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Psychological Readiness to Return to Sport After Anterior Cruciate Ligament Reconstruction in the Adolescent Athlete

Kate E. Webster, PhD*; Julian A. Feller, MBBS†

*School of Allied Health, Human Services and Sport, La Trobe University, Bundoora, Australia; †OrthoSport Victoria, Richmond, Australia

Context: Psychological readiness to return to sport has been shown to be associated with future play after anterior cruciate ligament (ACL) reconstruction surgery but has not been extensively studied in adolescent athletes.

Objective: To investigate the psychometric properties of the Anterior Cruciate Ligament-Return to Sport after Injury (ACL-RSI) scale in adolescent athletes at multiple time points after ACL reconstruction surgery and determine whether psychological readiness scores at 6 months predict return to competition sport at 12 months.

Design: Case series.

Setting: Private orthopaedic clinic.

Patients or Other Participants: A total of 115 adolescent athletes (65 girls, 50 boys) 17 years and younger who had undergone primary unilateral ACL reconstruction.

Main Outcome Measure(s): The ACL-RSI scale was administered at 6 and 12 months after surgery, and return-to-sport status was also documented. Factor analysis was undertaken and predictive validity assessed using between-groups comparisons and receiver operating characteristic (ROC) curve statistics.

Results: The ACL-RSI scores increased between 6 and 12 months (55 to 71; $P < .001$, effect size = 0.98). No floor or ceiling effects were present, and the scale had high internal consistency (Cronbach α at 6 months = 0.91 and at 12 months = 0.94). Principal component analysis showed that 2 factors were present: the first represented performance confidence and risk appraisal and the second, emotions. For the full-scale ACL-RSI, scores at 6 months had acceptable predictive ability for a return to play at 12 months (area under the ROC curve = 0.7, $P = .03$). When the 2 identified factors were analyzed separately, the emotions factor also had acceptable predictive ability (area under the ROC curve = 0.73, $P = .009$), but the confidence in performance and risk appraisal factors had poor predictive ability (area under the ROC curve = 0.59, $P = .09$).

Conclusions: Greater psychological readiness was associated with return to sport in adolescent athletes after ACL reconstruction, with the athletes' emotional response appearing to be more influential than their confidence in their performance or their appraisal of risk.

Key Words: fear of injury, knee, Anterior Cruciate Ligament-Return to Sport after Injury scale

Key Points

- The Anterior Cruciate Ligament-Return to Sport after Injury scale has good psychometric properties and is suitable for use in adolescent athletes.
- The adolescent athlete's emotional response appears to be a strong predictor of return to sport.

Anterior cruciate ligament (ACL) rupture is a serious injury that most often occurs during sport participation. Many athletes choose to undergo ACL reconstruction surgery with the aim of returning to their preinjury level of sport participation. However, the return-to-play rate has been estimated at only 50% to 80%.[1–3] Although many factors contribute to an athlete's return-to-sport decision, the importance of psychological recovery from such injuries is now well recognized.[4–6]

An athlete's psychological readiness to return to sport, when measured during the rehabilitation period, has been strongly associated with actual return-to-sport rates and sport performance in predominantly adult populations.[7–10] Some adolescent athletes have been included in these studies, but the extent to which these relationships hold for a larger adolescent population has not been clarified. In a qualitative study, DiSanti et al[11] reported that psychosocial barriers were more consistently described by high school athletes aged 15–18 years than physical barriers during rehabilitation from ACL injury. Mechanisms for coping with injury and rehabilitation have also been investigated in adolescent athletes, and several have been associated with the time it takes to recover from ACL reconstruction surgery.[12] Poorer coping skills, decreased concentration, and difficulty with peaking under pressure have all been linked with a delay in recovery.[12] In adolescent athletes, less psychological readiness and greater fear of movement may also be associated with an increased risk for a second ACL injury once sport is recommenced.[13,14] These findings of psychological disturbance after athletic injury in adolescents have been explained by the idea that, because sport participation is such an important part of an adolescent athlete's identity, not being able to participate due to injury can have a significant negative effect on

psychological well-being.[11] Therefore, psychological changes that occur after ACL injury in an adolescent athlete are likely to be of significant magnitude and may affect recovery.

