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# **The impact of psychological readiness to return to sport and recreational activities after anterior cruciate ligament reconstruction**

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## **ABSTRACT**

**Background:** This cross-sectional study aimed to examine whether psychological, appraisal of knee function, and demographic factors were related to returning to the pre-injury sport and recreational activity following ACL reconstruction.

**Method:** 164 participants were followed up between one and seven years after primary ACL reconstruction. Participants completed a questionnaire battery evaluating knee self-efficacy, health locus of control, psychological readiness to return to sport and recreational activity, fear of re-injury; and self-reported knee function in sport-specific tasks, knee-related quality of life, and satisfaction with knee function. The primary outcome was return to the pre-injury sport or recreational activity.

**Results:** At follow up, 40% (66/164) had returned to their pre-injury activity. Those who returned had more positive psychological responses, reported better knee function in sport and recreational activities, perceived a higher knee-related quality of life, and were more satisfied with their current knee function. The main reasons for not returning were not trusting the knee (28%), fear of a new injury (24%) and poor knee function (22%). The factor most strongly associated with returning to the pre-injury activity was psychological readiness to return to sport and recreational activity, measured with the ACL-Return to Sport after Injury scale (ACL-RSI). Age, sex, and pre-injury activity level were not related to returning to the pre-injury activity.

**Conclusions:** Less than one in two participants returned to their pre-injury sport or recreational activity after ACL reconstruction. Psychological readiness to return to sport, was the factor most strongly associated with returning to the pre-injury activity. Including interventions aimed at improving psychological readiness to return to sport in post-operative rehabilitation programs could be warranted to improve the rate of return to sport and recreational activities.

## INTRODUCTION

An important objective of anterior cruciate ligament (ACL) reconstruction is to enable patients to return to their pre-injury sport or recreational activity. Despite this, the focus of the orthopaedic literature has been on evaluating impairment-based outcomes, such as knee stability, after reconstruction as a measure of the success of the surgery, while non-physical factors, including psychological factors, have been under-researched.[1, 2] From an impairment perspective, patients recover physical function well after surgery.[3] However, between one- and two-thirds of patients may not return to participation in their pre-injury activity, despite being physically recovered when evaluated with standard objective instruments.[3-6]

Objective physical recovery and returning to the pre-injury sport and recreational activity may not necessarily coincide after ACL reconstruction,[4, 7] which raises the question of what other factors could impact on returning. Recent research has suggested that psychological factors may be important influences on returning to sport and recreation after athletic injury,[8, 9] but cautioned that because there are few studies examining the relationship between psychological factors and returning to sport and recreation, more research is needed to facilitate more definitive conclusions.[9] The only meta-analysis of the relationship between psychological factors and returning to the pre-injury sport following ACL reconstruction found large effects (standardised mean difference  $\geq 0.9$ ) for positive psychological responses favouring returning to sport, based on four studies.[9]

Psychological readiness to return to sport, recovery expectations, sport locus of control, and self-efficacy regarding knee function are psychological factors that have been shown to predict returning to the pre-injury sport at 12 months after ACL reconstruction;[5, 10] and self-efficacy of knee function, measured before surgery, has been shown to predict returning to physical activity at 1 year after ACL reconstruction.[10] Fear of sustaining another injury has also been associated with not returning to the pre-injury physical activity at up to seven years after

reconstruction,[4, 11, 12] and is a common reason cited by athletes for not returning to sport and recreational activities.[3, 4, 13, 14]

People who do not have ACL reconstruction after their ACL injury have reported a positive relationship between their physical knee function and confidence in their knee; and that this had a positive impact on their participation in sport and recreational activities.[14] However, to our knowledge, this relationship has not been investigated in people who have had an ACL reconstruction. Previous studies have found no relationship between objective measures of physical impairment and patient-reported knee function following ACL reconstruction.[15-17] In light of this, and the potential for an individual's report of knee function to impact on their return to sport and recreational activity after ACL injury, it may suggest that it is important to consider the impact of appraisals of knee function on returning to pre-injury activity after reconstruction.

