

# A Comparison of Psychological Readiness and Patient-Reported Function Between Sexes After Anterior Cruciate Ligament Reconstruction

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**Context:** Postoperative functional and return-to-sport outcomes after anterior cruciate ligament reconstruction (ACLR) differ by sex. However, whether sex disparities are observed in patient-reported outcome measures (PROMs) before return to sport after ACLR is unclear.

**Objectives:** To compare common PROMs between young men and women who had not yet returned to sport after ACLR.

**Design:** Cross-sectional study.

**Setting:** University laboratory.

**Patients or Other Participants:** Forty-five young men (age =  $18.7 \pm 2.7$  years, time since surgery =  $6.8 \pm 1.4$  months) and 45 women matched for age ( $\pm 1$  year) and time since surgery ( $\pm 1$  month; age =  $18.8 \pm 2.8$  years, time since surgery =  $6.9 \pm 1.4$  months) with ACLR participated.

**Main Outcome Measure(s):** Participants completed the Tegner Activity Scale, ACL Return to Sport After Injury scale, Tampa Scale of Kinesiophobia, International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Score, and Knee Injury and Osteoarthritis Outcome Score (KOOS). The PROMs were compared between men and women using Mann-Whitney *U* tests. Odds ratios were calculated to evaluate the

odds of a male reporting a PROM value above the previously established normative value as compared with a female.

**Results:** Sex differences were present for the IKDC score ( $P = .01$ ) and KOOS Pain score ( $P = .04$ ) but not for the Tegner Activity Scale ( $P = .22$ ), ACL Return to Sport After Injury scale score ( $P = .78$ ), Tampa Scale of Kinesiophobia score ( $P = .64$ ), or other KOOS subscales ( $P$  values =  $.40$  to  $.52$ ). The odds of reporting values above normative levels differed only for the IKDC score (odds ratio = 2.72, 95% confidence interval = 1.16, 6.38).

**Conclusions:** After ACLR, young men and women reported similar levels of knee-related function, fear of movement, and readiness for return to sport and were equally likely to meet clinically meaningful normative values before return to sport. Overreliance on patient reports or objective functional outcomes in evaluating patient progress and readiness for return to sport after ACLR may limit clinicians in their ability to comprehensively evaluate and develop individualized interventional approaches that optimize patient outcomes.

**Key Words:** ACL Return to Sport After Injury scale, fear of movement, fear of reinjury, symptoms, quality of life

## Key Points

- Young men and women matched for age and time since surgery reported similar scores and similar odds of meeting established clinical cutoff scores on the ACL Return to Sport After Injury scale and the Tampa Scale of Kinesiophobia.
- Young men demonstrated better scores on the International Knee Documentation Committee instrument (Cohen  $d = 0.48$ ) and Knee Injury and Osteoarthritis Outcome Score Pain subscale (Cohen  $d = 0.25$ ) than their young women counterparts.
- Young men had 2.72 times greater odds of reporting International Knee Documentation Committee scores equal to or greater than sex-specific normative values than the matched cohort of young women.
- Integration of objective evaluations of lower extremity strength, functional movement, and patient-reported outcomes is essential to effectively evaluate clinical success among this clinical population.

Rates of anterior cruciate ligament (ACL) injury and ACL reconstruction (ACLR) have increased more than 60% in the past 20 years. During this time, physically active women under 20 years of age experienced the highest rates of noncontact ACL injuries and the greatest increase in the total number of ACLRs.<sup>1,2</sup> More

concerning is the fact that 24% to 30% of young female athletes who do return to sport will experience a second ACL injury to the ipsilateral or contralateral knee within 2 years of ACLR, which is more than double the rate for young male athletes.<sup>2,3</sup> In addition, female patients tend to have worse functional outcomes,<sup>4</sup> are less likely to return to

sport,<sup>5</sup> and are more likely than male patients to develop posttraumatic osteoarthritis.<sup>6</sup> This is further supported by 2 prospective studies<sup>4,7</sup> that indicated female patients described worse pain at 1 year post-ACLR as well as less ability than male patients to participate in sport and recreation at 1, 2, and 5 years post-ACLR. These clear sex-related disparities in clinical outcomes highlight the need to identify modifiable clinical factors that may be targeted, specifically among female patients, during rehabilitation to improve the short- and long-term outlook for these patients attempting a return to sport after ACLR. A growing body of evidence has established clinically meaningful disparities between male and female patients in quadriceps strength,<sup>8</sup> movement quality,<sup>9</sup> and functional performance<sup>10</sup> after ACLR. In all cases, these findings have shown better recuperation among male patients of similar ages and activity levels.