The ACL-Return to Sport after Injury (ACL-RSI) scale has been used to quantify the psychological readiness to return to sport.[15] However, limited information is available on its use in adolescent athletes. Kostyun et al[16] recently used the ACL-RSI scale in a cohort of 93 adolescent athletes and found that scores sequentially increased over the first 6 to 7 months postsurgery and were typically higher than those reported in adult populations. Ellis et al[12] also showed that ACL-RSI scores improved over the first postoperative year in 68 adolescent athletes, and improvements were similar to those noted in adult populations. Neither group found an association between ACL-RSI scores and physician clearance to return to sport or the passing of a Y-balance test at 6 months. Unfortunately, neither study documented the actual return to sport, so any associations between ACL-RSI scores and return to play were not investigated. Therefore, we sought to examine the psychometric properties (reliability and validity) of the ACL-RSI scale in adolescent athletes at multiple time points after ACL reconstruction surgery. We also aimed to determine whether the scores for psychological readiness to return to sport could predict the return to sport in this younger cohort. We hypothesized that the scale would exhibit satisfactory psychometric properties and that scores at an earlier timepoint would predict the subsequent return to sport.

METHODS

Participants

The participants were part of a large longitudinal study of primary ACL reconstruction and were enrolled between December 2013 and June 2018. From this cohort, we selected all patients who were under 18 years at the time of surgery and had completed 6- and 12-month follow-up assessments. These time points were chosen because changes in the psychological readiness to return to sport are expected in this phase of rehabilitation, when patients begin to perform sport-specific drills and training before being cleared to return to play. This totaled 115 patients who were a highly active group pre-ACL injury (Table 1). All but 3 were full-time students.

All patients had undergone arthroscopically assisted ACL reconstruction with suspensory fixation on the femoral side and interference screw fixation on the tibial side by 1 of 3 experienced, specialized orthopaedic knee surgeons. The majority received hamstrings tendon grafts (n = 94). Medial meniscal tears were present in 28 patients (8 stable and not treated, 4 resected, 16 repaired) and lateral meniscal tears in 37 patients (15 stable and not treated, 17 resected, 5 repaired). Patients completed rehabilitation at a clinic of their choice, and standard rehabilitation protocols and guidelines were provided that encouraged immediate, full knee extension and the restoration of quadriceps function as soon as possible.[17] Clearance to return to competitive sport typically occurred at 9 to 12 months postsurgery and was determined by the treating surgeon. None of the included patients had further surgery or sustained further ACL injury during the 6- to 12-month follow-up period.

Table 1. Patient and Preinjury Sports Characteristics

Variable	Value
Age at surgery, mean ± SD, (range), y	16.2 ± 0.9 (13–17)
Sex, No.	
Male	50
Female	65
Sport level, No. (%)[a]	
Elite	4 (4)
High-level competition	58 (50)
Frequent sports	53 (46)
Sport frequency, No. (%)	
4–7 d/wk	88 (77)
1–3 d/wk	27 (23)
Sport of injury, No.	
Australian Rules football	39
Netball	34
Basketball	17
Soccer	11
Rugby	4
Skiing	3
Hockey	2
Gymnastics	1
Athletics (long jump)	1
Taekwondo	1
Not sport related	2

[a] Patients self-selected their sport level on the basis of these descriptive categories. Two other categories (*sport sometimes* and *no sport*) were also available but not selected by any patient.

Measures and Procedures

Patients completed the ACL-RSI scale and provided their return-to-sport status at both the 6- and 12-month postoperative visits. All procedures were approved by the hospital and university ethics committees (Study No. 572012; HEC19205). Parental consent was obtained, but the measures were completed by the patients themselves.