Participation in sport and recreational activity is complex and multifactorial; and there may be individual differences in the factors that impact on returning to participation in the pre-injury activity following ACL reconstruction. Therefore, taking account of a range of psychological and contextual factors may improve our understanding of what influences returning to the pre-injury activity, and help direct rehabilitation interventions aimed at improving the return to pre-injury sport and recreational activity rate. Therefore, the aim of the current study was to examine whether psychological, appraisal of knee function, and demographic factors were related to returning to the pre-injury sport and recreational activity after ACL reconstruction.

## **METHOD**

### **Design**

This was a cross-sectional study, approved by the Regional Ethics Committee (Linköping University approval number: 2012/425-32). Written, informed consent to participate was obtained from all participants.

## Participants

Participants were identified from two orthopaedic units (one tertiary teaching hospital and two local hospitals) in southeastern Sweden. The medical records of all patients with a knee injury diagnosis code of *chronic instability of the knee, dislocation of the knee, sprain or strain involving cruciate ligament of knee, and injury to multiple structures of the knee* recorded (International Classification of Diseases 10 codes M23.5, S83.1, S83.5, S83.7), and who were seen at the orthopaedic units between January 2004 and December 2008 were screened. Patients with non-operative treatment, bilateral injuries, revision surgery, other associated ligament pathology that required surgical treatment at the time of ACL reconstruction, or who had Outerbridge[18] grade III or IV chondral injury were excluded (Figure 1) to identify patients with a primary, uncomplicated ACL reconstruction. A total of 346 of 1447 patients met the inclusion criteria of age between 18 and 45 years at the time their medical record was reviewed, and one to seven years post-isolated primary unilateral ACL reconstruction performed at either of the two orthopaedic units. Five patients declined to participate, and 21 patients were unable to be contacted. Twelve patients had sustained a new knee injury between surgery and follow up (Figure 1).

There were 182 patients (59% of 308) who responded, 164 were included in the final analysis for the current study. Data from 18 participants were excluded because the participants either did not participate in sport or recreational activity prior to their knee injury ( $n = 9$ ), or because they were active in recreational activities with a pre-injury Tegner Activity Scale[19] score of less than 4 ( $n = 9$ ) (Figure 1). An updated Tegner Activity Scale,[20] with sports that were not included in the original scale was used to grade pre-injury activity level in the current study. The scale rates activity level according to functional demands on the knee, on an 11-level scale (scored from 0 to 10). Level 10 indicates the highest functional demand such as national or international level competitive football; level 7 indicates sports such as competitive tennis and recreational football; level 4 indicates sports such as recreational cycling or cross country skiing, and moderately heavy labour work; levels 3 to 1 indicate

walking for recreation and light labour to sedentary work; and level 0 indicates no participation in physical activity due to knee problems.[20]

