

Sports Participation 2 Years After Anterior Cruciate Ligament Reconstruction in Athletes Who Had Not Returned to Sport at 1 Year

A Prospective Follow-up of Physical Function and Psychological Factors in 122 Athletes

Clare L. Ardern,^{*†‡} PT, PhD, Nicholas F. Taylor,[†] PT, PhD, Julian A. Feller,^{†§} MD, FRACS, Timothy S. Whitehead,[§] MD, FRACS, and Kate E. Webster,[†] PhD
Investigation performed at La Trobe University, Melbourne, Australia

Background: A return to their preinjury level of sport is frequently expected within 1 year after anterior cruciate ligament (ACL) reconstruction, yet up to two-thirds of athletes may not have achieved this milestone. The subsequent sports participation outcomes of athletes who have not returned to their preinjury level sport by 1 year after surgery have not previously been investigated.

Purpose: To investigate return-to-sport rates at 2 years after surgery in athletes who had not returned to their preinjury level sport at 1 year after ACL reconstruction.

Study Design: Case series; Level of evidence, 4.

Methods: A consecutive cohort of competitive- and recreational-level athletes was recruited prospectively before undergoing ACL reconstruction at a private orthopaedic clinic. Participants were followed up at 1 and 2 years after surgery with a sports activity questionnaire that collected information regarding returning to sport, sports participation, and psychological responses. An independent physical therapist evaluated physical function at 1 year using hop tests and the International Knee Documentation Committee knee examination form and subjective knee evaluation.

Results: A group of 122 competitive- and recreational-level athletes who had not returned to their preinjury level sport at 1 year after ACL reconstruction participated. Ninety-one percent of the athletes returned to some form of sport after surgery. At 2 years after surgery, 66% were playing sport, with 41% playing their preinjury level of sport and 25% playing a lower level of sport. Having a previous ACL reconstruction to either knee, poorer hop-test symmetry and subjective knee function, and more negative psychological responses were associated with not playing the preinjury level sport at 2 years.

Conclusion: Most athletes who were not playing sport at 1 year had returned to some form of sport within 2 years after ACL reconstruction, which may suggest that athletes can take longer than the clinically expected time of 1 year to return to sport. However, only 2 of every 5 athletes were playing their preinjury level of sport at 2 years after surgery. When the results of the current study were combined with the results of athletes who had returned to sport at 1 year, the overall rate of return to the preinjury level sport at 2 years was 60%. Demographics, physical function, and psychological factors were related to playing the preinjury level sport at 2 years after surgery, supporting the notion that returning to sport after surgery is multifactorial.

Keywords: sport; orthopaedic; return to sport; psychology; anterior cruciate ligament; ACL

*Address correspondence to Clare L. Ardern, PT, PhD, Health Science 3 Building, La Trobe University, Bundoora, Vi, Australia 3086 (e-mail: c.ardern@latrobe.edu.au).

[†]School of Allied Health, La Trobe University, Melbourne, Australia.

[‡]Division of Physiotherapy, Linköping University, Linköping, Sweden.

[§]OrthoSport Victoria, Epworth Healthcare, Melbourne, Australia.

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Anterior cruciate ligament (ACL) injuries are common in young, active, and otherwise healthy athletes,²⁴ and because of this, returning to sport is often a key concern for athletes with an ACL injury.^{7,33} An ACL rupture often requires surgical treatment, and a return to the preinjury level sport is frequently assumed to take between 6 and 12 months.²⁸ Studies of professional athletes in pivoting sports including soccer, hockey, American football, and basketball show rates of return to the preinjury level sport ranging from 78% to 98% within 1 year after surgery.^{8-12,15,29,35} However, only

around 1 in 3 amateur athletes return to their preinjury level sport by this time.^{4,7,21} These findings have led to the suggestion that some athletes could require longer than the previously expected 12 months to return to their preinjury level sport.⁷ In support of this, it has been shown that around 2 in every 3 athletes returned to their preinjury sport at 2 to 7 years after surgery.⁶

To our knowledge, there are no studies investigating the sports participation outcomes of athletes who have not returned to their preinjury level sport 1 year after surgery. It is not clear how many of these athletes subsequently return to their preinjury level sport and whether they continue to play. Furthermore, the factors that could affect a return to sport in this group are unclear.

