

Female Soccer Players With Anterior Cruciate Ligament Reconstruction Have a Higher Risk of New Knee Injuries and Quit Soccer to a Higher Degree Than Knee-Healthy Controls

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Background: Many patients with anterior cruciate ligament (ACL) reconstruction who return to sport suffer new ACL injuries or quit sports soon after returning.

Purpose: To prospectively follow a cohort of female soccer players with primary unilateral ACL reconstruction and matched knee-healthy controls from the same soccer teams to compare (1) the rate of new traumatic and nontraumatic knee injuries and other injuries, (2) the proportion of players who quit soccer, and (3) player-reported activity level and satisfaction with activity level and knee function.

Study Design: Cohort study; Level of evidence, 2.

Methods: A total of 117 active female soccer players (mean \pm SD age, 19.9 \pm 2.5 years) 18.9 \pm 8.7 months after ACL reconstruction and 119 knee-healthy female soccer players (19.5 \pm 2.5 years) matched from the same teams were prospectively followed for 2 years for new knee injuries, other injuries, soccer playing level, activity level according to the Tegner Activity Scale, and satisfaction with activity level and knee function.

Results: Players with ACL reconstruction had a higher rate of new ACL injuries ($n = 29$ vs 8 ; 19 vs 4 per 100 player years; rate ratio [RR], 4.82; 95% CI, 2.20-10.54; $P < .001$), other traumatic knee injuries (29 vs 16 per 100 player years; RR, 1.84; 95% CI, 1.16-2.93; $P < .01$), and nontraumatic knee injuries (33 vs 9 per 100 player years; RR, 3.62; 95% CI, 2.11-6.21; $P < .001$) as compared with controls. There was no difference in the rate of other (not knee) injuries (43 vs 48 per 100 player years; RR, 0.90; 95% CI, 0.65-1.23; $P = .494$). During the 2-year follow-up, 72 (62%) players with ACL reconstruction quit soccer, as opposed to 43 (36%) controls ($P = .001$). The median Tegner Activity Scale score decreased in both groups ($P < .001$) but more for the ACL-reconstructed group ($P < .015$).

Conclusion: Female soccer players with ACL reconstruction had nearly a 5-fold-higher rate of new ACL injuries and a 2- to 4-fold-higher rate of other new knee injuries, quit soccer to a higher degree, and reduced their activity level to a greater extent as compared with knee-healthy controls.

Keywords: female; football; soccer; anterior cruciate ligament; return to sports; reinjury; satisfaction

Anterior cruciate ligament (ACL) injury is a severe injury for soccer players, and female players have a 2- to 3-fold-higher injury risk than men.³⁷ Athletes with an ACL rupture often seek surgical treatment with ACL reconstruction (ACLR),²⁶ and a common goal after ACLR is to return to sport.²⁵ A meta-analysis showed that 81%

returned to some kind of sport, but only 55% returned to competitive sports a mean 40 months after unilateral ACLR.⁴ The rate of return to soccer in a female population with ACLR ranges from 46% to 67%.^{9,11,33} Returning to soccer after ACLR increases the risk of new ACL injury to the ipsi- or contralateral knee, especially among young women.²⁹ The rate of additional ACL injury varies depending on the follow-up time but is reported to be as high as 25% to 34% within 2 to 10 years after ACLR.^{1,29} There are conflicting results regarding the risk of sustaining other knee injuries after ACLR and return to soccer as

compared with controls. However, this risk was investigated only in small cohorts ($n \leq 40$) of elite soccer players with ACLR.^{5,28,35}

Many soccer players quit their sport because of knee problems,¹¹ although long-term participation in soccer after ACLR is not well studied. Recently, Waldén et al³⁶ reported that 86% of elite male soccer players still played soccer 3 years after ACLR, 65% at the same level as before the ACL injury. Brophy et al⁹ reported that 38% of male soccer players and 31% of female soccer players still played 7 years after ACLR. Many players, regardless of whether they have ACLR, quit playing soccer at a young age for such reasons as changes in the team formation, other interests, traveling, studies, and lack of time. Their activity level and satisfaction with activity level after quitting are not known.

Career length, new traumatic and nontraumatic knee injuries, activity level, knee function, and satisfaction with knee function and activity level among female soccer players with ACLR are insufficiently studied. The aim of this study was to prospectively follow a cohort of female soccer players with primary unilateral ACLR and matched knee-healthy controls from the same soccer teams to compare (1) the rate of new traumatic and nontraumatic knee injuries and other injuries, (2) the proportion of players who quit soccer completely, and (3) player-reported activity level and satisfaction of activity level and knee function. Our hypotheses were that players with ACLR would have a higher rate of new traumatic and nontraumatic knee injuries, quit soccer to a higher degree, and decrease their activity level more as compared with controls during a 2-year follow-up.