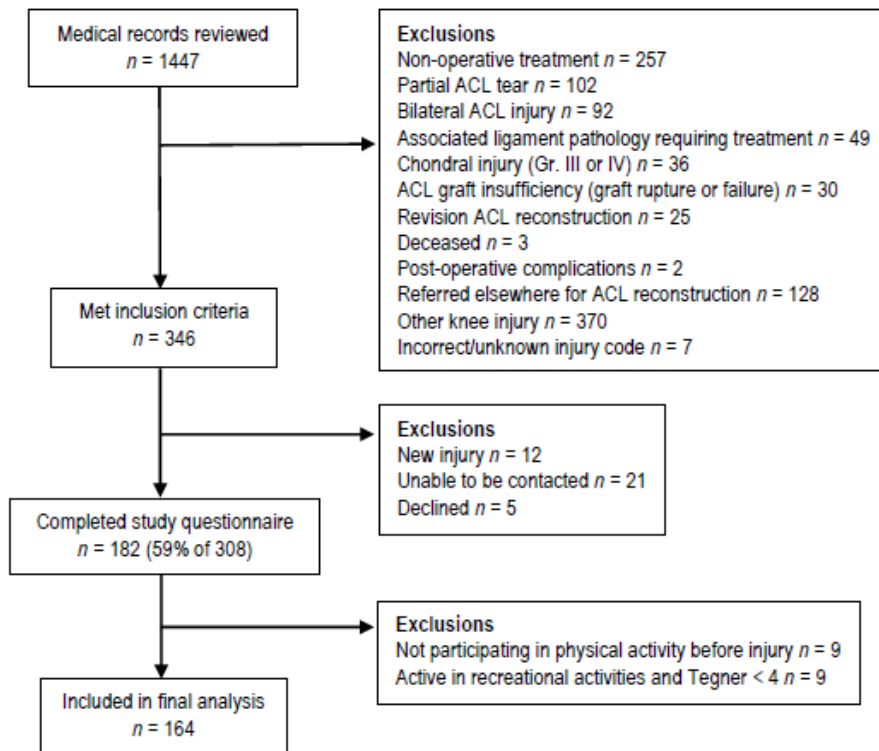


Figure 1. Participant identification.

## Procedures

A battery of patient-reported outcomes that took 30-40 minutes to complete was sent by post to all eligible participants. Up to three written reminders were sent over a six-week period (two weeks apart). Participants who had not completed the battery of patient-reported outcomes within two weeks were sent a reminder letter (and a new battery of outcomes). If they still had not responded within two weeks after the first reminder was sent, a second reminder letter was sent. A third and final reminder letter was sent to participants who had not returned the patient-reported outcomes within six weeks from the date the original questionnaire pack was sent. Participants completed the battery of outcomes, on average, at 35 months (range 12 to 81 months) after their ACL reconstruction surgery.

## **Outcome measures**

The primary outcome was return to the pre-injury sport or recreational activity.

Participants reported the main activity they participated in before their ACL injury, and answered the question “have you returned to your previous activity?”

Participants who reported that they had not returned to their pre-injury activity were asked to rank the following reasons for not returning from most important to least important: “poor knee function”, “do not trust the knee”, “fear getting a new injury”, “team or training has changed”, “family commitments”, “work commitments”, and “other reasons”.

A battery of validated patient-reported outcomes was used to evaluate factors that may influence participation in the pre-injury activity. The Swedish versions of all outcomes were used. Factors were chosen based on the researchers’ previous experience in the area of returning to sport and recreational activity after ACL reconstruction, and the findings of recently published literature. A systematic review of psychological factors associated with returning to sport following athletic injury [8] was used to guide the selection of psychological factors, based on the theoretical constructs of competence, autonomy and relatedness. Psychological factors and appraisal of knee function factors with evidence of construct or known-groups validity in ACL reconstruction populations were chosen (Supplementary Appendix). For analysis, the factors evaluated were grouped as psychological factors, appraisal of knee function factors, and demographic factors. Detailed description of patient-reported outcomes, including their psychometric properties, is provided in the Supplementary Appendix.

## **Explanatory variables**

### *Psychological factors*

The Knee Self-Efficacy Scale (K-SES) [21] was used to evaluate participants’ self-efficacy of current and future knee function.

The Multi-dimensional Health Locus of Control C-form (MHLC-C) [22] was used to evaluate the extent to which participants perceived their health was determined by



their own behaviour, or by external events or people. The MHLC comprises four domains – *Internal, Chance, Doctors, and Others*, reported as separate scores.

The ACL-Return to Sport after Injury scale (ACL-RSI) [23, 24] was used to evaluate psychological readiness to return to sport and recreational activity.

The Tampa Scale for Kinesiophobia (TSK),[25] adapted by Kvist et. al.[11] for use with patients with ACL injury, was used to evaluate fear of re-injury.

#### *Appraisal of knee function*

The *Sport* (five items) domain of the Knee Injury and Osteoarthritis Outcome Score (KOOS) [26] was used to evaluate participants' perceptions of knee function during sport and recreational activities. The *Quality of Life* (four items) domain of the KOOS was used to evaluate knee-related quality of life.

The Anterior Cruciate Ligament – Quality of Life scale (ACL-QoL)[27] was used to evaluate knee-related quality of life specifically related to ACL injury.

Participants also rated their overall satisfaction with their current level of knee function on a 10-point, numerical scale written specifically for the current study.

#### *Demographic factors*

Age at follow up, sex, and the pre-injury activity level, self-reported by participants as elite, sub-elite competitive or recreational level activity were analysed.