Investigations of return-to-sport rates after ACL reconstruction have identified specific demographic, physical, and psychological factors that may be associated with returning to sport after ACL reconstruction.⁴ Younger athletes and men have been found to be more likely to return to their preinjury level sport after surgery than older athletes and women.⁴ Athletes who have better physical function may also be more likely to return to their preinjury level sport than those with physical deficits.^{4,5,7,22} It is also possible that those with better physical function may return to sport earlier than those with physical deficits, who may need longer to recover sufficient physical capabilities. Psychological readiness to return to sport, fear of reinjury, sport locus of control, and recovery expectations are psychological factors that predict returning to the preinjury level sport in competitive and recreational athletes at 1 year after surgery.⁵ However, it is not known whether there are differences in demographics, physical, and psychological factors among athletes who have not returned to their preinjury level sport at 1 year that distinguish between later participation and nonparticipation in the preinjury level sport.

Understanding more about the sports participation outcomes of people who have not returned to their preinjury level sport by 1 year after ACL reconstruction may help clinicians identify athletes who might benefit from additional assistance to return to their preinjury level sport. Therefore, the primary aim of the current study was to investigate the sports participation outcomes of a group of athletes who had not returned to their preinjury level sport at 1 year after ACL reconstruction. The secondary aim was to explore whether demographic, physical functioning, and psychological factors were associated with their participation in sport at 2 years after surgery.

METHOD

Study Design

Data were collected prospectively from a group of patients who were consecutively recruited between April 2010 and April 2011 from a private orthopaedic clinic. Ethical approval was obtained for this study from the University Faculty Ethics Committee. All patients provided written informed consent to be contacted by the researchers and participate in this study. Completion of the online

questionnaire used for data collection in this study was accepted as implied consent to participate.

Participants

We previously reported return-to-sport outcomes for a prospective cohort of 187 competitive ($n = 133$) and recreational ($n = 54$) athletes at 1 year after ACL reconstruction.⁵ For inclusion in this study,⁵ patients must have undergone ACL reconstruction and been playing sport (at least at a recreational level) a minimum of twice per week before their knee injury. Participants included in the current study were those in the cohort of 187 who had not returned to their preinjury level sport at 1 year after surgery ($n = 122/187$, 65%). No professional or elite athletes participated. Of the athletes who participated in the current study, 84 (69% of 122) had attempted some form of sport at 1 year after surgery and 38 (31% of 122) had not played any sport. Of the athletes who had attempted sport, 65 (53% of 122) had returned to their preinjury sport at a lower level of play and 5 (4% of 122) had returned to a different sport. There were 14 athletes who had attempted sport but did not report the type of sport.

An arthroscopically assisted ACL reconstruction had been performed at a median of 3 months after injury. Weightbearing was permitted from the first postoperative day and braces or splints were not used. Patients were provided with written guidelines for their recovery and rehabilitation progression; attendance at supervised postoperative rehabilitation was not mandatory for inclusion. The operative procedure and rehabilitation guidelines employed in the current study have been described previously.^{5,7} Participants received clearance from the treating surgeon to return to their preinjury level sport from 9 months after surgery. The criteria for clearance to return to sport were a stable knee, symmetrical knee range of motion, absence of knee effusion, functional quadriceps control, and symptom-free completion of sport-specific exercises.

Procedures

Sports participation and psychological and demographic factors were collected using a study-specific online questionnaire (SurveyManager, Australian Research Group, Melbourne, Australia). Physical function was evaluated at 1 year after ACL reconstruction surgery by an independent research physical therapist experienced in orthopaedics. Sports participation was evaluated at 2 years after surgery using a study-specific questionnaire (see Appendix A, available in the online version of this article at <http://ajsm.sagepub.com/supplemental>) that comprised questions that we have used in previous studies of return to sport after ACL reconstruction.⁵⁻⁷ Psychological factors were measured at 1 year after surgery using a questionnaire battery of published psychological outcome measures with evidence of construct or known-groups validity in ACL reconstruction populations (psychometric properties described in Appendix B, available online) and 3 questions that examined athletes' appraisals regarding sports participation. Demographic data were collected preoperatively. The

questionnaires were sent by e-mail, and up to 3 reminders were sent to participants who did not respond. Participants who did not respond to the e-mail reminders or who did not have an e-mail address were sent a paper version of the questionnaires to complete and return by reply-paid post. The researchers attempted to follow up all participants who did not respond to the sports participation questionnaire (either by e-mail or post at 2 years after surgery) by telephone interview to determine their sports participation status.

Measures

Sports Participation. The main outcome was participation in the preinjury level sport at 2 years after surgery. Participants were asked to indicate the main sport and level they played before their ACL injury and instructed to use this sport and level as the reference to answer the question "Are you currently playing your main sport at the same level that you played before your knee injury?" Participants also indicated if they were participating in another sport or participating in their main sport at a lower level than before their ACL injury.