METHODS

This was a prospective cohort study exploring return-to-soccer outcomes among female soccer players after ACLR. Baseline data (ACL injury and soccer-related factors), associated methodology, and primary analyses with regard to knee function and return to soccer were published for parts of this cohort ($n = 77$ of the players with an ACL-reconstructed knee and 77 of the controls).¹² An additional 40 players meeting the same criteria are included in the current study.

Participants

Active female soccer players aged 16 to 25 years at the time of inclusion who received primary unilateral ACLR were

identified by searching the Swedish National Knee Ligament Register (SNKLR), which captures >90% of all ACLRs in Sweden,²⁴ and by advertising on 3 regional football district websites near Linköping University. The SNKLR contains information about the activity connected with the injury but no information regarding regular sport participation before or after ACLR. Therefore, to identify active soccer players, a survey was sent at the beginning of the soccer season to patients in the register who reported sustaining ACL injuries while playing soccer. We included currently active female soccer players (participating fully in soccer training, any playing level) who had undergone primary ACLR between 6 and 36 months earlier at any clinic in the 3 regional soccer districts. We excluded patients with an associated posterior cruciate ligament injury and/or surgically treated injuries to the medial or lateral collateral ligament of the knee. Baseline data were collected over 3 consecutive soccer preseasons (January–April 2013, 2014, and 2015). We identified 535 potentially eligible patients in the SNKLR, and 101 were included. An additional 16 active players with ACLR who were not registered in the SNKLR responded to the regional advertisements and were included for a total of 117 players with ACLR (Figure 1). The population of responders did not differ significantly from nonresponders regarding current age, age at the time of ACLR, time from ACLR to follow-up, graft type, or presence of concomitant injuries at ACLR ($P > .05$).

Players with ACLR were compared with 119 control players (without ACL injury/reconstruction and with no other current injuries that kept them away from play), who were recruited by coaches from the same teams as the injured players to ensure that groups were as similar as possible for soccer exposure, age, and playing position. The coaches were contacted by phone and asked to choose teammates (controls) as close to these criteria as possible. For 7 teams, no suitable controls were available; therefore, extra controls ($n = 9$) were recruited from other teams in the geographic area.

All players received written and oral information about the study, which was approved by the Regional Ethical Review Board (Dnr 2012/24-31 and 2013/75-32) and the SNKLR board. After giving written consent, players received a questionnaire about demographic and soccer-related factors for baseline measure. The soccer-related factors included playing position, dominant limb (preferred kicking leg), level of play, and time from ACLR to full training/match play with the team. Injury- and soccer-related factors for the players with ACLR are presented

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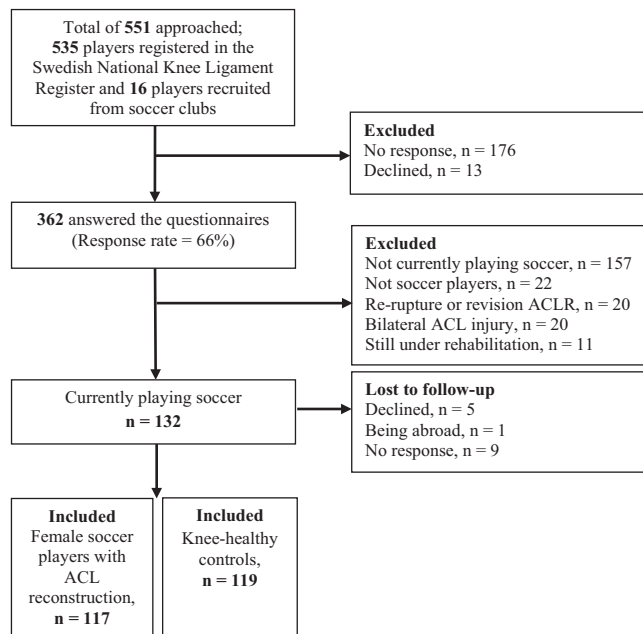


Figure 1. Study flowchart. ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction.

in Table 1, and baseline data for controls and players with ACLR are shown in Table 2. The technique for femoral drilling from 2010 to 2014 was performed exclusively through a separate medial portal. In our cohort, the most common form of fixation in the femur (96%) was cortical suspension devices, and for the tibia, it was 59% intratunnel fixation and 41% cortical suspension devices.