### **Statistical analysis**

All analyses were completed using SPSS 20.0 (IBM Corp, Armonk NY); and a listwise deletion approach was used to deal with missing data. The psychological factors evaluated were knee self-efficacy, health locus of control, psychological readiness to return to sport and recreational activity, and fear of re-injury. The appraisal of knee function factors were knee function during sport and recreational activities, knee-related quality of life, and satisfaction with knee function.

#### *Between-groups analyses*

A *P* value of  $\leq 0.05$  was used to indicate statistical significance. Descriptive statistics were calculated for all explanatory variables; and compared between participants

who had and had not returned to their pre-injury sport or recreational activity to give an overall impression of differences in individual patient-reported outcomes between those who had and had not returned to activity. Age was dichotomised based on the median age of the cohort. Between-groups comparisons were made using Chi-square tests, and independent samples *t*-tests or Mann-Whitney *U* tests as appropriate. Alpha corrections for multiple comparisons were made using Benjamini and Hochberg's [28] false-discovery rate method, which has been advocated for use in health research in place of Bonferroni adjustments.[29] Unadjusted and adjusted *P* values were calculated and presented to provide an indication of the likelihood of type I and type II error rates; given that it has been previously argued that minimisation of the likelihood of type II error is preferable in exploratory research.[30, 31]

#### *Multivariable analyses*

Binary logistic regression was used to determine the factors associated with returning to the pre-injury sport or recreational activity. Return to the pre-injury activity (yes or no) was the outcome variable.

A two-stage process was used to determine the psychological and appraisal of knee function explanatory variables to be included in the final model. First, simple regression analyses, where individual explanatory variables were regressed on the outcome variable were used to identify the psychological and appraisal of knee function factors to be included in the second stage. A significance level of  $\leq 0.10$  [32] was used to decide whether individual variables were retained. At this stage, all subscales of the Multi-dimensional Health Locus of Control scale (*Internal, Chance, Doctors* and *Others*) were excluded from further analysis. The explanatory variables that were retained were checked for multicollinearity using the linear regression method.[33] A Variance Inflation Factor (VIF) of  $> 5$  was used to denote significant multicollinearity. The ACL-QoL scale was excluded from further analyses due to significant multicollinearity. Then, the remaining explanatory variables were entered into a backward stepwise model. A significance level of  $\leq 0.05$  was used to identify variables that would be retained for the final model. Outliers were excluded based

on a standardised residual of > 3. Using this criterion, one outlier was excluded from the final model.

For the final model, the explanatory variable(s) that were retained were entered with the demographic age, sex, and pre-injury activity level. Time between surgery and follow up (months) was also included as an independent adjusting variable in the final model; interactions between explanatory variables were also examined.

## RESULTS

Ninety-nine men (median age 28 years) and 65 women (median age 24 years) with a median age of 26 years (range 18 to 45 years) at the time of follow up were included. The majority of participants were active at a sub-elite competitive level (64%) prior to their ACL injury; 24 participants (15%) were active at an elite competitive level and the remaining 35 (21%) were active at a recreational level. At the time of ACL injury, participants were most commonly participating in football ( $n = 83$ , 51%), floorball ( $n = 20$ , 12%) or handball ( $n = 8$ , 5%). At follow up, sixty-six participants (40%) had returned to their pre- injury sport or recreational activity, and the rate of return to activity was not associated with age, sex, or pre-injury activity level (Table 1).

Table 1. Demographic data for participants who had and had not returned to pre-injury sport or recreational activity

Variable	Returned to pre-injury activity		P
	Yes ( $n = 66$ )	No ( $n = 98$ )	
Time from surgery to follow up, months, mean (SD) (range 12 to 81 months)	34.3 (15.1)	35.8 (15.3)	0.54
Age group (years)			0.57
	18-26	36 (42%)	49 (58%)
	27-45	30 (38%)	49 (62%)
Sex			0.96
	Male	40 (40%)	59 (60%)
	Female	26 (40%)	39 (60%)
Pre-injury activity level <sup>a</sup>			0.89
	Elite	10 (42%)	14 (58%)
	Competitive	43 (42%)	60 (58%)
	Recreational	13 (37%)	22 (63%)

Note. <sup>a</sup>Data missing from 2 participants in the “No” group; *p* value for comparison between those who had and had not returned to pre-injury sport or recreation activity

Among the top-three most frequently participated in sports (football, floorball and handball) approximately one in three people had returned to their pre-injury activity participation (Table 2).