The clinical assessment of psychological outcomes has become increasingly common during the rehabilitation process after ACLR.<sup>11,12</sup> This has most commonly been done using patient-reported outcome measures (PROMs) that evaluate anxiety, confidence, fear of reinjury, and self-efficacy.<sup>11,12</sup> In support of these assessments, improved psychological readiness for return to sport and reduced fear of movement, assessed 4 to 6 months after ACLR via the ACL Return to Sport after Injury (ACL-RSI) scale and Tampa Scale of Kinesiophobia (TSK-11), respectively, have been linked to successful return to preinjury levels of sport at 1 year and a reduced risk of subsequent ACL injury at 2 years after ACLR among young and active individuals.<sup>11,12</sup> However, according to the authors of a recent review,<sup>13</sup> the psychological response to ACLR may not be consistent between the sexes. Female patients tended to describe greater psychological distress and lesser self-efficacy than male patients at similar time points after ACLR.<sup>13</sup> Whereas the ACL-RSI scale and TSK-11 are commonly used to assess psychological readiness for return to sport among individuals with ACLR, little is known about the influence of patient sex on these outcome measures. This factor is especially important given the previously described sex-based disparities in functional outcomes,<sup>10</sup> rates of return to sport,<sup>5</sup> and rates of reinjury,<sup>2</sup> all of which have been linked to psychological outcomes among this clinical population. A clear understanding of sex differences in ACL-RSI and TSK-11 scores and examinations of the relationships between these outcomes and patient-reported function will assist in identifying the importance of psychological outcomes in perceived function among male and female patients with recent ACLR.

Due to reported disparities in return to sport rates, reinjury rates, and long-term joint health between men and women with ACLR, it is essential to identify whether these sex-related differences are present while patients are still engaged in clinical care. If this is the case, then sex-specific evaluation and treatment strategies aimed at improving patient-reported outcomes and mitigating the risk of poor clinical outcomes among female patients after ACLR can be implemented. Therefore, the purpose of our study was to determine differences in patient-reported knee function, fear of movement, and psychological readiness for return to sport between male and female patients matched for age and time since surgery who had not yet returned to sport after ACLR. We hypothesized that female patients would

**Table 1. Participants' Demographic and Surgical Characteristics<sup>a</sup>**

Characteristic	Males	Females	P Value
Participants, No.	45	45	NA
Age, y	18.7 ± 2.7	18.8 ± 2.8	.94
Body mass index, kg/m <sup>2</sup>	25.1 ± 4.4	23.5 ± 3.4	.08
Preinjury Tegner Activity Level score <sup>b</sup>	9.0 [7.0, 10.0]	9.0 [6.0, 10.0] <sup>a</sup>	.34
Graft source, HSA/BTB	24/21	24/21	.99
Months since surgery	6.8 ± 1.4	6.9 ± 1.4	.59

Abbreviations: BTB, bone-patellar tendon-bone graft; HSA, hamstrings autograft; NA, not applicable.

<sup>a</sup> Reported as mean ± SD except where indicated.

<sup>b</sup> Data are reported as median [minimum, maximum].

report worse knee function, greater fear of movement, and less psychological readiness for return to sport than male patients. The exploratory purpose of our research was to evaluate the odds of a male patient meeting clinically acceptable thresholds for knee-related function, fear of movement, and psychological readiness for sport when compared with his female counterpart and to determine the strength of the relationships among these variables.

## METHODS

This investigation was a multisite cross-sectional study in which all reported measures were collected during a single testing session. This research was approved by Creighton University, Michigan State University, the University of North Carolina at Chapel Hill, and the University of Wisconsin—Madison Institutional Review Boards for Human Subjects or Health Science Research. All participants gave written informed consent before testing.

A total of 45 pairs of men and women matched for age ( $\pm 1$  year) and time since surgery ( $\pm 1$  month) with a history of primary, unilateral ACLR were enrolled in this study (Table 1). Demographic (age and sex) and surgical (graft source and date of surgery) characteristics were provided by participants at intake. Participants were included in the study if they were between 13 and 25 years old; had a history of primary, unilateral ACLR using patellar tendon or hamstrings autograft tissue; were between 5 and 9 months post-ACLR; and had not yet fully returned to sport. Participants were excluded if they had a history of lower extremity injury in the previous 6 weeks, a neurologic condition that might affect lower extremity strength assessment, or either a multiligament injury that required reconstruction or an articular cartilage injury that required surgical intervention.