During the 2-year follow-up, the players answered a web-based questionnaire 6 times: before each season, in the middle of each season, and after each season. The questions addressed the players' participation in soccer (any changes and any reasons for changing), new acute-onset or nontraumatic (insidious onset without any known trauma) injury to either knee, or injury to other body locations. We defined an injury as "any physical complaint sustained by a player irrespective of the need for medical attention or time-loss from football activities."¹⁴ We defined time-loss injuries as "an injury that results in a player's being unable to take a full part in future soccer training or match play."¹⁴ If the player had sustained a new knee injury, she was contacted by telephone for further information and confirmation from medical records. The players rated their absence from soccer play, and the injury severity was graded as minimal (1-3 days), mild (4-7 days), moderate (8-28 days), or severe (>28 days).¹⁹

At baseline and the 2-year follow-up, current activity level was graded according to the Tegner Activity Scale.^{13,34} The scale assesses activity level from 0 to 10, where 0 corresponds to the least strenuous activity for the knee and 10 is equal to participation in soccer on a national level.³⁴ Players rated their satisfaction with their current activity level on a scale from 1 (not satisfied at all) to 10 (very satisfied).^{3,13} Satisfaction with knee function was measured with the question "If you had to live with your current knee function for the rest of your life just the way it has been in the past

week, would you feel . . . ?" with response options ranging from 1 to 7: delighted (1), pleased, mostly satisfied, mixed, mostly dissatisfied, unhappy, and terrible (7).^{2,10,13} Players with ACLR completed the International Knee Documentation Committee Subjective Knee Form (IKDC-SKF).²² Scores range from 0 (worst) to 100 (best), and the test is valid and responsive for change.^{16,22} Players judged if they considered that they played soccer as before the ACL injury (yes/no) and if they could perform at the same level as before the ACL injury (yes/no).

Statistical Methods

All statistical analyses were performed with SPSS Statistics for Windows (v 22.0; IBM). Mean \pm SD or median and interquartile range (IQR) with range were calculated for descriptive statistics. Paired-sample *t* tests (for ratio data with normal distributions) and the Wilcoxon signed rank test (for ordinal data) or McNemar test (nominal data) were used to compare differences between baseline and the 2-year follow-up within players with ACLR and within controls. Player exposure was calculated in number of weeks from the day that players were included to the date when they quit playing soccer. Injury incidence was calculated as the number of injuries per 100 player years of exposure and compared between groups with a rate ratio (RR), 95% CI, and significance testing (*z* test) for (1) new ACL injuries, (2) new other traumatic knee injuries, (3) new nontraumatic knee injuries, (4) new knee injuries treated with surgery, and (5) new other injury (not knee). Between-group comparisons—demographics, soccer-related factors, appraisal of current knee function, activity level, and appraisal of activity level, as well as proportion of players with new injuries (ACL, knee, or other) and proportion of players who quit soccer—were made with the Student *t* test, Mann-Whitney *U* test, or the chi-square test as appropriate. Chi-square test was used for comparisons between players with ACLR with or without meniscus or cartilage injury at primary ACLR and the rate of new ACL injury, other traumatic knee injury, or nontraumatic knee injury. The significance level was set at *P* < .05.

RESULTS

At the 2-year follow-up of this prospective study, the mean time after ACLR was 43.7 ± 8.7 months (range, 30-65 months). All players were followed for 2 years. Total player exposure was 149 player years for the players with ACLR and 198 player years for the controls.

New Knee Injury During Follow-up

Players with ACLR had an almost 5-fold-higher incidence of new ACL injuries (*n* = 29, 25%; 15 reruptures, 7 partial reruptures, and 7 contralateral ruptures) as compared with the controls (*n* = 8, 7%; 7 total ruptures, 1 partial rupture). Players with ACLR had 19 ACL injuries (including reruptures and partial and contralateral tears) per 100

TABLE 1
ACL Injury- and Soccer-Related Factors
at Baseline: Female Soccer Players
With ACL Reconstruction (n = 117)^a

