

Psychological Aspects of Anterior Cruciate Ligament Injuries

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Psychological aspects of ACL injuries

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1 **Abstract**

2 Impairment-based evaluation has, until recently, been the mainstay of orthopaedic
3 research in anterior cruciate ligament (ACL) reconstruction. However, participation-
4 based outcomes, in particular returning to sport, have lately garnered increased
5 research attention. This is important because returning to sport is typically a main
6 concern of injured athletes. Recent meta-analyses have demonstrated that the return to
7 sport rate after ACL reconstruction is disappointingly low, and that a range of
8 contextual factors including age, sex, sport participation level and psychological
9 factors may affect the return to sport rate. Moderate to large effect sizes have been
10 demonstrated for greater psychological readiness to return to sport, and lower fear of
11 re-injury favouring returning to the pre-injury level sport after ACL reconstruction.
12 Understanding the relationship between psychological factors and returning to sport is
13 essential in light of the fact that most athletes recover good physical function after
14 surgery, and many athletes with good knee function do not return to sport.
15 Psychological factors are potentially modifiable with appropriate intervention, yet
16 these factors are not systematically addressed in routine post-operative rehabilitation.
17 This review summarises the recent evidence for the relationship between
18 psychological factors and ACL injury, including recovery from injury and returning
19 to sport.

20 An anterior cruciate ligament (ACL) rupture is one of the most common sports-
21 related injuries to the knee.¹ In contemporary orthopaedics, athletes who wish to
22 return to sport are typically advised to have ACL reconstruction surgery plus post-
23 operative rehabilitation to facilitate a safe return to sport;^{2, 3} and are usually absent
24 from sports participation for between 6 and 12 months after surgery.⁴

25 A ruptured ACL was once considered career ending for athletes.⁵ With the
26 introduction of non-invasive surgical techniques and accelerated rehabilitation
27 protocols,⁶ knee function outcomes improved, and with this came increased
28 expectations of a successful return to the pre-injury level of sports participation.
29 Patients also have high expectations of ACL reconstruction in terms of recovery of
30 knee function,⁷ conceivably driven by continual advances in surgery and
31 rehabilitation, and media coverage.⁸ To meet these expectations of function and
32 participation requires considerable commitment to rehabilitation, and being mentally
33 prepared for an extensive and involved recovery period.⁹

34 Until recently, the focus of orthopaedic research in ACL reconstruction has been on
35 evaluating impairment-based outcomes after surgery. This is despite the fact that a
36 key concern for athletes is returning to participation in sport, and a lack of association
37 between knee impairments and function.^{10, 11} Many athletes with good knee function
38 do not return to their previous level of sports participation after ACL reconstruction,¹²
39 and the rate of return to the pre-injury level and competitive sport is disappointingly
40 low.¹³ This has led researchers to question whether there are other factors that may
41 impact on returning to sport after surgery.

42 After injury, athletes often report anger, depression, anxiety, a lack of confidence and
43 fear of sustaining a new injury.^{14, 15} There is also evidence that these psychological

44 disturbances may affect recovery¹⁶⁻¹⁸ and returning to sport,^{16, 19} as well as increase
45 the risk of sustaining a new injury.^{20, 21} Recovery from sports injury is influenced not
46 only by physical factors, but also by psychological factors.^{19, 22} This means that to
47 successfully transition back to sport after injury athletes need to be physically as well
48 as psychologically ready; yet these states often do not coincide.^{19, 22}

49 There has been increased research attention paid to evaluating the impact of
50 psychological factors on outcomes after athletic injury. Therefore, the aim of the
51 present review was to review and summarise the evidence for associations between
52 psychological factors and returning to sport following ACL reconstruction.