All participants completed 5 PROMs after the intake and informed consent processes were conducted: (1) Tegner Activity Scale (TAS),<sup>14</sup> (2) ACL-RSI,<sup>15</sup> (3) TSK-11,<sup>16</sup> (4) International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Score,<sup>17,18</sup> and (5) Knee Injury and Osteoarthritis Outcome Score (KOOS).<sup>19</sup> The TAS was used descriptively in this study. Scoring criteria and normative or cutoff values for all outcomes in this study, except for the TAS, can be found in Supplemental Table 1 (available online at <http://dx.doi.org/10.4085/1062-6050-2020-20.S1>). The ACL-RSI was used to assess psychological readiness for return to sport and included items that described an individual's emotions, confidence in performance, and risk appraisal related to reengagement in sport

**Table 2. Sex Comparisons of Common Patient-Reported Outcomes Among Participants After Anterior Cruciate Ligament Reconstruction<sup>a</sup>**

Outcome	Males	Females	P Value	Cohen d Effect Size (95% CI)
Current Tegner Activity Scale score	6.0 [4.0, 10.0]	6.0 [3.0, 10.0]	.22	NA
Anterior Cruciate Ligament Return to Sport after Injury score	82.5 [35.0, 100.0]	75.0 [5.8, 98.3]	.86	0.06 (−0.35, 0.47)
Tampa Scale of Kinesiophobia score	19.0 [11.0, 33.0]	20.0 [11.0, 29.0]	.76	0.09 (−0.32, 0.51)
International Knee Documentation Committee subjective score	88.5 [50.0, 100.0]	79.3 [47.1, 98.9]	.01 <sup>b</sup>	0.48 (0.06, 0.90)
Knee Injury and Osteoarthritis Outcome Score				
Pain	97.2 [61.1, 100.0]	94.4 [72.2, 100.0]	.04 <sup>b</sup>	0.25 (−0.17, 0.66)
Symptoms	71.4 [42.9, 100.0]	67.9 [39.3, 100.0]	.52	0.10 (−0.32, 0.51)
Activities of Daily Living	100.0 [73.5, 100.0]	100.0 [80.9, 100.0]	.46	0.05 (−0.37, 0.46)
Sport and Recreation	95.0 [50.0, 100.0]	90.0 [50.0, 100.0]	.40	0.05 (−0.37, 0.46)
Quality of Life	62.5 [32.3, 100.0]	62.5 [12.5, 100.0]	.50	0.16 (−0.26, 0.57)

Abbreviation: NA, not applicable.

<sup>a</sup> All analyses were completed using Mann-Whitney *U* tests. Data were reported as median [minimum, maximum].

<sup>b</sup> Indicates a between-sexes difference ( $P < .05$ ).

after ACLR. Scores on the ACL-RSI below 62 and 77 have been reported to predict failed return to the preinjury level of sport<sup>20</sup> and subsequent ACL injury within 1 year of ACLR, respectively. Unfortunately, sex-specific cutoff values have not been established and, therefore, all comparisons in this analysis were based on the general recommendations for individuals with ACLR. We used the TSK-11 to assess fear of movement associated with the individual's ACLR; a score of greater than 17 at the time of clearance for return to sport has been linked to 3.73 times greater odds of subsequent ACL injury within 1 year of assessment.<sup>12</sup> The IKDC subjective score provided a single, general estimate of patient-reported knee function that takes into account symptoms and function after ACLR. Sex-specific normative values have been established for young individuals with and those without a history of knee injury.<sup>21</sup> Consistent with Logerstedt et al,<sup>22</sup> we considered the sex-specific value corresponding to the 15th percentile as indicating normal knee function. Last, the KOOS subscale scores were used to evaluate sex-related differences in patient-reported pain, symptoms, activities of daily living, sport and recreation, and quality of life. Sex-specific normative values have been established for the KOOS subscales among individuals without a history of knee-joint injury, and the corresponding mean value for each subscale was considered indicative of a normal subscale score.<sup>23</sup> The TAS was primarily used to describe the peak physical activity intensity in which participants were engaged before ACL injury.

Sample demographics were compared between the sexes using 1-way analyses of variance except for graft sources, which were compared using a Fisher exact test. Between-sexes comparisons of Tegner activity level, ACL-RSI score, TSK-11 score, and KOOS subscale scores were conducted using Mann-Whitney *U* tests. The magnitudes of between-groups differences were assessed via Cohen *d* effect sizes with 95% confidence intervals (CIs). Odds ratios and 95% CIs were calculated to evaluate the odds of a male participant providing a given patient-reported outcome value above the previously established clinical cutoff or normative value compared with a female participant. Sex-specific normative values established normal function with respect to the IKDC subjective score and the KOOS subscales (Supplemental Table 1). All statistical analyses were performed using SPSS (version

24.0; IBM Corp, Armonk, NY), and the a priori  $\alpha$  level for between-sexes comparisons was  $P < .05$ .