ACL Injury- and Soccer-Related Factors	n (%) or Median (IQR; Range)
Injury mechanism	
Contact	49 (42)
Noncontact	68 (58)
Age at ACL reconstruction, y	18.3 ± 2.4 ^b
Time between injury and ACL reconstruction, mo	3 (5, 0-22)
<3	42 (36)
3-12	69 (59)
>12	6 (5)
Time from ACL reconstruction at baseline, mo	16 (13; 6-39)
6-12	28 (24)
>12-24	58 (50)
>24-39	31 (26)
Graft: all autografts	
Hamstrings	
1- to 4-strand semitendinosus	58 (50)
Semitendinosus-gracilis	56 (48)
Patellar tendon	2 (2)
Quadriceps tendon	1 (1)
Graft diameter, mm	
<8.0	42 (36)
≥8.0	75 (64)
Index knee	
Right	60 (51)
Left	57 (49)
ACL reconstruction in the dominant limb (preferred kicking leg)	65 (56)
Presence of concomitant injuries at ACL reconstruction	
Meniscus injury (medial/lateral)	49 (42)
Surgically treated ^c	43 (88)
Meniscus repair ^c	17 (35)
Articular cartilage injury	11 (9)
Surgically treated ^c	1 (9)
Time from ACL reconstruction to full training with the team, mo	9 (5; 3-33)
≤6	18 (15)
7-9	44 (38)
10-12	29 (25)
>12	26 (22)
Time from ACL reconstruction to first match, mo	11 (5.5; 6-34)
≤6	2 (2)
7-9	28 (24)
10-12	44 (38)
>12	43 (37)
Time from return to full training with the team at baseline, mo	5 (12; 0.5-30)
≤3	51 (44)
>3-12	34 (29)
>12	32 (27)
Time from return to match play at baseline, mo ^d	6 (11.25; 0.5-29)
≤3	37 (40)
>3-12	35 (38)
>12	21 (23)

(continued)

TABLE 1
(continued)

ACL Injury- and Soccer-Related Factors	n (%) or Median (IQR; Range)
Level of play vs before the ACL injury ^e	
Same	70 (61)
Higher	21 (18)
Lower	24 (21)

^aACL, anterior cruciate ligament; IQR, interquartile range.^bMean ± SD.^cSubgroup percentage.^dn = 93; 24 players had not played any matches after ACL reconstruction at baseline.^en = 115; missing data from 2 players.

player years versus 4 ACL injuries per 100 player years for controls (RR, 4.82; 95% CI, 2.20-10.54; $P < .001$). Players with ACLR experienced 29 other traumatic knee injuries per 100 player years, as opposed to 16 injuries per 100 player years for controls (RR, 1.84; 95% CI, 1.16-2.93; $P < .01$). Among players with ACLR, there were 33 nontraumatic knee injuries per 100 player years, and among controls, there were 9 injuries per 100 player years (RR 3.62; 95% CI, 2.11-6.21; $P < .001$). Twenty-six (22%) players with ACLR and 11 (9%) controls reported 2 new knee injuries, which means that 121 and 58 knee injuries were reported in the 2 groups, respectively.

Players with ACLR had a 7-times-higher incidence of knee injury treated with surgery when compared with controls (28 vs 4 injuries per 100 player years; RR, 6.81; 95% CI, 3.19-14.53; $P < .001$) (Figure 2, Table 3). One additional partial rerupture of the ACL graft occurred during skiing after the player had quit soccer and was not included in the analyses. Of the 37 new ACL injuries, 23 (62%) occurred in soccer matches (n = 15, 65% in the first half of the game), 13 (35%) in soccer training, and 1 (3%) in skiing. Of the 36 ACL injuries that occurred in soccer, 25 (69%) had a noncontact injury mechanism.

In terms of the rate of new ACL injury, other traumatic knee injury, or nontraumatic knee injury, there were no significant differences between players who had a meniscus or cartilage injury at primary ACLR and those who did not ($P > .05$).

Other Injuries

Forty-six (39%) players with ACLR and 60 (50%) controls reported other injuries (not knee) (Table 4). There was no difference between groups in the incidence of other injuries with 43 versus 48 injuries per 100 player years, respectively (RR, 0.90; 95% CI, 0.65-1.23; $P = .494$) (Figure 2).

Soccer Participation

Seventy-two (62%) players with ACLR quit soccer during the 2-year follow-up (median, 28 months; IQR, 14 months; range, 13-57 months after ACLR) as opposed to 43 (36%) controls ($P = .001$). The most common reason for quitting soccer among players with ACLR was "had sustained

TABLE 2
Demographic and Soccer-Related Factors at Baseline:
Female Soccer Players With ACL Reconstruction vs Knee-Healthy Controls^a