The ACL-RSI scale consists of 12 items and was designed to measure psychological readiness to return to sport after ACL injury or reconstruction surgery.[15] Each item was presented with a 100-mm visual analog scale with anchor descriptors of *not at all* and *extremely* representing the opposite ends of the response continuum, and participants were asked to indicate how they were feeling relative to the 2 extremes. The items were developed around 3 conceptual domains: emotions, confidence in performance, and risk appraisal. These domains are, however, highly related to each other, and the scale is considered unidimensional. An overall score was thus calculated by summing and averaging all 12 items for a score from 0 to 100. Higher scores indicate greater psychological readiness.

To document return-to-sport status, patients were required to select from 1 of the following categories: *not returned*, *returned to training*, *returned to a lower level of competition*, *returned to the same/higher level of competition*.

Data and Statistical Analysis

Psychometric Properties (Aim 1). Descriptive statistics for ACL-RSI scores were computed for the 6- and 12-month time points, and change over time was analyzed using paired-samples *t* tests. (Both time points showed a normal distribution of scores.) Floor or ceiling effects were

Table 2. Descriptive Statistics for Anterior Cruciate Ligament-Return to Sport after Injury Scale Scores at 6 and 12 Months

	All Patients		Female Patients		Male Patients	
Measure	6 mo	12 mo	6 mo	12 mo	6 mo	12 mo
Mean ± SD	55.3 ± 19.5	71.1 ± 20.2	50.9 ± 18.5	66.7 ± 21.0	61.1 ± 19.4	76.9 ± 17.8
Median	53.25	72	48.9	65	59.1	77
Range	82.0	84.5	76.8	84.5	82.0	59
Minimum	18	15.5	19.1	15.5	18	41
Maximum	100	100	95.8	100	100	100
No. scoring 0	0	0	0	0	0	0
No. scoring 100	1	8	0	3	1	5

considered present if >15% of patients reported the worst (floor effect) or best (ceiling effect) possible score. Internal consistency of the scale at both time points was assessed with the Cronbach α (a reliability measure of how well the individual items of the scale measure the same construct, ie, psychological readiness). Principal component analysis with varimax rotation was also performed to evaluate the structure of the scale and determine whether 1 or more underlying constructs were present (ie, whether psychological readiness contained 1 or more components or elements).

Predictive Validity (Aim 2). The ability of the scale to predict return to sport was assessed via between-groups comparisons and receiver operating characteristic (ROC) curve statistics for the ACL-RSI scores at 6 months (dependent variable) and return-to-sport status at 12 months (independent variable). For this analysis, return to sport was dichotomized as patients who had returned to play and those who had not returned or who had returned to training only. Level of return was not a subcategory given that patients may not have all had the same opportunity to return to their prior level of participation by the 12-month time point. The area under the ROC curve shows how good a logistic regression model is at correctly predicting positive and negative outcomes. The area under the ROC curve was interpreted as follows: 0.5 is *random*, 0.7 to 0.8 is *acceptable*, and 0.8 to 0.9 is *excellent*.[18] Statistical calculations were conducted using SPSS (version 27; IBM Corp), and statistical significance was set at $P < .05$.

RESULTS

The ACL-RSI scores recorded at the 6- and 12-month follow-ups are shown in Table 2. No floor or ceiling effects were present; 1 patient scored the maximum 100 at 6 months, as did 8 patients at 12 months. Scores for female patients were lower than for male patients at both time points; however, the same increase in scores was seen between the time points (mean difference for both male and female patients was 15.8 points, $P < .0001$, effect size = 0.98).

The scale displayed high internal consistency, with a Cronbach α of 0.91 at 6 months and 0.94 at 12 months. At both time points, principal component analysis indicated the presence of 2 underlying factors, which accounted for 64% (33% by factor 1, 31% by factor 2) of the variance at 6 months and 73% (38% by factor 1, 35% by factor 2) of the variance at 12 months. The 7 items associated with factor 1 were all from the confidence in performance and risk appraisal domains of the scale, whereas the 5 items that were associated with factor 2 were the emotions items (Table 3). Therefore, we calculated scores for these 2 factors (confidence and risk appraisal subscale and emotions subscale), as well as the overall scale. Mean values were higher for confidence in performance and risk appraisal items than for emotions items. The item on which the patients scored lowest was "Do you find it frustrating to have to consider your knee with respect to your sport?" with a mean value of only 30 out of 100 at the 6-month follow-up (Table 3).