A priori sample-size estimates were based on moderate effects for sex on the KOOS Sport and Recreation score among 4438 individuals 12 months after ACLR.<sup>4</sup> Based on these estimates, a minimum of 72 total participants (36 per group) were required to detect differences between groups in this study. Sample-size estimation was completed using G\*Power (version 3.1; Heinrich-Heine-Universität, Düsseldorf, Germany).<sup>24</sup>

## RESULTS

Male and female participants did not significantly differ by age, body mass index, preinjury activity level, graft source, or time since surgery (Table 1). Between-groups comparison of PROMs indicated sex differences for the IKDC subjective score ( $P = .01$ ) and KOOS Pain subscale ( $P = .04$ ), whereas no differences were evident in ACL-RSI score ( $P = .86$ ), TSK-11 score ( $P = .76$ ), or any of the other KOOS subscale scores ( $P$  values = .40 to .52; Table 2). Male participants were at 2.72 (95% CI = 1.16, 6.38) times greater odds of reporting IKDC scores equal to or greater than age- and sex-specific normative values than were female participants. Male participants were not at greater odds than female participants of reporting values above clinical cutoffs for the ACL-RSI or TSK-11 scores or age- and sex-specific normative values for the KOOS subscale scores (Table 3).

## DISCUSSION

The primary purpose of our study was to evaluate sex differences in PROMs of knee function, fear of movement, and psychological readiness for sport among individuals who had not yet returned to sport after ACLR. Young men demonstrated better IKDC scores (Cohen *d* = 0.48), 2.72 times greater odds of scores equal to or greater than sex-specific normative values, and better KOOS Pain subscale scores (Cohen *d* = 0.25) than young women (Table 2). Contrary to our hypothesis, male and female participants did not differ in ACL-RSI, TSK-11, or KOOS subscale scores except on the Pain subscale at this important clinical time point (Table 2). Similarly, male and female participants displayed similar odds of achieving established clinical cutoff scores or normative values on the PROMs

**Table 3. Sex-Specific Odds of Achieving Clinically Important Cutoff Scores After Anterior Cruciate Ligament Reconstruction**

Instrument	Sex	Met Cutoff Total	n (%)		Odds Ratio (95% CI)
			Did Not Meet Cutoff Total	Fisher Exact <i>P</i> Value	
Anterior Cruciate Ligament Return to Sport after Injury scale score					
>62.0	Male	29 (64.4)	16 (35.6)	1.00	1.00 (0.42, 2.37)
	Female	29 (64.4)	16 (35.6)		
>77.0	Male	25 (55.6)	20 (44.4)	.53	1.43 (0.62, 3.28)
	Female	21 (46.7)	24 (53.3)		
Tampa Scale of Kinesiophobia score					
	Male	14 (31.1)	31 (68.9)	.99	0.90 (0.37, 2.19)
	Female	15 (33.3)	30 (66.7)		
International Knee Documentation Committee Subjective score					
	Male	27 (60.0)	18 (40.0)	.03	2.72 (1.16, 6.38)
	Female	16 (35.6)	29 (64.4)		
Knee Injury and Osteoarthritis Outcome score					
Pain					
	Male	33 (73.3)	12 (26.7)	.12	2.20 (0.91, 5.33)
	Female	25 (55.6)	20 (44.4)		
Symptoms					
	Male	9 (20.0)	36 (80.0)	.99	1.16 (0.40, 3.33)
	Female	8 (17.8)	37 (82.2)		
Activities of Daily Living					
	Male	39 (86.7)	6 (13.3)	.99	0.81 (0.23, 2.88)
	Female	40 (88.9)	5 (11.1)		
Sport and Recreation					
	Male	30 (66.7)	15 (33.3)	.66	1.33 (0.56, 3.15)
	Female	27 (60.0)	18 (40.0)		
Quality of Life					
	Male	13 (28.9)	32 (71.1)	.46	1.63 (0.61, 4.31)
	Female	9 (20.0)	36 (80.0)		

(Table 3). With these results, we showed that despite consistently poorer objective outcomes during the first year after ACLR, women were not more likely to perceive worse functional or psychological effects of ACLR than men during the terminal phases of their rehabilitation.