Demographic Factors and Injury History. The demographic factors analyzed were age at surgery, sex, preinjury sport participation level (recreational or competitive sport), and history of ACL injury to either knee.

Physical Function. The physical function factors measured were patient-reported knee symptoms and function using the International Knee Documentation Committee (IKDC) subjective knee evaluation form,¹⁶ clinical assessment (IKDC knee examination), and hop symmetry using the single and triple hop-for-distance tests,³⁰ from which an overall limb symmetry index was calculated.

Psychological Factors. The psychological factors measured were psychological readiness to return to sport using the ACL-Return to Sport after Injury scale (ACL-RSI),³⁸ fear of reinjury using the Tampa Scale for Kinesiophobia (TSK),^{19,20} sport locus of control using the Sport Rehabilitation Locus of Control scale (SRLC),²⁷ emotions using the Emotional Responses of Athletes to Injury Questionnaire (ERAIQ), and mood using the Incredibly Short Profile of Mood States (ISP) (unpublished data: Dean J, Whelan J, Meyers A. An incredibly quick way to assess mood states: the Incredibly Short POMS. Poster presented at the Association for the Advancement of Applied Sport Psychology Convention; San Antonio, TX. 1990).²⁶ Description of the types of questions including scoring instructions and measurement properties for each of the outcome measures have been described previously.⁵

At 1 year after surgery, we also examined athletes' appraisals regarding returning to sport using 3 questions: "How important is it for you to return to your previous sports level?" (scale anchors *not important at all* to *very important*); "Do you think it is possible for you to return to your previous sports level?" (scale anchors *don't believe it is possible* to *strongly believe it is possible*); and "How much time and effort are you willing to invest to return to your previous sports level?" (scale anchors *as little as possible* to *as much as possible*). Participants answered

each question on a 1 to 10 point scale, with a higher score indicating a more positive response.

Data Analysis

Data were analyzed using SPSS version 22 (IBM Corp). Descriptive statistics were calculated for all variables and presented as proportions, medians, and interquartile ranges as appropriate because the data were not normally distributed. To address the primary aim of this study, the proportions of athletes playing any sport and the preinjury sport at the 2-year follow-up were calculated. The return to any sport and return to preinjury sport rates were also calculated. Preinjury level sport participation rates at 2 years were calculated across all sports as well as separately for individual sports (Australian football, soccer, netball, and basketball), competitive- and recreational-level athletes, and pivoting/nonpivoting and contact/noncontact sport.

To address the secondary aim of this study, univariate analyses were completed. Demographic, physical functioning, and psychological factors data were compared between those who were and were not playing sport at 2 years with odds ratios for dichotomous data and Mann-Whitney *U* tests for continuous data. A *P* value of $\leq .05$ was considered significant. Data from participants who sustained a second ACL injury to either knee were excluded from the univariate analyses as there were significant differences in the relationships between sports participation at 2 years and demographic, physical function, and psychological factors compared with those who did not sustain a subsequent ACL injury. Therefore, the univariate analyses were based on a total sample of 115 participants. Multivariable logistic regression was precluded due to sample size and missing data.

RESULTS

There were 122 athletes (76 men, 62%) included, with a mean age at surgery of 28.3 years (SD, 8.4 years; range, 15.1-60.1 years). Seven index surgeries were revision ACL reconstructions (6% of 122), and 66 athletes (54% of 122) had meniscal treatment (either repair or resection) at the time of their index surgery. Eighty (66%) played competitive sport, and 42 (34%) played recreational-level sport before their ACL injury, most commonly for 6 to 10 hours per week (range, 1-20 hours). Before their ACL injury, most athletes played Australian football ($n = 40$, 33%), soccer ($n = 20$, 16%), netball ($n = 19$, 16%), or basketball ($n = 16$, 13%). In total, 60% of athletes played pivoting, noncontact sports; 33% played contact sports; and 7% played nonpivoting, noncontact sports before their ACL injury.

Overall, 94% of athletes returned to some form of sport between 1 and 2 years after their ACL reconstruction, 49% to their preinjury level sport (Table 1). At 2 years after surgery, 68% of athletes were playing some form of sport, and of these, 41% were playing their preinjury level sport (Table 1). At 2 years' follow-up, 7 participants had sustained a new ACL injury (5 graft ruptures, 2 contralateral ACL ruptures). Six reinjuries occurred after the athletes

TABLE 1
Sports Participation Rates^a

	Yes, n (%)	No, n (%)	Total, n (N = 122)
Playing any kind of sport at 2 years	77 (68)	36 (32) ^b	113 ^c
Playing preinjury sport at 2 years	47 (41)	67 (59) ^b	114 ^d
Returned to any sport between 1 and 2 years	106 (94)	7 (6)	113 ^c
Returned to preinjury sport between 1 and 2 years	55 (49)	57 (51)	112 ^e

^aThere are variable numbers of missing data because some participants responded to some of the return to sport questions but not all.