53 **Theoretical perspectives**

54 Dysfunctional psychological responses to injury are hypothesised to persist due to
55 combinations of and interactions between biological, environmental, and psychosocial
56 factors.²³ Similarly, returning to sport after injury is complex and multifactorial –
57 directly and indirectly influenced by a range of physical, contextual and psychological
58 factors (Figure 1).^{13, 19, 24-26} To account for the myriad factors and complex
59 relationships between these factors, biopsychosocial models have been proposed.^{18, 27}

60 In these models, psychological factors are hypothesised to have a central mediating
61 role on physical factors (impairments of body structure including muscle strength,
62 pain, stability, swelling and movement), social/contextual factors (e.g. recovery
63 expectations and quality of life), functional performance (including aspects of motor
64 control such as balance), and ultimately on returning to sport (Figure 1). A strength of
65 the biopsychosocial model is that it specifies pathways through which psychological
66 factors impact on treatment outcomes.²⁸ In addition, the characteristics of an injury,
67 such as the cause, severity, and type; and sociodemographic factors, such as age, sex,

68 ethnicity and socioeconomic status, are hypothesised to indirectly influence returning
69 to sport via their impact on physical, psychological and social/contextual factors
70 (Figure 1). The potential for psychological factors to influence returning to sport after
71 injury via a range of different pathways is illustrated in Figure 1, and underscores the
72 importance of understanding and addressing psychological factors as part of the
73 management of ACL injury.

74 *Figure 1 about here*

75 **Psychological response to athletic injury**

76 An athlete's response to psychological stress is hypothesised to play a major role in
77 injury occurrence;²⁹ and the perception of stress is likely to be influenced by a range of
78 athlete-related factors including personality, available coping resources, and history of
79 stressors (both physical and psychological).^{29, 30} The athlete's psychological stress
80 response may also continue long after the injury has occurred.³¹⁻³³ Subsequently, the
81 response to stress influences the athlete's cognitive appraisal of their injury.¹⁸ The
82 cognitive appraisal directly affects an athlete's emotional response and ultimately
83 their behaviour.¹⁸ Therefore, the chain of psychological sequelae to injury could
84 conceivably have an impact on rehabilitation and return to sport outcomes. For
85 example, effective coping strategies could translate to an improved prognosis for
86 recovery if the athlete is more adherent to rehabilitation, and as a result, able to return
87 to function faster and with fewer debilitating psychological responses.^{18, 27}

88 Heightened negative emotional responses, including shock, frustration, depression,
89 boredom, tension and anger, have been reported immediately after athletic injury³⁴⁻³⁶
90 and during recovery from injury.^{34, 35, 37, 38} Conversely, injury may also be associated
91 with positive emotions, with some injured athletes reporting feeling relieved after

92 sustaining an injury because they are no longer under pressure to perform.¹⁸ The
93 psychological response may also be linked to athletes' sense of athletic identity, with
94 athletes who were more involved in their sport conceivably having a stronger
95 emotional response to athletic injury as a result of their greater investment in sports
96 participation.^{14, 36, 39}

97 In a study of professional Australian Rules Football players, those who had severe
98 injuries that potentially threatened their future performance or career reported a
99 stronger negative psychological response compared to those who saw their injury as
100 more minor.³⁶ The nature and duration of the injury were key factors that impacted on
101 athletes' psychological responses to injury, along with a perception of isolation from
102 the team while undertaking rehabilitation, being sidelined from the team and the
103 game, and the extent of social support from medical staff, team mates and family.³⁶

104 In the early post-operative phase after ACL reconstruction, significant reductions in
105 kinesiophobia and pain catastrophising, and significant increases in self-efficacy for
106 rehabilitation have been demonstrated.⁴⁰ The increase in self-efficacy was found to be
107 associated with a reduction in knee pain intensity. Improved self-efficacy and reduced
108 kinesiophobia were also associated with improved knee function.⁴⁰ These findings
109 suggest that psychological factors may have an important influence on recovery early
110 after ACL reconstruction; although this is not to discount the likely impact of early
111 physical recovery on psychological responses. The findings also suggest that
112 psychological interventions, particularly aimed at addressing self-efficacy and
113 kinesiophobia early in the post-operative phase, may have the potential to contribute
114 to improved short-term rehabilitation outcomes after ACL reconstruction.