At 6 months, no patient had returned to play; 76% (87/115) of patients had not attempted any form of sport and

Table 3. Anterior Cruciate Ligament-Return to Sport after Injury Scale Scores at 6 and 12 Months for the 2 Identified Factors (Mean ± SD)

Scale Item	6 mo	12 mo
Factor 1: Confidence in performance and risk appraisal		
Are you confident that your knee will not give way by playing your sport?	60.6 ± 25.0	76.9 ± 24.6
Are you confident that you could play your sport without concern for your knee?	52.2 ± 28.3	74.0 ± 26.0
Are you confident about your knee holding up under pressure?	64.8 ± 21.9	77.3 ± 21.4
Are you confident that you can perform at your previous level of participation?	66.4 ± 29.3	86.2 ± 18.0
Are you confident about your ability to perform well at your sport?	68.8 ± 26.1	81.4 ± 21.1
Do you think you are likely to reinjure your knee by participating in your sport?	58.2 ± 25.7	72.9 ± 23.6
Do thoughts of having to go through surgery and rehabilitation again prevent you from playing your sport?	63.6 ± 30.8	76.3 ± 27.2
Mean factor 1[a]	62.1 ± 20.1	77.9 ± 18.7
Factor 2: Emotions		
Are you nervous about playing your sport?	51.9 ± 30.3	64.8 ± 28.5
Do you find it frustrating to have to consider your knee with respect to your sport?	30.4 ± 27.5	51.2 ± 33.1
Do you feel relaxed about playing your sport?	56.1 ± 25.2	69.7 ± 23.8
Are you fearful of reinjuring your knee by playing your sport?	41.5 ± 28.9	55.8 ± 29.7
Are you afraid of accidentally injuring your knee by playing your sport?	44.4 ± 28.3	57.9 ± 28.1
Mean factor 2[a]	45.8 ± 22.5	60.7 ± 25.2

[a] Mean score for each identified factor.

Table 4. Comparison of Anterior Cruciate Ligament-Return to Sport after Injury Scale Scores at 6 Months With Return-to-Play Status at 12 Months Postreconstruction

Scale or Subscale	Returned to Play	No Return or Training Only	*P* Value
Overall score	61.7 ± 23.1	52.2 ± 16.7	.014
Emotions subscale	54.7 ± 26.6	41.4 ± 18.8	.002
Confidence and risk appraisal subscale	66.6 ± 22.7	59.9 ± 18.4	.09

24% (28/115) had recommenced training. At 12 months, 30% (34/115) of patients had not attempted any form of sport, 37% (43/115) had recommenced training, and 33% (38/115) had recommenced play at any level of competition (27 at the same or a higher level than preinjury and 11 at a lower level). The ACL-RSI scores at 6 months were higher for patients who had returned to play at 12 months (Table 4). Of the 2 subscales, scores on the emotions subscale were higher at 6 months for patients who returned to play at 12 months, but there was no difference between the scores of those who did and those who did not return to play on the confidence and risk appraisal subscale (Table 4). The ROC analysis showed the same pattern of results: 6-month ACL-RSI scores and scores on the emotions subscale had fair to good predictive ability for a return to play at 12 months (full scale: area under the ROC curve = 0.7, $P = .03$; emotions subscale: area under ROC curve = 0.73, $P = .009$; Figure), whereas no significant association was seen for the confidence and risk appraisal subscale (area under the ROC curve = 0.59, $P = .09$).