Men and women reported similar ACL-RSI and TSK-11 scores (Table 2) and were equally likely to reach clinically meaningful cutoff scores for these measures (Table 3) within the first 9 months after ACLR. This absence of sex differences in fear of movement and psychological readiness is interesting, given that authors<sup>6</sup> of a recent review of the literature indicated that men and women coped with ACL injury and experienced the process of rehabilitation differently from psychological and psychosocial perspectives. Although the literature in this area is still developing, men have tended to display greater self-efficacy after surgery, whereas women described greater anxiety related to recovery and return to activity after ACLR.<sup>13</sup> We hypothesized that these variations would ultimately result in clinically meaningful differences in fear of movement and readiness for return to sport during the terminal phases of rehabilitation; however, our results did not support these hypotheses. Patients who fail to meet clinically important cutoff scores on the ACL-RSI or TSK-11 scales during rehabilitation may reflect a variety of psychological barriers that may or may not be informed by their sex, gender identification, or other factors (eg, strength, jumping performance, movement biomechanics) that we did not examine in this study. Therefore, if a patient exhibits fear of movement or a lack psychological readiness on the basis of these scales, it may be beneficial to evaluate a broad complement of psychological outcomes (ie, locus of control, self-efficacy, anxiety, athletic identity, and fear of reinjury) postoperatively in order to develop an individualized patient profile that can guide selection of the best treatment approach for the person's needs.

Sex-based differences were present for the KOOS Pain subscale but were not identified for any of the other KOOS subscale scores (Table 2). This finding is consistent with the work of Ageberg et al,<sup>4</sup> who also identified sex differences in the KOOS Pain score among individuals who were 1 year post-ACLR; however, the sex difference they reported was no longer apparent at the 2-year follow-up. In our work, although a significant ( $P = .04$ ), small-magnitude (Cohen  $d = 0.25$ ) difference occurred between the sexes, the odds of a male or female participant describing pain scores equal to or better than sex-specific normative values did not differ (odds ratio = 2.20, 95% CI = 0.91, 5.33). In addition, women reported moderately worse IKDC scores (mean difference = 5.5 points, Cohen  $d = 0.48$ ) than men did, which is both interesting and contrary to previous literature in this area.<sup>25</sup> Similarly, whereas previous researchers<sup>4</sup> have observed sex differences in sport and recreation and quality-of-life subscale scores, it is important to note that these differences, reported 1 and 2 years post-ACLR, were small in magnitude (Cohen  $d$  values = 0.05 to 0.16, mean difference = 1.4 to 4.4 points) and the change between time points did not exceed the minimal clinically important difference ( $\geq 8$  points). Furthermore, sex did not significantly influence the odds of participants achieving important sex- and age-specific normative scores on any KOOS subscales (Table 3). These results suggest that although female sex may have a small effect on general knee function, the magnitude of difference may not be large enough to be detected consistently during the terminal phases of rehabilitation before return to activity after ACLR. We suggest that overreliance on perceived knee function, without the use of evidence-based functional assessments,<sup>26</sup> may result in rehabilitative decisions, based on incomplete information, that do not adequately address the needs of individual patients with ACLR while taking into account demographic considerations.<sup>3,27</sup>

The cross-sectional research design of our work allowed for an expanded sample size but introduced heterogeneity into the patient population, specifically in the time since surgery at the point of study enrollment. Our participants were 5 to 9 months post-ACLR, which, although an important clinical period, can be a highly variable time for functional recovery, ranging from reintegration into activities of daily living to the transition to sport-specific activities. Narrowing of the inclusion criteria according to functional progress instead of time since surgery and a prospective research design to allow assessment of outcomes across the therapeutic window would enable future researchers to overcome these limitations. Furthermore, rehabilitation access, intensity, and compliance were not controlled in this study. Postsurgical rehabilitation was performed at several facilities, local to each data-collection site, and under the direction of numerous providers (eg, physical therapist, athletic trainer), thereby introducing additional sources of variation to our data. Standardized rehabilitation programs would remove these sources of clinical variations.

## CONCLUSIONS

Men and women reported similar knee-related function, fear of movement, and readiness for return to sport despite consistent evidence that women experienced worse objectively measured clinical outcomes after ACLR. Overreliance on patient reports or objective functional outcomes in evaluating patient progress and readiness for return to sport after ACLR may limit a clinician's ability to comprehensively evaluate and develop individualized interventional approaches that optimize patient outcomes. Integration of objective evaluations of lower extremity strength, functional movement, and patient-reported outcomes are essential for effectively evaluating clinical success among this population.

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