	Players With ACL Reconstruction (n = 117)	Controls (n = 119)	P Value
Age, y	19.9 ± 2.5	19.5 ± 2.5	.230
Height, m	1.68 ± 0.05	1.67 ± 0.06	.376
Body mass index, kg/m ²	23.0 ± 2.6	22.3 ± 2.2	.034
Immediate family with ACL injury	36 (31)	23 (19)	.042
Smokers			
No	115 (98)	118 (99)	.551
Yes	2 (2)	1 (1)	
Occupation			
Worker	35 (30)	31 (26)	.508
Student	82 (70)	88 (74)	
Playing position			
Goalkeeper	6 (5)	6 (5)	.666
Defender	40 (34)	50 (42)	
Midfield	52 (44)	46 (39)	
Forward	19 (16)	17 (14)	
Level of play			
Elite (2 top divisions)	14 (12)	13 (11)	.960
3rd-6th division	91 (78)	93 (78)	
Lowest division or youth play	12 (10)	13 (11)	
Dominant limb (preferred kicking leg)			
Right	97 (83)	108 (91)	.186
Left	7 (6)	3 (3)	
Both (the right limb was analyzed as dominant)	13 (11)	8 (7)	

^aValues are reported as mean ± SD or n (%). Bolded values indicate statistically significant between-group differences ($P < .05$). ACL, anterior cruciate ligament.

a new knee injury" (n = 26, 36%). Among controls, the most common reason to quit soccer was "family or work commitments" (n = 10, 23%) (Table 5).

Knee Function, Activity Level, Satisfaction With Knee Function, and Activity Level

Knee function measured with the IKDC-SKF among the players with ACLR decreased from 84.2 ± 11.3 at baseline to 80.2 ± 19.0 at the 2-year follow-up ($P = .019$) (Table 6). Controls had greater satisfaction with knee function at baseline and follow-up as compared with players with ACLR ($P < .001$). From baseline to follow-up, players in both groups were less satisfied with their activity level ($P < .001$ and $P = .005$, respectively) and had lowered their activity level ($P < .001$). In total, players with ACLR had lowered their activity level to a greater extent than the controls ($P = .015$) because of their quitting soccer to a higher degree. However, among those who quit soccer during the 2-year follow-up (n = 115), the players with ACLR had an activity level (Tegner Activity Scale, 4; IQR, 2; range, 1-9) similar to that of controls (Tegner Activity Scale, 2; IQR, 3; range, 1-10; $P = .14$).

DISCUSSION

In our study, active female soccer players with ACLR had close to a 5-times-greater risk of sustaining a new ACL

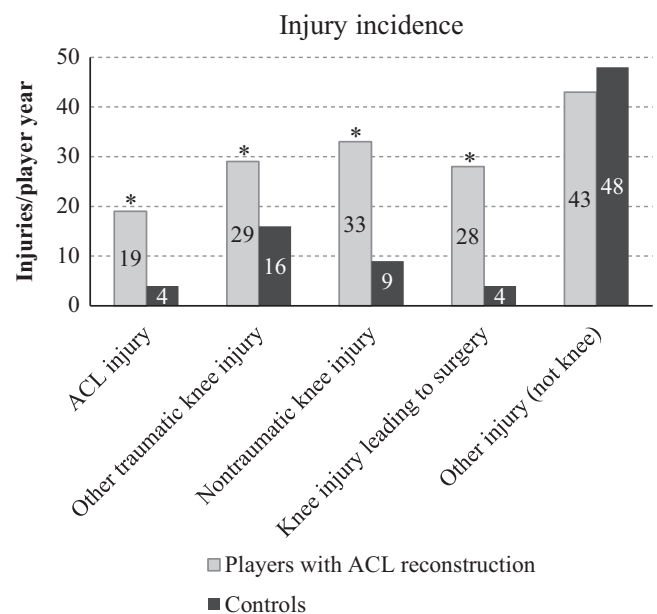


Figure 2. Analysis of the new injury incidence (injuries per 100 player years) between players with anterior cruciate ligament (ACL) reconstruction and controls. * $P < .001$ (other traumatic knee injuries, $P = .01$).

injury than players who never had an ACL injury. This is in line with previous studies reporting 4- to 6-times-

TABLE 3
New Knee Injuries Reported From Baseline to 2-Year Follow-up:
Female Players With ACL Reconstruction vs Knee-Healthy Controls^a

	Players With ACL Reconstruction (n = 117)	Controls (n = 119)	P Value
Total players with new knee injury	95 (81)	47 (39)	<.001
New ACL injury	29 (25)	8 (7)	<.001
Other traumatic or nontraumatic knee injuries	66 (56)	39 (33)	<.001
Total players treated with surgery	41 (35)	8 (7)	<.001
1 knee procedure	35 (30)	7 (6)	
>1 knee procedure	6 (5)	1 (1)	
Injury severity			<.001
No absence or no information	22 (18)	11 (19)	
Minimal (1-3 d)	5 (4)	16 (28)	
Mild (4-7 d)	15 (12)	8 (14)	
Moderate (8-28 d)	20 (17)	6 (10)	
Severe (>28 d)	59 (49)	17 (29)	