Table 2. Frequency of returning to pre-injury sport or recreation activities by sport

Sport	Number of participants in pre-injury activity, % of total sample	Returned to pre-injury activity	
		Yes <i>n</i> = 65 <sup>†</sup>	No <i>n</i> = 96 <sup>‡</sup>
Football	83 (52%)	29 (35%)	54 (65%)
Floorball	20 (12%)	6 (30%)	14 (70%)
Handball	8 (5%)	3 (38%)	5 (62%)
Martial arts <sup>#</sup>	6 (4%)	4	2
Motocross <sup>¥</sup>	6 (4%)	4	2
Running	6 (4%)	2	4
Basketball	5 (3%)	0	5
Horse-riding	5 (3%)	4	1
Gymnasium exercises <sup>¶</sup>	4 (2%)	3	1
Hockey <sup>§</sup>	3 (2%)	2	1
Athletics	2 (1%)	2	0
Orienteering	2 (1%)	2	0
Skateboard	2 (1%)	0	2
Snow sports	2 (1%)	1	1
Squash	2 (1%)	1	1
Bandy	1 (< 1%)	0	1
Cycling	1 (< 1%)	0	1
Team gymnastics	1 (< 1%)	1	0
Tennis	1 (< 1%)	1	0
Volleyball	1 (< 1%)	0	1

Note. <sup>†</sup>One participant did not report their pre-injury physical activity; <sup>‡</sup>Two participants did not report their pre-injury physical activity; <sup>#</sup> includes karate, jujitsu, judo; <sup>¥</sup> includes short- and endurance distance competition; <sup>¶</sup>Includes aerobics and weight training; <sup>§</sup>Includes 1 ice hockey referee. The percentage of participants who had returned and not returned for each activity is presented in parentheses.

The three most common reasons for not returning were a lack of trust in the knee (*n* = 25 of 88, 28%), fear of sustaining a new injury (*n* = 21 of 88, 24%), and poor knee function (*n* = 19 of 88, 22 %) (Table 3).

Table 3. Reasons for not returning to the pre-injury sport or recreational activity after ACL reconstruction (proportion of responses ranked by participants as most important)

Do not trust the knee	<i>n</i> = 25	28%
Fear getting a new injury	<i>n</i> = 21	24%
Poor knee function	<i>n</i> = 19	22%
Family or work commitments	<i>n</i> = 9	10%
Other reasons	<i>n</i> = 9	10%
Change in team or coach	<i>n</i> = 5	6%
<hr/>		
Total	<i>n</i> = 88 <sup>a, b</sup>	100%

*Note.* <sup>a</sup>Data were excluded from 6 participants who ranked more than 1 reason as the most important for not returning; <sup>b</sup>Missing data from 4 participants

### Between-group comparisons

There were significant differences in psychological and appraisal of knee function factors between participants who had and had not returned to their previous sport or recreational activity (Table 4). Participants who had returned to their previous activity reported higher knee self-efficacy (K-SES); greater psychological readiness to return to sport and recreational activity (ACL-RSI); and lower fear of re-injury (TSK). They also reported better knee function in sport and recreational activities (KOOS Sport), higher knee-related quality of life (ACL-QoL, KOOS QoL), and greater satisfaction with knee function (Table 4).

Table 4. Comparisons of psychological and appraisal of knee function between participants who had and had not returned to their pre-injury sport or recreational activity activity