^bIncludes 6 participants who sustained a second ACL injury.

^cMissing data from 9 of 122 participants.

^dMissing data from 8 of 122 participants.

^eMissing data from 9 of 122 participants.

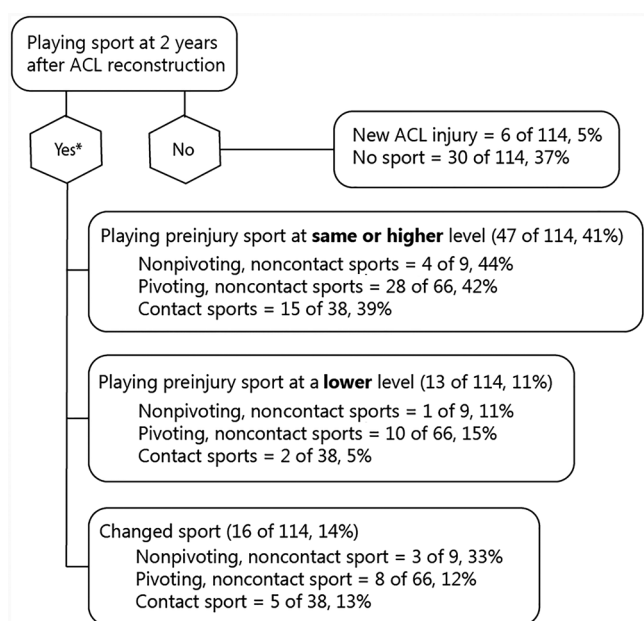


Figure 1. Summary of sports participation at 2 years after ACL reconstruction according to type of sport played before ACL injury. *One athlete who was not playing their preinjury level sport did not specify whether they were playing at a lower level or had changed sports; missing data for 1 athlete who reported not playing their preinjury level sport but did not report whether they were playing at a lower level or had changed sports, or they were not playing sport. For changed sport, the numbers reported in the figure relate to the sport played prior to ACL injury.

had returned to sport; the injury circumstances for 1 could not be determined. Of those who sustained a new injury, 1 athlete was playing sport at the 2-year follow-up. The primary outcome of playing the preinjury level sport at 2 years was unable to be determined for 8 (7% of 122) participants.

Figure 1 shows sports participation rates at 2 years after surgery summarized according to the type of sport played before ACL injury. Of those who were playing their

TABLE 2
Frequency of Preinjury Level Sports Participation at 2 Years After Surgery by Sport^a

	Playing Preinjury Level Sport at 2 Years, ^b n	
	Yes	No
Australian football (n = 40)	14 (37)	24 (63)
Competitive (n = 36)	12	22 ^c
Recreational (n = 4)	2	2
Soccer (n = 20)	5 (26)	14 (74)
Competitive (n = 11)	4	6 ^c
Recreational (n = 9)	1	8
Netball (n = 19)	7 (41)	10 (59)
Competitive (n = 16)	6	8
Recreational (n = 3)	1	2
Basketball (n = 16)	8 (50)	8 (50)
Competitive (n = 11)	5	6 ^d
Recreational (n = 5)	3	2
Other (n = 27)	13 (54)	11 (46)
Competitive (n = 6)	3	2
Recreational (n = 21)	10	9 ^d

^aValues in parentheses represent percentages.

^bMissing data for 1 athlete who played soccer, 2 athletes who played Australian football, 2 athletes who played netball, and 3 athletes who played other sports.

^cTwo athletes sustained a subsequent ACL injury after returning to sport.

^dOne athlete sustained a subsequent ACL injury after returning to sport.

preinjury level sport at 2 years after surgery, there were similar rates of participation for nonpivoting, noncontact sports (44%); pivoting, noncontact sports (42%); and contact sports (39%) (Figure 1). A small proportion of athletes had changed sports (14% of 114). Of these, at follow-up, 9 were playing nonpivoting, noncontact sports; 5 were playing pivoting, noncontact sports; and 2 were playing contact sports. Greater than one-third of athletes were not playing sport at 2 years' follow-up (Figure 1).