	ACL Reconstructed Knee	Contralateral Knee	Nondominant Leg	Dominant Leg
No. of new traumatic knee injuries ^b				
ACL: total rupture	15 ^c	7 ^d	3 ^e	4 ^e
ACL: partial rupture	7 ^f			1 ^g
Meniscus	8 ^e		1 ^g	1
Medial or lateral collateral ligament	3	3	3	5
Cartilage	2 ^h			
Patellar subluxation	2	1	1	1
Distortion: unspecified	8	4	1	7
Contusion	5		2	5
Graft problems (fixation, scar tissue)	2 ^e			
Pain, instability, locking	3	2 ^g	4	
Wound			1	
No. of nontraumatic knee injuries ^b				
Meniscus	4 ^e	2 ^e		
Cartilage	4 ⁱ			
Graft problems (fixation, scar tissue)	3 ^e			
Pain, instability, locking	27	9	7	11

^aValues are reported as n (%). Bolded values indicate statistically significant between-group differences ($P < .05$). ACL, anterior cruciate ligament.

^bn = 26 players with ACL reconstruction had 2 knee injuries or knee problems; n = 11 controls had 2 knee injuries or knee problems.

^cn = 12 surgically diagnosed/treated; n = 2 diagnosed with magnetic resonance imaging and 1 clinically.

^dn = 6 surgically diagnosed/treated; n = 1 diagnosed with magnetic resonance imaging.

^eAll surgically treated.

^fn = 5 surgically diagnosed/treated; n = 2 diagnosed clinically.

^gn = 1 surgically diagnosed/treated.

^hn = 1 surgically diagnosed/treated; n = 1 diagnosed with magnetic resonance imaging.

ⁱn = 3 surgically diagnosed/treated; n = 1 diagnosed with magnetic resonance imaging.

higher risk of sustaining a second ACL injury as compared with a first-time ACL injury.^{1,30} The incidence of a first-time ACL injury is increased in soccer and is as high as 0.5 to 8.5 per 100 player years.³⁷ The rate of additional ACL injuries varies depending on the follow-up time but seems to peak in the first 2 years after ACLR.^{29,30} Our results mirror those of additional ACL injuries in a young cohort (10-25 years old) who returned to sport after undergoing ACLR between 2007 and 2008: within the first 2 years after return to sport, the rate of additional ACL injuries was 29.5% as opposed to 8.5% for controls.³⁰ Among female soccer players treated with

ACLR between 1998 and 2013 who had returned to soccer, up to 34% of the players may sustain an additional ACL injury.^{1,9}

Previous research highlighted a high reinjury incidence but was limited by small samples of female soccer players treated with ACLR over 10 years ago. Our results also suggest a high rate of additional ACL injuries among female soccer players despite increased knowledge and development of surgery technique, rehabilitation, and prevention strategies. Players may have underlying neuromuscular control deficits that led to the primary ACL injury,⁸ and these must be addressed.

TABLE 4
Other Injuries (Not Knee) Reported From Baseline
to 2-Year Follow-up: Female Players With
ACL Reconstruction vs Knee-Healthy Controls^a

	Players With ACL Reconstruction (n = 117)	Controls (n = 119)
Players with other injuries	46 (39)	60 (50)
No. of other injuries	64	95
0	71	59
1	32	35
2	11	17
≥3	3	8
Type/location of injury		
Ankle sprain	18 (28)	34 (36)
Muscle injury/thigh	13 (20)	16 (17)
Hip/groin	11 (17)	11 (12)
Back	5 (8)	9 (9)
Concussion	5 (8)	7 (7)
Overuse (eg, shin splints)	5 (8)	6 (6)
Shoulder	0 (0)	2 (2)
Other	7 (11)	10 (11)
Injury severity		
Minimal (1-3 d)	7 (11)	13 (14)
Mild (4-7 d)	17 (27)	21 (22)
Moderate (8-28 d)	23 (36)	30 (32)
Severe (>28 d)	17 (27)	31 (33)

^aValues are reported as n (%). ACL, anterior cruciate ligament.