Variable	Overall, Mean (SD)	Returned to pre-injury activity (n = 66)	Not returned to pre-injury activity (n = 98)	Mean difference, (95% CI)	P	FDR-adjusted significance, q
K-SES (0-10) (n = 157)	6.9 (2.1)	7.7 (1.8)	6.4 (2.1)	1.3 (0.7 to 2.0)	< 0.001	< 0.001
MHLC_internal (6-36) (n = 156)	25.8 (5.5)	25.7 (5.3)	25.9 (5.7)	-0.2 (-2.0 to 1.5)	0.68	0.69
MHLC_chance (6-36) (n = 155)	13.0 (5.2)	13.2 (5.3)	12.9 (5.2)	0.3 (-1.4 to 2.1)	0.69	0.69
MHLC_doctors (6-18) (n = 157)	11.7 (3.1)	11.2 (3.0)	12.0 (3.2)	-0.8 (-1.8 to 0.2)	0.16	0.22
MHLC_others (6-18) (n = 157)	6.9 (2.1)	6.8 (2.1)	7.1 (2.2)	-0.3 (-1.0 to 0.4)	0.34	0.42
ACL-RSI (1-10) (n = 163)	4.9 (2.1)	6.2 (2.0)	4.5 (2.1)	1.6 (1.0 to 2.3)	< 0.001	< 0.001
TSK (17-68) (n = 148)	35.6 (8.0)	32.1 (7.2)	37.8 (7.9)	-5.6 (-8.1 to -3.1)	< 0.001	< 0.001
KOOS_Sport (0-100) (n = 157)	70.6 (24.8)	77.5 (22.3)	65.8 (25.5)	11.7 (4.1 to 19.3)	< 0.01	< 0.001
KOOS_QoL (0-100) (n = 159)	62.0 (22.7)	70.0 (19.8)	56.6 (23.1)	13.4 (6.7 to 20.2)	< 0.001	< 0.001
ACL-QoL (1-10) (n = 155)	6.5 (2.0)	7.5 (1.8)	5.9 (1.9)	1.6 (1.0 to 2.2)	< 0.001	< 0.001
Satisfaction (1-10) (n = 164)	6.0 (2.7)	7.0 (2.4)	5.3 (2.6)	1.6 (0.8 to 2.4)	< 0.001	< 0.001

Note K-SES, Knee Self-Efficacy Scale; MHLC, Multidimensional Health Locus of Control scale; ACL-RSI, ACL-Return to Sport after Injury scale; TSK, Tampa Scale for Kinesiophobia; KOOS\_Sport, Knee Osteoarthritis Outcome Scale sport domain, KOOS\_QoL, Knee Osteoarthritis Outcome Scale quality of life domain; ACL-QoL, ACL-Quality of life scale; FDR, false discovery rate

### Factors associated with returning to the pre-injury sport and recreational activity

Psychological readiness to return to sport and recreational activity (ACL-RSI) was the only explanatory variable that met our statistical criteria for inclusion in the final model ( $B = 0.59$ , Wald = 27.7,  $P < 0.0001$ , odds ratio, 95% CI = 1.8, 1.4 to 2.2).

The final model ( $\chi^2_{(5)} = 48.3$ ,  $p < 0.001$ ; Nagelkerke  $R^2 = 0.36$ ) demonstrated that ACL-RSI score and time between injury and follow up made significant independent contributions to explaining approximately 36% of the variance in returning to the

pre-injury sport or recreational activity. For every one point increase in ACL-RSI scale score, there was approximately twice the odds of returning to the pre-injury activity. For every month increase in time to follow up, the odds of returning to sport or recreational activity reduced by 3% (Table 5). There were no significant interaction effects between ACL-RSI scale score and time to follow up, age, sex or pre-injury activity level; and no main effects of age, sex, or pre-injury activity level on returning to the pre-injury sport or recreational activity (Table 5).

Table 5. Regression model of the relationship between returning to the pre-injury sport or recreational activity, and psychological and demographic factors

Variable	B	S.E	Wald statistic	P	Odds ratio (95% CI)
ACL-RSI	0.67	0.12	31.2	< 0.001*	1.95 (1.5 to 2.5)
Time to follow up	-0.03	0.02	4.7	0.03*	0.97 (0.94 to 0.997)
Age	-0.39	0.43	0.82	0.37	0.68 (0.3 to 1.6)
Sex	0.28	0.41	0.46	0.50	1.32 (0.3 to 1.6)
Pre-injury activity level					
Elite			1.3	0.52	
Competitive	-0.61	0.57	1.15	0.28	0.54 (0.2 to 1.7)
Recreational	-0.70	0.69	1.03	0.31	0.51 (0.1 to 1.9)

Note ACL-RSI, ACL-Return to Sport after Injury scale

## DISCUSSION

Participants who had returned to their pre-injury sport or recreational activity had more positive responses to the psychological outcomes, a higher knee-related quality of life and self-reported knee function, were more satisfied with their current knee function, and reported better knee function in sport and recreational activities compared to those who had not returned. The factor most strongly associated with returning to the pre-injury activity was the ACL-RSI scale, which evaluates psychological readiness to return to sport and recreational activity after ACL reconstruction. There was reduced odds of returning with increasing time between surgery and follow up; and age, sex, and pre-injury activity level were not related to returning to the pre-injury sport or recreational activity.