115 **How do psychological factors influence sport injury rehabilitation?**

116 Recovery of sufficient physical capacity to safely participate in sport after injury is
117 vital, and well addressed by physical rehabilitation.⁴¹ Systematic reviews have shown
118 that the majority of patients achieve good physical recovery after ACL
119 reconstruction,¹² based on standard outcomes that measure aspects of function
120 important for successful performance of sport.⁴² Key milestones in rehabilitation after
121 ACL reconstruction are restoration of knee joint motion and muscle function,
122 independent function in daily activities including employment, sport-specific training,
123 and re-establishment of an athletic identity.⁴³ Although the primary concern of most
124 athletes is returning to sport.

125 Psychological responses are prominent during rehabilitation, and make an important
126 contribution to the overall quality and progression of rehabilitation.^{28, 39} Emotions
127 change over time during the rehabilitation period,^{34, 37} and the emotional response has
128 been linked to an individual's sense of athletic identity.³⁹ While negative emotional
129 responses immediately after the injury have been reported,³⁴ the literature
130 demonstrates a consistent improvement in psychological responses as rehabilitation
131 progresses. However, for some athletes, the response may become more negative
132 around the time of clearance to return to sport and when they are making the
133 transition back to sport.^{14, 34}

134 Morrey et. al.³⁴ found that athletes' emotional responses to ACL injury and
135 reconstruction followed a U-shaped progression through rehabilitation, with peaks in
136 the negative responses immediately following injury and at the time of clearance to
137 return to sport (at 6 months post-operative). In contrast to Morrey's et. al.³⁴ findings
138 of a U-shaped emotional response, Langford et. al.³⁷ found athletes' emotional

139 responses and psychological readiness to return to sport improved linearly over time
140 during rehabilitation, and psychological readiness to return to sport at 6 months after
141 surgery predicted returning to the pre-injury level sport at 1 year. Self-efficacy has
142 also been found to significantly improve as people progress through post-operative
143 rehabilitation,⁴⁴ and there are correlations between self-efficacy and knee symptoms
144 and function (measured with the Knee Injury and Osteoarthritis Outcome Score) after
145 3, 6, and 12 months of rehabilitation.⁴⁴

146 **How do psychological factors influence returning to sport?**

147 Athletes undergoing ACL reconstruction and their treating clinicians typically expect
148 a successful return to sport to following surgery.^{7, 45, 46} However, while surgery
149 addresses the underlying impairments in knee function, this does not always translate
150 to a successful return to sport¹³ – one in every three athletes do not return to their pre-
151 injury level sport after surgery.¹³ Non-modifiable contextual factors have been found
152 to be associated with returning to the pre-injury level sport following ACL
153 reconstruction, including being young, male, and playing elite level sport prior to
154 injury.¹³ Psychological responses are potentially modifiable factors that have also
155 been shown to be associated with returning or not returning to the pre-injury level
156 sport after surgery. Psychological factors may conceivably be modifiable with
157 specific interventions, and it could be hypothesised that addressing these factors could
158 have an impact on returning to sport.^{13, 24}

159 The extent to which an individual feels their engagement in a particular behaviour is
160 freely chosen, that they have the necessary competence to successfully complete the
161 behaviour, and perceive a meaningful connection to others as a result of engaging in a
162 behaviour is theorised to directly impact on the likelihood of an individual engaging

163 in a behaviour.⁴⁷ These autonomy, competence and relatedness constructs, when
164 fulfilled, increase self-motivation to engage in a particular behaviour.⁴⁷ When applied
165 to the return to sport context, there is evidence that athletes who feel they have greater
166 personal control over their return to sport (autonomy), have greater confidence in their
167 body (competence), and feel more socially connected to teammates (relatedness) are
168 more likely to return to their previous level of sport.¹⁹ In addition, motivation,
169 confidence, self-efficacy, optimism and lower fear of a new injury are psychological
170 factors that have been associated with the likelihood of returning to the pre-injury
171 level following athletic injury³ and ACL reconstruction.^{25, 26, 39}