TABLE 5
Reasons for Quitting Soccer: Players With
ACL Reconstruction vs Knee-Healthy Controls^a

	Players With ACL Reconstruction (n = 117)	Controls (n = 119)
Sustained a new knee injury	26 (36)	8 (19)
Sustained other injury (not knee)	4 (6)	3 (7)
Poor knee function	8 (11)	1 (2)
Do not trust the knee	1 (1)	0 (0)
Fear of getting a new injury	2 (3)	0 (0)
Change in team or coach	2 (3)	7 (16)
Not fun to play anymore	13 (18)	9 (21)
Family or work commitments	11 (15)	10 (23)
Other reasons	5 (7)	5 (12)
Total	72 (62)	43 (36)

^aProportion of responses ranked by players as most important. Values are reported as n (%). ACL, anterior cruciate ligament.

Surveillance for new ACL injuries is important. However, clinicians also need to pay attention to other new traumatic and nontraumatic knee injuries, such as pain, instability, and locking. Sustaining new knee injuries after ACLR and returning to soccer were previously investigated in small cohorts of elite soccer players: Waldén et al³⁵ (men) and Nilstad et al²⁸ (women) reported a higher risk of sustaining knee injuries versus controls, but Arundale et al⁵ (men) recently reported no such difference. In our study, women with ACLR had a 2- to 4-fold-higher rate of other traumatic and nontraumatic knee injuries as compared with controls. Half of all knee injuries or problems reported by players with ACLR were classified as severe (ie, leading to an absence from soccer for >4 weeks). In a previous study reporting all acute knee reinjuries in the first 2 years after ACLR, 30% of athletes who returned to level I sports (jumping, hard pivoting, and cutting; eg, soccer, basketball) sustained a knee injury, as opposed to 8% of those returning to lower-level sports.¹⁷ Our study included nontraumatic knee injuries, longer follow-up, younger patients, and only female soccer players, which could explain the higher rate of reported knee injuries. Thus, it is important to be aware that other knee injuries have to be prevented.

Players with ACLR and controls had similar rates of injury to body parts other than the knee. Approximately one-third of these injuries were classified as severe. This is in line with Nilstad et al,²⁸ who reported no difference in the rate of sustaining a lower extremity injury between players with and without ACLR and who indicated that one-third of the injuries among elite female soccer players

were severe. This is a positive finding, as an often observed decrease in strength and function after ACLR⁷ did not seem to lead to more lower extremity injuries in general for our cohort; this also indicates that the matching of knee-healthy controls with players with ACLR was successful, since they had a comparable general injury risk.

More than half of female soccer players with ACLR did not return to soccer because of a “lack of trust in the knee” and “fear of new injury.”¹¹ In our study, only 38% of the players with ACLR continued to play soccer during the time of follow-up—significantly fewer than controls. This finding agrees with previous studies with small samples of female soccer players and no control participants.^{6,9,32} At a median 4 years after ACLR, 68% of soccer players were still playing soccer,⁶ and at 7-year follow-up, 12% to 31% of female soccer players were still playing.^{9,32} It is important that clinicians share accurate information regarding participation rates and reinjury rates with the female soccer player before she makes a decision regarding treatment, especially since the desire to return to soccer is often a primary reason for choosing ACLR.²⁰

Some other important results are that the activity level and satisfaction with the activity level decreased over time in both groups. The challenge is to find other satisfying activities to continue a healthy lifestyle among the women who quit soccer at young ages. Many players stated that they quit soccer because they sustained a new knee injury. Still, self-reported knee function measured with the IKDC-SKF decreased but only by a mean of 4 points, which is not of clinical importance. The score is in an acceptable symptom state.²⁷

Our results point to an unacceptably high rate of new traumatic and nontraumatic knee injuries among female soccer players with ACLR. High-quality research is required to identify which factors increase or decrease the risk for sustaining additional knee injuries. This information may subsequently help to inform the development and implementation of injury prevention strategies. The

TABLE 6
Knee Function, Activity Level, and Soccer-Specific Questions at Baseline and 2-Year Follow-up:
Female Soccer Players With ACL Reconstruction vs Knee-Healthy Controls^a