Table 2 shows the preinjury sports participation rates for competitive and recreational athletes at 2 years in the most common sports. While the rates varied among the

TABLE 3
Comparison of Demographic Characteristics Between Athletes
Who Were and Were Not Playing Their Preinjury Level Sport at 2 Years^a

	Playing Preinjury Level Sport (n = 47)	Not Playing Preinjury Level Sport (n = 67)	P
Sex, n (%)			.09
Male	25 (35)	46 (65)	
Female	22 (51)	21 (49)	
Previous ACL reconstruction, n (%) ^a			.02 ^b
No	44 (47)	49 (53)	
Yes	3 (17)	15 (83)	
Preinjury sport participation, n (%)			.84
Recreational	17 (43)	23 (57)	
Competitive	30 (41)	44 (59)	
Age at surgery, y, mean ± SD	27.5 ± 8.3	28.9 ± 8.5	.41

^aMissing data from 3 athletes who were not playing their preinjury level sport.

^bStatistically significant difference.

different sports, there were no statistical differences observed ($\chi^2_{(4)} = 4.2$, $P = .38$). Comparisons were not made between competitive and recreational athletes in each sport due to low cell counts.

Athletes for whom this was their first ACL surgery had more than 4 times increased odds of playing their preinjury sport at 2 years' follow-up when compared with those who had previously had an ACL reconstruction on either knee (OR = 4.5; 95% CI, 1.2-16.6; $P = .02$). There were no differences in age, sex, and preinjury sports participation level between those who were and were not playing their preinjury sport at 2 years after surgery (Table 3).

Physical function data, measured at 1 year after surgery, were available for 102 participants (89% of 115). Overall, the group had stable knees, demonstrated symmetrical hop performance, and reported good subjective function (Table 4). Seventy percent of participants had objective knee function classified as "normal" (IKDC category A), and a further 26% had function classified as "nearly normal" (IKDC category B) (Table 4). Athletes who were playing their preinjury sport at 2 years had significantly higher overall hop test limb symmetry index and IKDC subjective scores compared with those who were not playing (Table 4). There were no other differences in physical function between athletes who were playing their preinjury sport at 2 years and those who were not.

Athletes who were playing their preinjury sport at 2 years after ACL reconstruction had significantly greater psychological readiness to return to sport (measured with the ACL-RSI) and significantly less mood disturbance (measured with the ISP) at 1 year after surgery, compared with those who were not playing (Table 5).

Overall, athletes in the current study indicated high importance and possibility to return to their preinjury sport and that they were willing to invest time and effort to return (median, 8 points out of 10 for all 3 questions) (Table 5). However, athletes who were playing their preinjury sport at 2 years scored significantly higher for the importance of returning, possibility of returning, and the time and effort they were willing to invest to return to their preinjury sport when compared with those who were not playing at 2 years (Table 5).

The response rate for the self-motivation questions was 68%, and for the psychological factors it was 83%. Eighty-nine percent of participants completed the clinical assessment at 1 year after surgery. For all of these outcomes, there were no differences in age, sex, preinjury sport participation level, or preinjury sport participation rate at 2 years between those who responded and those who did not.

DISCUSSION

This study examined the subsequent sports participation of athletes who had not returned to their preinjury sport by 1 year after ACL reconstruction. The results demonstrated that between 1 and 2 years after surgery almost all of these athletes (91%) had returned to some form of sport. However, less than half of athletes (45%) returned to their preinjury level sport within this time, and only 2 in every 5 were playing their preinjury level sport at 2 years after surgery. Univariate analyses demonstrated that there were relationships between specific demographic, physical function, and psychological factors and playing the preinjury level sport at 2 years after ACL reconstruction. Having a history of ACL reconstruction to either knee, poorer hop test symmetry and subjective knee function, and more negative psychological responses were prospectively associated with not playing the preinjury level sport 2 years after surgery.

The findings of this study suggest that athletes can take longer than the frequently assumed time of 1 year to return to their preinjury level sport after ACL reconstruction surgery. In the original cohort of 187 athletes,⁵ 31% had returned to their preinjury level sport at 1 year after surgery. When the results of the current study are added, which accounts for the subsequent sports participation outcomes of the 69% who had not returned at 1 year, the overall rate of return to the preinjury level sport at 2 years was 60%. This could be an important consideration for clinicians and supports the notion that just because an athlete has not returned to sport by 1 year, it does not mean they will not return to sport at all.⁶ Clinicians and patients may need to reassess their expectations for rehabilitation and

TABLE 4
Physical Knee Function at 1 Year Postoperative Between Athletes
Who Were and Were Not Playing Their Preinjury Level Sport at 2 Years^a