In the current study, psychological readiness to return to sport and recreational activity (measured with the ACL-RSI) was the factor most strongly associated with



returning to the pre-injury activity. In line with that, two previous studies of competitive and recreational level athletes have shown that the ACL-RSI has been identified as the best predictor of returning to the pre-injury level sport at 12 months after ACL reconstruction.[5, 34] The scale is a condition-specific measure of psychological readiness (structured under the concepts of emotions, confidence and risk appraisal) and the current results provide further evidence of the construct validity of this scale. The specificity of this scale to the population, and the fact that the scale specifically addresses psychological factors related to performing sport and recreational activities may support its use as a key patient-reported outcome after ACL reconstruction.

The rate of return in the current study is similar to a previous study that evaluated the return to sport rate at two to seven years following ACL reconstruction in an Australian population.[4] In the Australian study, 45% of athletes had returned to their pre-injury sport at follow up. The authors also noted that some athletes returned to sport after reconstruction, then stopped participating. Promoting life-long participation in physical activity may be an important means of maintaining physical and mental health,[35] and reducing chronic disease.[36, 37] Therefore, identifying the key factors that impact on returning to sport and recreation activities may be important so that physical activity promotion efforts may be directed toward addressing the factors relevant to those who do not return to activity.[5, 34]

Previously reported minimum detectable change (MDC) scores for the KOOS *Sport* (range 5.8 to 12 points out of 100 points) and *Quality of Life* (range 7 to 7.2 points out of 100 points) domains,[38] and the ACL-RSI (0.3 points out of 10 points) [23] (MDC scores for other patient-reported outcomes have not been published) could suggest that the statistically significant differences in patient-reported outcomes, observed in the univariate analyses, between participants who had and had not returned to their pre-injury activity may have clinical significance.

However, while there was an association between returning to sport or recreational activity, and psychological factors including self-efficacy (measured with the K-SES) and appraisals of knee function (measured with the *Sport* domain of the KOOS) in

the between-group comparison, these factors were not significant in the regression analysis. This could be because, in contrast to the ACL-RSI, both the K-SES and KOOS *Sport* scales are not sport-specific. Given that an individual's confidence in performance of tasks (self-efficacy) is theorised to be situation- and task-specific,[39] and that performance in tasks such as squatting, kneeling, twisting, and turning may be important for occupational functioning as well as for sport and recreation; this may explain the lack of association of the K-SES and KOOS *Sport* with returning to sport and recreational activities in the regression analysis.

There are limited data regarding the reasons why people do not return to pre-injury activity following ACL reconstruction. Some previous studies have shown that knee function and a fear of re-injury are frequently cited as the reasons for not returning after ACL reconstruction.[4, 11, 13, 40] Around one in two participants in the current study who did not return to their previous activity cited a lack of confidence in the knee or fear of sustaining a new injury as the main reason for not returning. Around one in five reported that the main reason for not returning was poor knee function. It might be reasonable to expect that family or work commitments could contribute to people not returning to their previous activity. However, only approximately one in ten participants who did not return to their previous activity reported work or family commitments as the primary reason for their non-return. This could suggest that the most important factors influencing the decision to return may be related to the individual's appraisal of their capacity to participate and the risks associated with participating. From the clinician's perspective, these findings may suggest that addressing psychological factors including fear and confidence in post-operative rehabilitation could have merit in helping people return to their pre-injury sport or recreational activity. However, further research is required to test this hypothesis.

