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Composite Psychosocial Risk Based on the Fear Avoidance Model in Patients Undergoing Anterior Cruciate Ligament Reconstruction: Cluster-Based Analysis

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Abstract

Objectives—To examine associations between preoperative fear-avoidance model (FAM) risk subgroup status and patient expectation of surgical success with postoperative outcomes at 6 and 12 months after anterior cruciate ligament reconstruction (ACLR).

Design—Cohort study.

Setting—Academic medical center.

Participants—54 patients (25 females) undergoing unilateral ACLR.

Main Outcome Measures—Cluster analysis distinguished FAM risk subgroups based on preoperative fear of movement/reinjury, self-efficacy, and pain catastrophizing. Preoperative expectation for surgical success was assessed with a numeric rating scale. Six and 12-

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month outcomes included Subjective Patient Outcomes for Return to Sport, Knee Injury and Osteoarthritis Outcome Score (KOOS) sports/recreation and quality of life, and International Knee Documentation Committee (IKDC) Subjective Knee Form.

Results—Thirteen (24%) patients were “moderate-to-high FAM risk.” Moderate-to-high FAM risk patients had lower odds of return to sport at 12 months (OR=.3, $p=.05$) and lower KOOS sports/recreation at 6 months (st. beta=-.27, $p=.05$), KOOS quality of life at 12 months (st. beta=-.42, $p=.007$), and IKDC at 6 (st. beta=-.29, $p=.04$) and 12 months (st. beta=-.47, $p=.001$). Higher expectation was associated with lower 6-month IKDC (st. beta=-.36, $p=.008$) and 12-month KOOS quality of life (st. beta=-0.29, $p=.05$).

Conclusions—Preoperative FAM risk influences patient-reported outcomes and return to sport at 6 and 12 months.

Keywords

Knee injuries; patient expectations; psychological adaptation; return to sport

INTRODUCTION

Psychosocial characteristics are risk factors for poor rates of return to sport and patient-reported outcomes after anterior cruciate ligament reconstruction (ACLR) (Arder, 2015; Arder, Taylor, Feller, & Webster, 2013; Forsdyke, Smith, Jones, & Gledhill, 2016; Hsu, Meierbachtol, George, & Chmielewski, 2017). Several authors have highlighted fear-avoidance model (FAM) factors such as fear of movement/reinjury, pain catastrophizing, and self-efficacy for their associations with recovery after ACLR (Arder, 2015; Chmielewski & George, 2019; Nwachukwu et al., 2019; te Wierike, van der Sluis, van den Akker-Scheek, Elferink-Gemser, & Visscher, 2013). The majority of ACLR studies investigating psychosocial factors have been cross-sectional (Beischer, Hamrin Senorski, Thomee, Samuelsson, & Thomee, 2019; Lentz et al., 2009; Lentz et al., 2012; Tripp, Stanish, Ebel-Lam, Brewer, & Birchard, 2007) or examined associations over the postoperative period (Arder, Taylor, Feller, Whitehead, & Webster, 2015; Chmielewski et al., 2011; Hamrin Senorski et al., 2017; Langford, Webster, & Feller, 2009; Lentz et al., 2015; McCullough et al., 2012; Nwachukwu et al., 2019; Paterno, Flynn, Thomas, & Schmitt, 2018), which limits conclusions related to preoperative screening or prognosis. Additionally, few studies have examined preoperative FAM risk factors and their relationship with return to sport or activity (Arder, Taylor, Feller, Whitehead, & Webster, 2013; Thomee et al., 2008). Arder et al. (2013) found preoperative fear of movement/reinjury and psychological readiness were significant predictors of return to sport, while Thomee et al. (2008) found significant associations between preoperative self-efficacy and 1-year physical activity. There remains a significant knowledge gap regarding preoperative risk based on FAM factors for return to sport after ACLR. Individual self-report measures representing single psychosocial constructs are often used to determine relationships between preoperative FAM factors and postoperative outcomes. Examining more complex profiles may provide additional insight into FAM risk factor influence. Clustering methods consider the composite influence of multiple psychosocial factors through subgrouping based on similar cohort characteristics. An empirically-derived psychosocial cluster approach has been undertaken