Physical Function Variable	Overall	Playing Preinjury Level Sport At 2 Years (n = 41) ^b	Not Playing Preinjury Level Sport At 2 Years (n = 53) ^c	P
Anterior knee laxity, mm	1.0 (2.0)	1.0 (2.0)	1.0 (1.0)	.37
Overall hop performance, LSI ^d	97.1 (13.0)	100.5 (12.0)	96.1 (12.0)	.01 ^e
IKDC subjective knee score	85.0 (15.0)	89.0 (15.0)	82.5 (14.0)	.04 ^e
IKDC objective classification, n (%)				.07
Category A	71 (70)	26 (63)	40 (75)	
Category B	27 (26)	13 (32)	12 (23)	
Category C	4 (4)	2 (5)	1 (2)	

^aValues are reported as median (IQR) unless otherwise indicated. Analysis based on sample of 115 athletes. IKDC, International Knee Documentation Committee; IQR, interquartile range; LSI, limb symmetry index.

^bMissing data from 5 athletes.

^cMissing data from 8 athletes.

^dThe LSI is calculated as a percentage of the nonoperated limb.

^e $P \leq .05$ parametric tests.

TABLE 5
Psychological Responses at 1 Year Postoperative Between Athletes
Who Were and Were Not Playing Their Preinjury Sport at 2 Years^a

Psychological Factor	Overall	Playing Preinjury Level Sport (n = 37) ^b	Not Playing Preinjury Level Sport (n = 50) ^c	P
ACL-RSI ^d (0-100)	46.3 (27.0)	47.5 (29.0)	40.8 (23.0)	.03 ^e
TSK ^d (17-68)	34.0 (8.0)	33.0 (9.0)	34.0 (8.0)	.49
SRLC_internal ^d (0-15)	4.5 (3.0)	4.0 (3.0)	5.0 (3.0)	.29
SRLC_powerful others ^d (0-15)	10.0 (3.0)	10.0 (3.0)	10.0 (2.0)	.38
SRLC_chance ^d (0-15)	12.0 (3.0)	13.0 (4.0)	12.0 (3.0)	.10
ERAIQ ^d (0-120)	24.5 (47.0)	24.0 (34.0)	29.0 (54.0)	.59
ISP ^d (0-20)	4.0 (6.0)	3.0 (5.0)	4.0 (7.0)	.05 ^e
Motivation_importance ^d (1-10)	8.0 (4.0)	9.0 (2.0)	7.0 (2.0)	.001 ^e
Motivation_possible ^d (1-10)	8.0 (3.0)	8.0 (2.0)	8.0 (3.0)	.03 ^e
Motivation_time ^f (1-10)	8.0 (2.0)	9.0 (2.0)	7.0 (2.0)	.001 ^e

^aValues are reported as median (IQR). Analysis based on sample of 115 athletes. ACL-RSI, ACL-Return to Sport after Injury scale; ERAIQ, Emotional Responses of Athletes to Injury Questionnaire; ISP, Incredibly Short Profile of Mood States; SRLC_internal, Sport Rehabilitation Locus of Control scale internal items; SRLC_chance, Sport Rehabilitation Locus of Control scale chance items; SRLC_powerful others, Sport Rehabilitation Locus of Control scale powerful others items; TSK, Tampa Scale for Kinesiophobia.

^bMissing data from 13 athletes who were playing their preinjury sport at 2 years.

^cMissing data from 8 athletes who were not playing their preinjury sport at 2 years.

^dMissing data from 20 athletes.

^eStatistically significant at $P \leq .05$.

^fMissing data from 37 athletes.

return to the preinjury level sport after ACL reconstruction, particularly given that all participants in the current study reported preoperatively that they intended to return to sport and received surgical clearance to return to sport from 9 months after surgery.

The fact that specific demographic, physical function, and psychological factors were associated with returning to the preinjury sport after ACL reconstruction supports the notion that returning to sport is multifactorial, with all aspects warranting consideration during rehabilitation. In the current study, we found that athletes who were playing their preinjury level sport at 2 years had better hop symmetry, reported significantly better knee function (measured with the IKDC

subjective evaluation), and had significantly more positive psychological readiness to return to sport and mood at 1 year after surgery compared with those who were not playing. In addition, those who were playing at 2 years scored significantly higher at 1 year after surgery for the importance and possibility of returning to sport and the amount of time and effort they were willing to invest to return to sport. These findings are supported by a recent systematic review that demonstrated a small effect favoring symmetrical hopping performance and returning to the preinjury level sport after surgery and large effects (standardized mean differences of at least 0.9) favoring positive psychological responses and returning to the preinjury level sport.⁴