	Players With ACL Reconstruction (n = 117)			Controls (n = 119)				
	Baseline	2-y Follow-up	P Value	Baseline	2-y Follow-up	P Value	P Value ^b	P Value ^c
IKDC-SKF (0-100), mean ± SD	84.2 ± 11.3	80.2 ± 19.0 ^d	.019					
Satisfaction with current knee function (1-7)	2 (1.5; 1-7)	3 (3; 1-7) ^d	.250	1 (1; 1-7)	1 (1; 1-7)	.203	<.001	<.001
Delighted to pleased (1-2)	59 (50)	54 (47)		108 (91)	104 (87)			
Unhappy to terrible (6-7)	4 (3)	16 (14)		2 (2)	5 (4)			
Tegner Activity Scale (0-10)	9 (0; 9-10)	4 (7; 1-10) ^e	<.001	9 (0; 9-10)	9 (5; 1-10)	<.001	.802	.015
Satisfaction with current activity level (1-10)	8 (1.5; 1-10)	7 (3; 1-10) ^d	<.001	8 (2; 2-10)	8 (3; 1-10)	.005	.807	.176
Soccer-specific questions								
I feel limited when playing soccer after the ACL injury.	62 (54) ^d	10 (20) ^f	<.001					
I cannot perform at the same level as before the ACL injury when playing soccer.	64 (56) ^d	17 (34) ^f	.027					

^aValues are reported as median (interquartile range; range) or n (%) unless otherwise stated. Bolded values indicate statistically significant between-group differences ($P < .05$). ACL, anterior cruciate ligament; IKDC-SKF, International Knee Documentation Committee Subjective Knee Form.

^bP values reported for between-group comparisons between players with ACL reconstruction and controls at baseline.

^cP values reported for between-group comparisons between players with ACL reconstruction and controls at the 2-year follow-up.

^dn = 114, missing data from 3 players.

^en = 115, missing data from 2 players.

^fn = 50, missing data from 1 player.

clinical conundrum is (1) when is it safe for a patient to return to sport after ACLR and (2) who will achieve a favorable outcome. Many young athletes return to knee-strenuous sports after ACLR, often without recovering sufficient muscle function.⁷ Many young female soccer players, with and without ACLR, have movement asymmetries and a high knee abduction moment,¹² which might predispose them to increased risk for primary²¹ and secondary ACL injury.^{23,31}

Functional performance and individualized rehabilitation are important after ACLR. However, it is also important to allow the knee to recover. One-fourth of the players in our cohort had played their first match within 9 months after ACLR. At least 9 months is needed to minimize the risk of new knee injuries after ACLR and should be the minimum time before clearance to return to cutting and pivoting sports.¹⁷ It may be appropriate for all soccer players to have follow-up meetings with their physical therapist after return to sport to evaluate function. Also, the surgery procedure and graft choice could be developed and discussed. Ninety-seven percent of the players had reconstruction with a hamstring autograft; perhaps the use of other grafts¹⁵ or extra-articular augmentation¹⁸ could reduce the rerupture rate, but more research is needed.

Our study includes a homogeneous cohort of female soccer players, with controls recruited from the same soccer teams as the players with ACL-reconstructed knees. Most studies following soccer players with ACLR did not include a knee-healthy control group.^{1,9} Without a control

group, it is difficult to draw conclusions regarding the relative contribution of the ACL injury and other social factors to the decision to quit playing soccer. Another strength is the prospective data collection, which reduces the risk of recall bias. In addition, the 2-year follow-up data were almost complete, with only 1 to 3 missing answers for questions on knee function, activity level, and satisfaction with knee function. Importantly, we had complete data regarding new knee injuries and soccer participation. In our study, we evaluated all new traumatic and nontraumatic knee injuries after ACLR and return to soccer. To our knowledge, this is the first study to evaluate common knee problems after ACLR, such as pain, instability, and locking, in an active female soccer population. This is important because injuries other than a new ACL injury may lead to significant morbidity and could be career ending for a soccer player. Separate analyses of candidate risk factors for subsequent injury of female soccer players after ACLR are planned and will be presented in another article.

Some limitations should be acknowledged. First, the response rate from the SNKLR was 66%, and only 132 of the 362 who answered (36%) fulfilled the inclusion criteria. To include as many active players meeting our inclusion criteria as possible and to capture players with ACLR who were not registered in the SNKLR, an advertisement was made on the homepages of 3 regional soccer districts. This procedure might have led to a selection bias; however, we believe that the influence on our overall results is minimal. Second, almost all players had ACLR with

a hamstring autograft, which prohibits comparison and extrapolation to other graft options. Players were asked regularly during the 2-year follow-up to report if they had problems with the knee, if they sought medical attention, and if they had any other injuries. The number of injuries and the absence from soccer play were registered. However, the amount of soccer exposure was not registered. Therefore, we cannot report the risk of sustaining an injury attributed to soccer exposure.

CONCLUSION

Female soccer players with ACLR had nearly a 5-fold-higher rate of new ACL injuries and a 2- to 4-fold-higher rate of other new knee injuries, quit soccer to a higher degree, and decreased their activity level more as compared with knee-healthy controls.

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