172 Anxiety about the risk of sustaining a new injury has been identified as a prominent
173 emotional response of athletes around the time that they are transitioning from
174 rehabilitation back to full participation in sport after serious injury.^{14, 48} Emotional
175 responses are particularly powerful for athletes who sustain a serious injury,¹⁴ and are
176 a strong influence on an athlete's decision to return to sport or not.⁴⁹⁻⁵¹ While some
177 athletes use fear as a motivation during the return to sport transition, with the fear
178 dissipating when the injured body part is tested and holds up in competition; for
179 others, the fear of a new injury can hinder their return to sport.^{23, 52} While poor or
180 inadequate rehabilitation after ACL reconstruction may negatively impact returning to
181 sport as athletes may lack the physical capabilities to safely and effectively participate
182 at their optimum level, the most common reason that athletes give for not returning to
183 their previous level of sport after surgery is fear of sustaining a new injury.¹² Adding
184 further weight to the notion of fear of re-injury being a key psychological factor
185 impacting on returning to sport after ACL reconstruction, a recently published meta-
186 analysis demonstrated a moderately large effect (standardised mean difference 0.7)

187 for low fear of re-injury (measured with the Tampa Scale for Kinesiophobia⁵³)
188 favouring returning to the pre-injury level sport following surgery.²⁴

189 Meta-analysis has demonstrated large effects (standardised mean difference 0.9) for
190 psychological readiness to return to sport (measured with the ACL-Return to Sport
191 after Injury scale⁵⁴) favouring returning to the pre-injury level sport after surgery.²⁴ In
192 a recent qualitative investigation by Podlog et. al.,⁵⁵ psychological readiness to return
193 to sport was suggested by athletes to be multi-dimensional and comprise three key
194 dimensions that increased their perceived likelihood of successful return: confidence
195 in returning to sport, realistic expectations of sporting capabilities, and motivation to
196 regain the pre-injury performance standards.⁵⁵ Athletes reported that their confidence
197 to return to sport was strongly influenced by their belief in the rehabilitation they
198 completed, their perception that the injured body part was completely healed and no
199 longer susceptible to re-injury, and that performance at the same pre-injury level was
200 possible.⁵⁵

201 Given the prospective associations between psychological factors and returning to
202 sport, it may be reasonable to hypothesise that addressing psychological factors
203 during rehabilitation could be a way to help injured athletes maximise their chances of
204 returning to the pre-injury level sport. However, current rehabilitation after ACL
205 reconstruction focuses on physical recovery and helping athletes recover the physical
206 capacity to participate in sport. Despite this, many do not return to sport. Therefore, a
207 re-evaluation of current rehabilitation programs may be needed to incorporate
208 interventions that address confidence and psychological readiness to return to sport
209 after surgery.

210 Competitive athletes reported that recovery of physical capacity to manage a return to
211 sport was a key part of building confidence to return,⁵⁵ suggesting an inter-
212 relationship between physical and psychological readiness to return to sport. This
213 supports the notion that to optimise the likelihood of returning to sport, rehabilitation
214 should systematically address both physical and psychological factors.^{24, 56}

215 Interventions to address psychological factors could conceivably influence an
216 athlete's confidence. For example, goal setting, education, modelling and rapport
217 building strategies could help to improve self-efficacy of rehabilitation and
218 confidence in the injured knee.^{19, 38, 55, 57} Imagery and relaxation training may help to
219 allay fears of re-injury and improve self-confidence in performance.^{19, 38, 55} On the
220 other hand, it could also be argued that facilitating athletes' return to high demand
221 activities, such as pivoting sports, by addressing psychological barriers may increase
222 the risk of new ACL injury. To some extent, a degree of anxiety may be protective if
223 it means that athletes do not recklessly resume sports participation without undue
224 consideration for the health and function of their knee.

225 During the transition back to sport, athletes typically lack the support of a
226 rehabilitation professional, having already completed and been discharged from
227 rehabilitation months before.⁴ Therefore, this period might be considered critical for
228 the likelihood of successfully transitioning back to the previous level of sport. While
229 top athletes may have the resources to access psychological support during recovery
230 and rehabilitation, this type of support is not easily accessible for amateur athletes.
231 Hence, there is a need to develop easily accessible programs to address potentially
232 modifiable psychological factors that could conceivably impact on returning to sport.