Athletes without a history of ACL reconstruction to either knee had more than 4 times greater odds of playing their preinjury level sport at 2 years compared with those who had had a previous ACL reconstruction. The wide confidence interval for this estimate suggests there could be variability in this outcome, particularly given the relatively small number of athletes with a previous ACL reconstruction. Nevertheless, this finding is consistent with a systematic review of outcomes after revision ACL reconstruction, which demonstrated lower rates of return to sport when compared with primary surgery.⁴¹ In addition, physical function after revision ACL reconstruction has been shown to be lower than after primary surgery.⁴¹ Given the fact that physical function may influence participation in the preinjury level sport after surgery, the findings of the current study could suggest that athletes who are not having their first ACL reconstruction and who have not returned to sport by 1 year may benefit from additional support to maximize their chances for returning to their preinjury sport after surgery. However, further research is necessary to confirm this hypothesis.

Overall, 6% of athletes in the current study sustained a new ACL injury in the first 2 years after their ACL reconstruction, which is very similar to other published research with the same follow-up.⁴⁰ All athletes who sustained reinjuries were men, and 4 of them were aged 22 years or younger at the time of their index ACL reconstruction. In addition, 5 sustained their reinjury while playing pivoting sports. All were cleared to return to sport by their surgeon, which suggests that they had sufficient physical capabilities to manage a return to their preinjury level sport and the reinjury was not simply a case of inadequate rehabilitation and being physically underprepared to play sport. Being young and male have been identified as factors potentially increasing the risk for graft rupture after ACL reconstruction.³⁹ This may help to explain the relatively high incidence of graft rupture (5/122, 4%) in the current study, when compared with an overall rupture rate of 5.8% at a minimum of 5 years' follow-up reported in a systematic review of ACL reinjury rates.⁴² There is also some evidence to suggest that athletes who return to pivoting sports after surgery may be at increased risk of sustaining a new ACL injury,³⁹ although the literature is inconclusive regarding whether the risk is higher for graft rupture or contralateral ACL injury.³⁹ Therefore, it seems reasonable that some or all of these factors may have contributed to increasing the risk for new injury in those who sustained a subsequent ACL injury in the current study.

Almost all athletes (94%) in the current study returned to some form of sport at some time after surgery, yet less than half were playing their preinjury sport at 2 years. One in 4 athletes had changed sport or level of participation at 2 years after surgery, while 1 in 3 had stopped playing sport all together. Athletes in this study were predominantly playing pivoting sports at a competitive level before their ACL injury. The rate of return to competitive sport after ACL reconstruction has been shown to be low, with a meta-analysis of 30 studies demonstrating only 55% of athletes returned after surgery.⁴ Therefore, it is possible that the type and level of sport played, reflecting the

demands on the knee, may have influenced the return to sport rate.³⁷ For example, it may be more challenging to return to competitive-level soccer than recreational-level cycling. Further research is required to test this hypothesis.

We did not investigate the reasons for changing or stopping sport, but it has previously been suggested that lifestyle factors such as employment or family commitments could play an important role in an athlete's decision to return to and continue playing their preinjury sport.^{4,6} There has been limited empirical investigation of the reasons why athletes do not return to their preinjury sport, although 1 recent quantitative study has demonstrated that around 10% of athletes cited family or work commitments as the primary reason for not returning to their preinjury sport or recreational activity,² and athletes have reported that change in personal lifestyle circumstances was a central consideration influencing their decision to return to the preinjury sport.³⁴ For some athletes, it is possible that participating in the preinjury level sport may become less of a priority in comparison to other aspects of their life, and this could contribute to a change in participation. When sports participation rates in individual sports were examined, the only group with a preinjury level participation rate above 50% were those playing "other" sports (these included badminton, cycling, and tennis). This group had a high proportion of recreational athletes—78% compared with 10% for Australian football. Perhaps this could suggest their sports participation might have had lower demands, for example in time commitment (eg, fewer training sessions) or physical conditioning, and because of this it was easier for athletes to include them alongside other life commitments?

Athletes in the current study were also older than their peers who had returned to preinjury sport at 1 year after ACL reconstruction (mean 28.3 years compared with 25.6 years).⁵ Perhaps older athletes may be more likely to have competing family and employment commitments than younger athletes. Younger athletes may also have greater opportunity to participate in their preinjury level sport through school and university, and they may have a greater sense of athletic identity.^{4,32,34} Further research is required to confirm these hypotheses regarding the effect of lifestyle and other factors on sports participation.