We found no influence of age on returning to sport or recreational activity. In contrast, recently, an association between younger age and an increased likelihood of returning to the previous activity has been demonstrated.[4, 13, 41] One possible explanation for this discrepancy could be that there are geographical differences in the treatment of acute ACL injuries. In Sweden, where the current study was conducted, patients with acute ACL injuries routinely complete a three- to six-month

period of rehabilitation before a decision is made regarding ACL reconstruction.[42] Reconstruction is typically recommended to young patients, and to older patients with symptomatic instability.[42] It could be speculated that older patients who elect for reconstruction following the completion of the initial rehabilitation program may have greater motivation to return to their previous sport or recreational activity; and this may help to explain why the rate of return to activity was similar across the age groups.

Most previous literature has evaluated physical impairments after ACL reconstruction. A strength of the current study is that by evaluating several psychological factors, appraisal of knee function and demographic factors, and using a multivariable analysis, it takes into account the multi-factorial nature of returning to the pre-injury sport and recreational activity after ACL reconstruction. This is important given that previous research has tended to evaluate single factors. In addition, the current study examined the reasons for not returning to the pre-injury activity.

A limitation of this study was that only 59% of potential participants responded to the battery of patient-reported outcomes. It is possible that, given the number of patient-reported outcomes included in the battery, some participants were deterred from completing it. Non-responders may have had a different rate of return to the pre-injury sport and recreational activity, responses to the psychological outcomes and appraisal of knee function, than those who responded to the battery of outcomes. However, this response rate is comparable to a previous report of return to sport rates at two to seven years after ACL reconstruction surgery,[4] and above the 50% minimum suggested to reduce bias.[43, 44]

The population in the current study is heterogeneous in terms of pre-injury sport and recreational activity participation. However, it is important to note that the sport and recreational activities participated in reflect the typical distribution of activities played at the time of ACL injury, reported in the Swedish National ACL register.[45] Activities that place higher demands on the operated knee, such as competitive football may be more challenging for people to return to in comparison

to activities such as recreational cycling that place lower demands on knee function.[46] Further research is required to explore differences in the rates of return to the pre-injury activity following ACL reconstruction in different sport and recreational activities with different physical demands.[46] The cross-sectional design of the current study means that it is not possible to determine whether positive psychological factors and better appraisal of knee function predict returning to the pre-injury sport and recreational activity. In addition, we chose to focus on one group of non-physical factors, psychological factors, as it was beyond the scope of this study to investigate all the factors that could impact on returning to sport and recreational activities (both physical and non-physical). Therefore, consideration of the impact of other factors not evaluated in the current study may be warranted in future prospective studies.

As time from surgery to follow up increased, the odds of returning to the pre-injury activity decreased, which may suggest that for some, other commitments took priority over participating in sport and recreational activity. It is also possible that some participants may have returned to sport or recreation early after surgery and ceased participation before follow up or changed to participate in a different activity. However, further research is necessary to confirm these hypotheses.

#### **What are the new findings?**

- Psychological readiness to return to sport (measured with the ACL-RSI scale) was the factor most strongly associated with returning to the preinjury sport or recreational activity after ACL reconstruction.
- Age, sex and pre-injury activity level were not associated with returning to the pre-injury sport or recreational activity.
- The most common reasons given by participants for not returning to the pre-injury activity were, not trusting the knee, fear of another injury and poor knee function.

### **How might it impact on clinical practice in the near future?**

- A stronger and more systematic emphasis on addressing psychological readiness to return to activity in post-operative rehabilitation programs could be warranted to help improve returning to activity after ACL reconstruction.
- Patients reporting a lack of confidence in the knee or fear of sustaining a new injury, which may be at increased risk of not returning to their pre-injury sport or recreational activity, and could require additional support during rehabilitation.
- Clinicians may wish to consider the use of the ACL-Return to Sport after Injury scale as a key patient-reported outcome after ACL reconstruction.

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### **Contributor statement**

All authors contributed to the design of the study. AÖ was responsible for participant recruitment and JK and AÖ for data collection. CA, JK and AÖ analysed the data. CA and AÖ drafted the manuscript, and JK, HG, ST and KW revised it for important intellectual content. All authors approved the final manuscript. CA is responsible for the overall content as the guarantor.

### **Competing interests**

There are no competing interests.

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