DISCUSSION

We explored the use of the ACL-RSI scale to measure psychological readiness to return to sport in adolescent athletes after ACL reconstruction. Our results suggest that the scale has value for use in this population. The scale was not subject to floor or ceiling effects, and scores at a 6-month postoperative assessment subsequently improved. Recent work[19] has shown that a change score of 13.4 points reflects a minimally important change in psychological readiness at a group level. Thus, the magnitude of change (15.8 points) seen in this adolescent cohort was of sufficient magnitude to be clinically meaningful. The scale also had good ability to predict return-to-sport status at 12 months. This is consistent with and complements previous findings in adult populations.[20,21]

Similar to adults, the scale had high internal consistency in adolescents, indicating that the items were measuring the same construct, that of psychological readiness. However, an interesting point of difference between the current adolescent cohort and previous adult populations was the factor structure of the scale. The ACL-RSI scale was designed around 3 domains (emotions, confidence in performance, and risk appraisal), and although it was initially thought that this might result in 3 underlying factors, most prior adult population samples have revealed that only 1 underlying factor was present.[15,20,22–25] Yet in the current adolescent cohort, 2 underlying factors were found at both time points. The first factor included all 7 items from the confidence in performance and risk appraisal domains, whereas the second included all 5 items from the emotions domain. From a user perspective, this means that a total score for the scale can be calculated, as can separate scores for each of these factors. It is interesting that 2 similar factors were identified during the Spanish translation of the ACL-RSI scale in which the mean age of the sample was 21 years.[26] This cohort was older than ours but younger than the participants in most of the earlier studies, in which the typical mean age was 28 to 30 years.[15,23–25]

The presence of subfactors does not change the overall scale validity, and scores on the full ACL-RSI scale at 6 months adequately predicted the return to sport at 12 months. Nonetheless and of potential benefit is that exploration of subscale scores may enable a more thorough understanding of which specific aspects of psychological readiness might be important or relevant in adolescent athletes. In this regard, it was clear that our sample's emotional response seemed to be the most influential determinant of psychological readiness to return to sport. At 6 months, our cohort showed relatively high levels of frustration followed by fear, and scores on the emotions subscale had good predictive ability for the return to sport at 12 months. It is not surprising that adolescent athletes, particularly those who are eager to resume sport, might be frustrated at this point in their rehabilitation, because adolescents who strongly identify with the athletic role (ie, have a high degree of athletic identity) are known to display higher levels of emotional disturbance after injury.[27] This is thought to be due to a loss of identity when they are unable

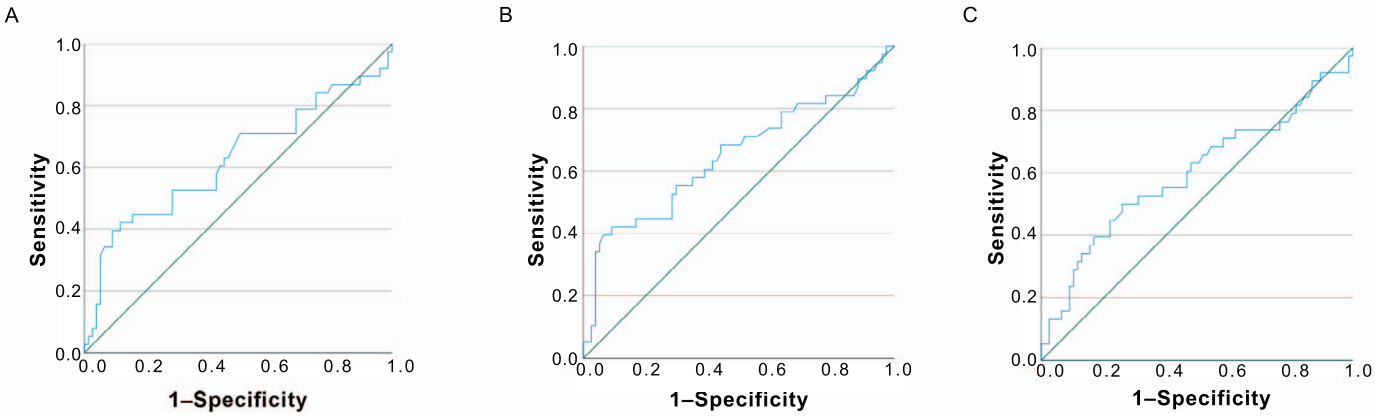

Figure. Receiver operating characteristic curve for full 12-item Anterior Cruciate Ligament Return to Sport after Injury scale (A), emotions subscale (B), and confidence and risk appraisal subscale (C).