in patients with low back pain (Beneciuk, Robinson, & George, 2012, 2015; Nisenzon et al., 2014; Rabey, Smith, Beales, Slater, & O'Sullivan, 2016) and chronic pain (Boersma & Linton, 2006; Larsson, Gerdle, Bernfort, Levin, & Dragioti, 2017; Widerstrom-Noga, Felix, Cruz-Almeida, & Turk, 2007). Examining the influence of a preoperative FAM risk subgroup rather than only single FAM measures on ACLR outcomes has the potential to provide a more comprehensive prognostic assessment.

A related and rarely studied contextual factor is preoperative expectation of surgical recovery. While not a central tenet within the FAM, patient expectations predict functional outcomes in various orthopaedic surgery populations (Bialosky, Bishop, & Cleland, 2010; Coronado, Seitz, Pelote, Archer, & Jain, 2018; Yee, Adjei, Do, Ford, & Finkelstein, 2008). A greater understanding of the relative influence of preoperative FAM factors and expectation for surgical success on ACLR recovery can potentially form optimal screening methods for identifying athletes at risk for not returning to sport. Such screening methods can also inform risk mitigation strategies.

The primary objective of this study was to examine the association between preoperative composite FAM risk (fear of movement/reinjury, self-efficacy, pain catastrophizing) and patient-reported ACLR outcomes at 6 and 12 months using a cluster-based approach. Our secondary objective was to examine the association of preoperative patient expectation for surgical success and 6- and 12-month patient-reported outcomes. We hypothesized that higher FAM risk status and patient expectation for surgical success would be associated with poor return to sport, sports participation, knee function, and quality of life after ACLR.

MATERIAL AND METHODS

Study Design

This was a prospective cohort study of patients undergoing primary unilateral ACLR. The Institutional Review Board of Vanderbilt University Medical Center approved the study.

Patients

Consecutive English-speaking patients, between the ages of 12 and 33 years, were recruited preoperatively over a 14-month period from a single academic medical center. Inclusion criteria were: 1) enrollment into the parent Multicenter Orthopaedic Outcomes Network (MOON) study (Wright et al., 2007); 2) undergoing primary unilateral ACLR; 3) injured while playing a sport; and 4) no history of prior surgery to either knee. Patients undergoing simultaneous bilateral ACLR, revision ACLR, or surgical repair of additional knee ligaments were excluded.

Procedures

After obtaining written informed consent (or assent with parental consent for minors), patients completed a questionnaire for age, sex, race, height and weight, years of education, depression (scores greater than 10 on the 9-item Patient Health Questionnaire (Kroenke, Spitzer, Williams, & Lowe, 2010; Richardson et al., 2010; Spitzer et al., 1994)), preoperative activity level (Marx Activity Rating Scale (Marx, Stump, Jones, Wickiewicz, & Warren,

2001)), expectation for surgical success, and primary type of sport and sport level. Preoperative fear of movement/reinjury, self-efficacy, and pain catastrophizing were assessed using the Tampa Scale for Kinesiophobia (TSK) (Roelofs, Goubert, Peters, Vlaeyen, & Crombez, 2004), Knee Self-Efficacy Scale (K-SES) (Thomee et al., 2006), and Pain Catastrophizing Scale (PCS) (Sullivan, Bishop, & Pivik, 1995), respectively. Preoperative outcomes of sports participation and quality of life were assessed with Knee Injury and Osteoarthritis Outcome Score (KOOS) (Roos, Roos, Lohmander, Ekdhahl, & Beynnon, 1998) sports/recreation and quality of life subscales, and knee function with the International Knee Documentation Committees (IKDC) Subjective Knee Form (Irrgang et al., 2001). Follow-up assessment was conducted by mail on printed forms at 6 and 12 months following surgery using the same validated outcome measures. Return to sport was assessed at 6 and 12 months with the Subjective Patient Outcome for Return to Sports (SPORTS) score (Blonna, Lee, & O'Driscoll, 2010).

