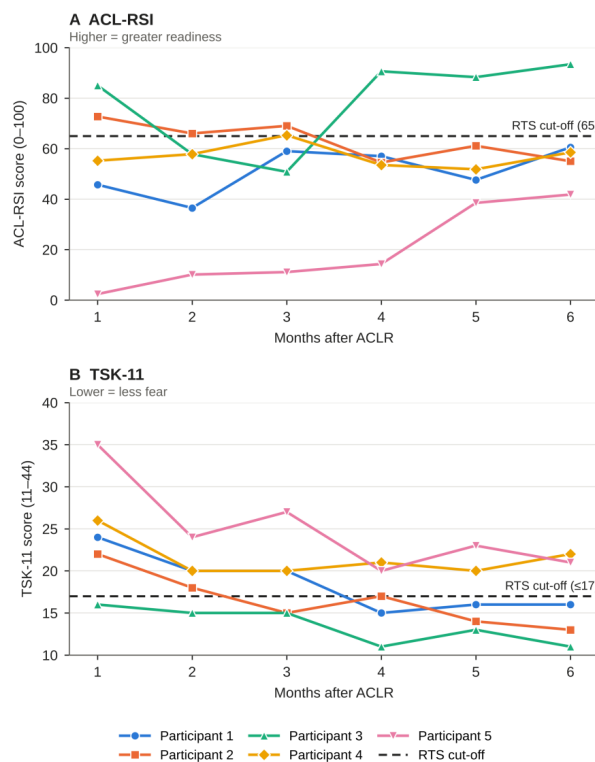
Table 1 presents participant demographics and Figure 1 individual ACL-RSI and TSK-11 trajectories. For the ACL-RSI, Participant 3 followed a U-shaped pattern from baseline to 4 months, but transitioned to a zigzag pattern for subsequent months. Participants 1, 2, and 4 followed a zigzag trajectory. Participant 5 followed a positive step-wise linear pattern where her scores improved, plateaued, and improved again. For the TSK-11, trajectories were equally individual, and none of the

participants exhibited an A pattern. Participant 1 followed a downward step-wise linear pattern where scores dropped (improved), plateaued, dropped again, and plateaued again. Participant 2 followed a U-shaped pattern from baseline to 4 months, then transitioned to a downward linear pattern where scores dropped. Participants 3, 4, and 5 demonstrated a zigzag pattern where Participant 5 had the greatest magnitude of change. Month-to-month changes rarely exceeded the MIC for either instrument. Participants crossed the RTS cut-off

repeatedly: participant 2 met the ACL-RSI cut-off from baseline to 3 months, then dropped below it (worsened) and stayed there; participant 3 started above RTS cut-off, fell below by 2 months and climbed back above (improved) by 4 months; participant 4 crossed the RTS cut-off in both directions; participants 1 and 5 never reached it. On the TSK-11, participant 3 met the cut-off at every time point, participant 2 from month 3 onward and participant 1 from month 4 onward, while participants 4 and 5 never did.

Table 1. Participant Demographics

Measures	Values (Mean $\pm$ SD), N=5
Age (yrs)	30.22 $\pm$ 12.34 (range 19.8-51.5)
BMI	21.26 $\pm$ 1.48 (range 18.81-22.49)
Ethnicity	3 Caucasian, 1 Asian, 1 Hispanic/Latino
Time from injury to surgery (weeks)	10.94 $\pm$ 5.67 (range: 4.14–19.86)
MOI	2 contact, 3 non-contact
Previous sports/activities	Track, cross-country, running, cycling, Zumba, yoga, dance, rock climbing, snowboarding, swimming
Preinjury activity level	Tegner level: 7.2 $\pm$ 1.30 (range 6-9)
Graft Type	3 BPTB, 1 Allograft, 1 STG
Episodes of giving way	2.6 $\pm$ 1.67 (range 1-5)
SD=standard deviation, BMI= body mass index, yrs=years, MOI= mechanism of injury, BPTB= bone patellar tendon bone, STG= semitendinosus-gracilis graft	



Return-to-sport (RTS) cut-off scores and minimal important change (MIC) for the ACL-RSI is 65 points^{8,11} and 13.4 points¹² respectively. The TSK-11 RTS scores and MIC is ≤ 17 points¹³ and 5.6 points¹⁴ respectively. The RTS cut-off is represented in black.

Fig. 1. Individual ACL-Return to Sport after Injury scale (ACL-RSI) and 11-item Tampa Scale for Kinesiophobia (TSK-11) scores at each timepoint.