to participate in sport and, for those who play team sports, the loss of involvement with their team.[28,29] Frustration may also be related to the athlete's coping style; evidence suggests this differs according to the athlete's age, with younger athletes less able to identify ways in which a stressor may be beneficial (positive reframing).[30] Although it is unclear whether a strong desire to return to sport, a loss of athletic identity, or coping style contributed to the feelings of frustration and emotional responses expressed by the adolescent athletes in this study, our results indicate that addressing such frustrations may be beneficial. This should be explored in future research.

Fear of reinjury has been one of the most common reasons cited by athletes who do not resume sport after ACL injury.[31] Consistent with prior work, the current cohort of adolescent athletes was moderately fearful at both time points. Fear of movement has also been studied in young athletes returning to sport after ACL reconstruction.[14] This pilot work showed that athletes (aged 10–25 years) with high levels of fear were 4 times more likely to report lower levels of activity and 6 to 7 times more likely to score worse on tests of functional performance.[14] They were also 13 times more likely to have a graft rupture within 2 years after returning to sport. However, some degree of imprecision exists regarding this estimate due to the relatively small sample size of 40 athletes. Nonetheless, it clearly highlights the potential negative effect such emotions may have on recovery and even the future risk of injury. Adolescent athletes' emotional responses recorded using the short version of the ACL-RSI were similarly shown to be lower at 12 months postsurgery in adolescent athletes who went on to sustain a further ACL injury, whereas confidence in performance and risk appraisal items were not different.[32] Confidence did not seem to be a significant concern in our cohort of younger athletes, who by 12 months were highly confident about their ability to perform well (mean scores >80/100).

Limited additional data exist with which to compare our findings. Fones et al[33] surveyed a group of young athletes (mean age = 16 years at surgery) at a mean of 4 years after surgery and reported that ACL-RSI scores were lower for patients who did not successfully return to their primary sport. Yet because the measures were only obtained at 1 time point, it is unclear whether the higher scores in the group that returned were simply because they were already participating in sport. Still, the strong association between ACL-RSI scores and sporting status is consistent with our current results.

Our study was not without limitations. Patients were from a single private metropolitan clinic and were a relatively homogeneous population. Responses were measured at only 2 time points 6 months apart, and further work is needed to investigate longer-term outcomes. Most of the patients were at the upper end of the adolescent age range (15–17 years), and thus, the current data may be less generalizable to the early adolescent years. In our prediction analysis, we did not differentiate between patients who had returned to the same level of sport as before injury and those who returned to a lower level. We felt that 12 months was too early for all patients to have an adequate opportunity to return to their prior level of participation, and as such, future researchers should explore the relationship between psychological readiness and the level of sport to which adolescent athletes return over a longer follow-up period. Male patients scored higher on the ACL-RSI than female patients, although the absolute change in scores over time was the same. The current study was insufficiently powered to further investigate sex differences, and this is also an area worthy of examination.

CONCLUSIONS

We confirmed that the ACL-RSI scale can be used without modification in adolescent athletes. The psychometric properties are sound, and the scores at 6 months were associated with subsequent return to sport. We also found that the adolescent athletes' emotional response appeared to be more influential than their confidence or appraisal of risk in predicting a return to sport.

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Address correspondence to Kate E. Webster, PhD, La Trobe University, School of Allied Health, Human Services and Sport, Bundoora, 3086, Australia. Address email to k.webster@latrobe.edu.au.