Surgical and Rehabilitation Procedures—Surgery was performed by a single board-certified orthopaedic surgeon (K.P.S.) Surgeon discretion was used for graft choice and concurrent meniscal procedures. Articular cartilage pathology in the medial, lateral, and patellofemoral compartments was documented. Surgical data were extracted using a questionnaire and the medical record. Following surgery, all patients underwent the same prescribed physical therapy protocol using MOON ACLR rehabilitation guidelines (Wright et al., 2015). These published guidelines were informed by best evidence and content experts. The phased approach followed functional progression criteria. The duration of physical therapy was estimated to involve a total of 16 to 24 visits (minimum of 6 visits), with most visits occurring within the first 6 weeks. Compliance to postoperative physical therapy was not documented.

FAM Measures

Fear of movement/reinjury—The TSK is a valid and reliable measure of fear of movement/reinjury in surgical patients and patients with various musculoskeletal conditions (Archer et al., 2012; French, France, Vigneau, French, & Evans, 2007; Kori, Miller, & Todd, 1990; Roelofs et al., 2004; Swinkels-Meewisse et al., 2006). The TSK has been used in adolescent and adult patients with knee injuries, including ACLR (Chmielewski & George, 2019; Selhorst, Fernandez-Fernandez, Schmitt, & Hoehn, 2020). We used the 17-item version, with scores ranging from 17 to 68. Higher TSK scores indicate higher fear of movement/reinjury.

Self-Efficacy—The K-SES is a valid and reliable measure that assesses four domains of self-efficacy (daily activities, sports activities, knee function activities, knee function in future) (Thomee et al., 2006, 2007). The K-SES has been used as a measure of self-efficacy in adolescent patients after ACLR (Beischer et al., 2019). We used the 6-item subscale for knee function activities. The K-SES knee function activities subscale assesses how confident patients are about performing functional activities at that moment in time, despite knee pain/discomfort. K-SES knee function subscale scores range from 0 to 10, with higher scores indicating greater confidence in knee function.

Pain Catastrophizing—The PCS is a valid and reliable measure that assesses unhelpful catastrophic thoughts or emotions about pain (Sullivan et al., 1995). PCS scores have shown associations with pain intensity, patient-reported disability, negative affect, and pain-related fear (Osman et al., 2000; Sullivan et al., 1995). The PCS has been assessed in adolescent and adult patients with knee injuries, including ACLR (Chmielewski & George, 2019; Selhorst et al., 2020; Tripp, Stanish, Reardon, Coady, & Sullivan, 2003). The PCS contains 13 items with scores ranging from 0 to 52. Higher PCS scores indicate greater pain catastrophizing.

Expectation for Surgical Success

Patients rated their preoperative expectation of having a successful surgery on a scale from 1 to 10, with 1 indicating low expectation and 10 indicating high expectation. We used a modified scale similar to previously reported expectation assessments of overall surgical success (Haanstra et al., 2012).

Outcome Measures

Return to sport—The single-item SPORTS score was used to assess a participant's return to sport status (Blonna et al., 2010). The SPORTS score has excellent test-retest reliability and good concurrent validity with moderately high correlations with the KOOS sports/recreation subscale and Lysholm scale in patients after ACLR (Blonna et al., 2012). For the SPORTS score, patients select whether they can 1) perform same sport at same level of effort and performance as before onset of impairment, and with no pain; 2) perform same sport at same level of effort and performance as before onset of impairment, but with pain; 3) perform same sport at same level of effort but reduced performance level compared to before onset of impairment; 4) perform same sport, but at reduced levels of effort and performance compared to before onset of impairment; or 5) unable to return to the same sport.

Sports Participation and Quality of Life—The KOOS was used to assess sports participation and quality of life (Roos et al., 1998). The KOOS consists of five subscales and was developed for use in a young, highly active population with knee injuries (Roos et al., 1998). KOOS subscales have good reliability and validity in patients with knee injuries (Roos & Lohmander, 2003; Roos et al., 1998; Roos & Toksvig-Larsen, 2003). For this study, we considered the 5-item sports/recreation and 4-item quality of life subscales as outcomes. KOOS subscale scores range from 0 to 100, with higher scores indicating higher sports participation or quality of life. The minimum clinically important difference (MCID) for the KOOS subscales is 8 points (Roos & Lohmander, 2003).