Discussion

Each participant showed an individual pattern of psychological readiness and kinesiophobia early after ACLR. Psychological readiness followed the hypothesized “U”-shaped course for Participant 3 with the ACL-RSI during the first 4 months before plateauing for the subsequent months. None of the participants followed the hypothesized “A”-shaped pattern for the TSK-11. The zigzag pattern was most common, and monthly changes rarely met the MIC. These findings are similar to other studies that found athletes tend to exhibit a U-shaped or zigzag pattern for the ACL-RSI, with wide between-individual variability in psychological outcomes after ACLR.^{9,15,16}

For the ACL-RSI, 2 patterns stand out as clinically useful. These are early scores above the cut-off that later fall below it (participants 2,3) and scores that stay well below the cut-off despite steady improvement in clinical and functional performance (participant 5). These profiles are linked to maladaptive responses to injury and higher risk of a second ACL injury or no RTS.^{16,17} The ACL-RSI is commonly administered once, near the time of RTS. Participant 4 stayed within MIC bounds yet crossed the cut-off repeatedly, so an RTS clearance decision hinged on which month the questionnaire was administered. ACL-RSI scores may plateau between 3-6 months and 2 years post-op,⁸ so an early stagnating trajectory is unlikely to correct itself unaided.

TSK-11 trends resembled, but did not mirror, ACL-RSI trends; kinesiophobia captures a different construct than readiness, so both measures should be assessed regularly. Those more likely to meet the cut-off (≤ 17) (participants 1-3), scores that fluctuate but never meet the cut-off (Participant 5), and scores that consistently meet the cut-off (Participant 3) stand out as clinically useful patterns that may be addressed during rehabilitation. Patterns of participants 1-3 are consistent with a cohort in which 38% had slightly improved scores from baseline to 6 months.¹⁸ Higher kinesiophobia scores at 4 weeks predict failure to meet advanced rehabilitation criteria,^{19,20} and scores ≥ 19 at RTS are associated with a 13-fold increase in second ACL injury within 2 years.²¹ For the ACL-RSI, meeting the RTS cut-off early in rehabil-

itation is associated with an increased risk of a second ACL injury;¹⁶ whether an early TSK-11 score within the RTS cut-off carries a similar risk is unknown. Monitoring it may still be clinically useful in case it reflects a maladaptive response.

Psychological interventions used to improve TSK-11 scores at 3 or 6 months include cognitive restructuring, exposure therapy, or observational learning.^{22,23} Guided imagery and mirror therapy used for 20 weeks and cognitive-behavior-based physical therapy used for 24 weeks improved ACL-RSI scores;^{24,25} but a meta-analysis found both had no significant effect due to substantial heterogeneity.²³ Monthly measurements may identify who needs further interventions. Individual variability in psychological readiness is the rule rather than the exception in the acute phase after ACLR in females, and early, frequent assessment makes the variability visible in time to act on it.

Practical applications

- Administer the ACL-RSI and TSK-11 monthly from the first post-operative month, alongside range of motion and strength, rather than once before RTS testing.
- Read the trend, not just the score. A single value above the cut-off can sit inside a downward trajectory.
- Monitor two patterns closely: high early scores that later fall, and scores that stay well below the cut-off despite steady clinical and functional improvement. These patients may need real-time modification of the rehabilitation protocol, intermittent or ongoing professional psychological support, and monitoring of how these changes affect readiness scores.
- Compare consecutive scores against the MIC (13.4 points for the ACL-RSI, 5.6 points for the TSK-11) to separate real change from noise.
- Treat a plateaued or falling trajectory as a prompt to discuss fear and confidence with your patient, reassess how aggressively ACLR exercises and treatment are progressed, and consider referral to a sport psychologist when needed.

Limitations

- We had a small sample size; only five participants completed all six timepoints.
- Data collection ran through the COVID-19 pandemic, so access to gyms, in-person rehabilitation, and social support varied, and sport seasons were disrupted. This may have limited real-time opportunities to test readiness during rehabilitation.
- We were unable to include any in-person objective testing, so all findings are patient-reported measures.
- Due to a lack of resources, follow-up stopped at 6 months. These findings cannot be linked to return to sport or performance, or re-injury rates.

AI Use Statement

No AI tools were used.

Conflicts of Interest

The authors declare no financial, institutional or personal relationships that could have inappropriately influenced this work.

Accompanying dataset

Anonymized participant-level ACL-RSI and TSK-11 scores at each timepoint are provided as an accompanying spreadsheet.

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