Among the studies that have investigated the reasons for not returning to sport after ACL reconstruction, fear of sustaining a new injury has been identified as 1 of the most common reasons for athletes not returning to the preinjury sport.^{13,20,22} In addition, among athletes who had returned to sport after surgery, those who returned to their preinjury sport had lower fear than those who returned to a lower level sport.³ In the current study there was no relationship between fear of reinjury (measured with the TSK) and playing the preinjury sport at 2 years, which was unexpected given the results of previous studies. However, a previous multivariable analysis of demographic, physical function, and psychological factors also found no relationship between returning to the preinjury sport and TSK scores.²² It could be speculated that our findings might be explained by the fact that the questions comprising the TSK relate to movement as the cause of injury or

pain (eg, “simply being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my pain from worsening”) and do not address anxiety and an appraisal of the potential consequences of reinjury, which has been suggested to be more relevant to athletes.³⁶

A strength of the current study is that it considers the effect of a range of demographic, physical function, and psychological factors on playing the preinjury sport after surgery. In addition, sports participation data were collected prospectively, which reduces the likelihood of recall bias and may better account for the complex and changeable nature of sports participation.¹⁴ A limitation of the study was that multivariable analysis of the relationship between demographic, physical function, and psychological factors and playing the preinjury sport was precluded due to the available sample size. Multivariable analysis could facilitate inferences about the relative importance of different factors to explaining the variance in sports participation and whether particular factors independently predict sports participation outcomes after surgery taking account of other factors. Some participants were unable to be contacted, which meant there were missing data. However, we had greater than 80% follow-up for all outcomes except the self-motivation questions (which had 68% follow-up) and over 90% follow-up for the primary outcome. This compares favorably with other published reports of return to sport at a minimum 2-year follow-up.^{6,25} The self-motivation questions were not validated, although the fact that there was a relationship between returning to the preinjury level sport and higher scores suggests preliminary evidence of known-groups validity for these questions. We suggest further validation of these questions as surrogate measures of motivation to return to sport after surgery is needed if they are to be used as a primary outcome.

There was some heterogeneity in the sports athletes played before their ACL injury, and as previously discussed, it is possible that this could have affected the return to sport outcomes reported in the current study. However, it is important to note that almost all athletes (93%) played pivoting sports before their ACL injury, suggesting they likely had similar demands on their knee, and the sports played reflected the typical distribution of participation in southeastern Australia,^{1,7,17} where this study was conducted. Postoperative rehabilitation was not standardized to enhance the generalizability of the results, and we did not collect data regarding rehabilitation adherence. It is possible that the type and amount of rehabilitation completed may have influenced subsequent sports participation via an effect on physical function and/or psychological factors. However, the results at 1 year showed that overall, participants had sufficient physical capabilities to participate in sport and relatively low psychological disturbance.

It is possible that physical function and psychological factors may be different at 2 years after surgery compared with 1 year after surgery (as measured in the current study), and this may affect participation in the preinjury level sport at this time. While we collected data regarding the number of hours of sports participation per week before ACL injury, we did not collect data regarding frequency of

sports participation after surgery. Comparison of participation frequency may provide additional insight into whether athletes who return to their preinjury sports level also return to their preinjury performance level after ACL reconstruction.

An evaluation of athletes' perceptions of their performance upon returning to sport was beyond the scope of the current study. Objective analysis of performance after return to the preinjury level in professional hockey, soccer, American football, and basketball has shown inconsistent results, with some reports demonstrating a decline in performance compared with non-ACL-injured athletes^{9,15} and others showing no difference.^{8,10-12,29} In all of these studies, performance was assessed according to objective data (eg, minutes played, goals scored, assists, touchdowns); athletes' self-report of their assessment of their own performance after returning to sport was not evaluated. Individual differences in patients' experiences of physical activity performance after nonreconstructed ACL injury have been reported, with some patients reporting their performance was unchanged compared with before their ACL injury and others reporting they altered their performances to accommodate functional deficits.³¹ Upon returning to sport after injury, athletes frequently report holding back and not giving 100% effort as behavioral manifestations of a lack of athletic confidence.¹⁸ Therefore, evaluating athletes' perceptions of performance in future research may give important insights into the success²³ of return-to-sport outcomes after ACL reconstruction.

CONCLUSION

Within 2 years after ACL reconstruction, 94% of athletes who had not returned to their preinjury sport at 1 year after surgery had returned to some form of sport, suggesting that some athletes may take longer than the clinically expected time of 1 year to return to sport. However, less than half had returned to their preinjury sport, and at 2 years after surgery only 2 in every 5 athletes were playing their preinjury level sport. Having a previous ACL reconstruction and poorer physical function and psychological responses at 1 year after surgery were associated with not playing the preinjury level sport at 2 years. These results confirm the multifactorial nature of returning to sport after surgery.

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