233 **Outcome measures**

234 Evaluating aspects of cognitions, emotions and behaviour during sports injury
235 rehabilitation has been the focus of previous sports injury psychological research, and
236 a wide range of outcomes have been used to evaluate aspects including coping,⁵⁸
237 emotions,³⁴ mood,⁵⁹ locus of control,⁶⁰ and adherence to rehabilitation.⁶¹ There has
238 been less focus on the return to sport phase, although increasing research interest has
239 seen the recent development of scales that specifically focus on measuring
240 psychological factors during the return to sport. The Injury Psychological Readiness
241 to Return to Sport scale,⁶² Return to Sport after Serious Injury Questionnaire,⁶³ and
242 Re-Injury Anxiety Inventory⁶⁴ all focus on evaluating an athlete's confidence and
243 concerns with regard to their return to competition after athletic injury.

244 Two scales, which specifically focus on psychological factors and returning to sport
245 after ACL injury and reconstruction, have evidence of good validity. The ACL-Return
246 to Sport after Injury (ACL-RSI) scale⁵⁴ was developed to evaluate psychological
247 readiness to return to sport after surgery. This 12-item scale addresses emotions, risk
248 appraisal and confidence in relation to returning to sport,⁵⁴ and has been translated
249 from English to Swedish,⁶⁵ French,⁶⁶ and German⁶⁷ languages. The Knee Self-
250 Efficacy scale⁶⁸ (K-SES) was developed to prospectively evaluate an individual's
251 perception of their ability to participate in physical activity as before their ACL
252 injury. This 22-item scale assesses activities of daily living, sport and recreational
253 activities, physical activities, and perceptions of knee function in the future.⁶⁸

254 Among a range of sport-specific psychological measures, the ACL-RSI score,
255 measured before surgery and at 4 months after surgery, was found to be the best
256 predictor of returning to the pre-injury level sport at 1 year after ACL

257 reconstruction.⁵⁶ A recent study of Swedish recreational and competitive athletes
258 found that psychological readiness to return to sport, measured with the ACL-RSI,
259 was the psychological factor most strongly related to returning to the pre-injury
260 physical activity.⁴⁹ Two studies have also reported ACL-RSI cut-off scores that
261 discriminated between athletes who subsequently did and did not return to their pre-
262 injury level sport after surgery.^{56, 67} One study found a score of 51 points at 6 months
263 after ACL reconstruction (sensitivity 74%, specificity 88%) discriminated returners
264 and non-returners to sport at 7 months;⁶⁷ while in the other study, a score of 56 points
265 at 4 months after surgery (sensitivity 58%, specificity 83%) was discriminative of
266 returning to sport at 1 year.⁵⁶ Therefore, it may be possible that ACL-RSI scores
267 could be used to identify athletes who may be at risk of not returning to their pre-
268 injury level sport after ACL reconstruction.

269 Pre-operative K-SES scores were found to predict returning to the pre-injury intensity
270 and frequency of physical activity at 1 year following ACL reconstruction.⁶⁹ Further,
271 K-SES scores also predicted muscle function and symptoms at 1 year after surgery.⁶⁹
272 Our research group has also found that self-efficacy (measured with the K-SES) was
273 the psychological factor with the strongest association to satisfaction at 2 to 5 years
274 after ACL reconstruction (unpublished data). Self-efficacy has been shown to
275 improve with time during rehabilitation; men, those who were physically active at a
276 higher level before ACL injury, and those aged under 30 years reported higher pre-
277 operative self-efficacy compared to women, people who were active at a lower
278 intensity and people aged 30 years and over.⁴⁴

279 **Conclusions**

280 Recovery from ACL injury and reconstruction is influenced by a multitude of
281 physical and non-physical factors. This review has demonstrated that psychological
282 factors influence the likelihood of injury, and the prognosis for recovery and returning
283 to sport following surgery. Therefore, the impact of psychological factors should not
284 be underestimated. The results of recent meta-analyses demonstrate moderate to large
285 effects for positive psychological factors favouring returning to the pre-injury level
286 following surgery. Therefore, there is a rationale for the re-evaluation of post-
287 operative rehabilitation programs to include interventions that systematically address
288 psychological factors, with the hypothesis that addressing these factors may improve
289 the return to sport after surgery.

290 **Figure legend**

291 Figure 1. Adapted biopsychosocial model of return to sport after injury

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