Knee Function—The 18-item IKDC was used to assess patient-reported perceptions of knee pain, stiffness, swelling, joint locking and instability, and function (Irrgang et al., 2001). The IKDC demonstrates good internal consistency and test-retest reliability in patients with various knee problems, including ACLR (Greco et al., 2010; Higgins et al., 2007; Irrgang et al., 2001). IKDC scores range from 0 to 100, with higher scores indicating better knee function. The MCID for the IKDC is 9 points (Nwachukwu et al., 2017).

Data Analysis

We performed a two-step cluster analysis to identify preoperative FAM risk subgroups based on fear of movement/reinjury, self-efficacy, and pain catastrophizing. Cluster analysis differentiates cases based on homogenous structures within the data. We did not specify the number of clusters *a priori*. Cluster subgrouping was assessed with a silhouette coefficient and measure of variable contribution. We repeated the cluster analysis with cases randomly sorted to ensure subgroup stability (IBM Corporation, 2016). Independent samples t-tests were used to confirm subgroup differences in FAM variables.

Descriptive statistics were used for generating mean [SD] and proportion (frequency) for continuous and categorical variables, respectively. Multivariable proportional odds regression with odds ratio [95% CI] was used to examine the association between preoperative FAM risk subgroups and expectation for surgical success and 6- and 12-month return to sport. Multivariable linear regression with unstandardized beta [95% CI] and standardized beta were used for 6- and 12-month sports participation, knee function, and quality of life. Separate models were generated for each outcome and time point, and included *a priori* covariates of age, sex, and preoperative outcome score. Marx score was used as a baseline covariate for return to sport and sports participation models (Spindler et al., 2018).

We used IBM SPSS Statistics version 26.0 software (IBM Corporation, Armonk, NY) for cluster subgrouping and linear models and R software (R Foundation for Statistical Computing, Vienna, Austria) using the *rms* package for proportional odds models (R Core Team). Only complete cases were analyzed. Data from 50 (93%) and 51 (94%) patients were available at 6 months and 12 months, respectively. Alpha was set at the .05 level or lower for statistical significance.

RESULTS

Patient Sample

Fifty-four consecutive patients (mean [95% CI] age = 19.1 [17.7; 20.5] years, 29 (54%) males) were enrolled (Table 1). All patients reported a high preoperative level of activity. Most patients were involved in contact sports (soccer, basketball, football) and sports at the high school level. Preoperative expectation for surgical success was high, where 46 (83%) patients rated their expectation as a 9 or higher (median [IQR] = 9.0 [9.0; 10.0]). All patients had bone-patellar tendon-bone autografts. Six (11%) patients had concomitant grade 2 medial collateral ligament (MCL) injury and 1 (2%) patient had a grade 1 MCL injury. No patients had a concomitant lateral collateral ligament involvement. Surgical management of medial and lateral meniscus tears occurred in 13 (24%) and 23 (43%) patients, respectively.

FAM Risk Subgroups

Two subgroups were identified based on a good cluster solution (silhouette coefficient = .5). Thirteen (24%) patients fit within a “moderate-to-high FAM risk” group with higher preoperative scores for fear of movement/reinjury (mean difference = 6.6 [3.1 to 10.2], $p < .001$) and pain catastrophizing (mean difference = 12.0 [8.3 to 15.8], $p < .001$), and

lower preoperative scores for self-efficacy (mean difference [95% CI] = -14.3 [-18.9 to -9.6], $p < .001$) compared to the “low FAM risk” group. The order of importance for differentiating subgroups was pain catastrophizing (relative importance = 1.0), self-efficacy (relative importance = .95), and fear of movement/reinjury (relative importance = .45). Characteristics of the subgroups are presented in Table 1. Patients in the moderate-to-high FAM risk group had lower preoperative expectation for surgical success (mean difference [95% CI] = -.7 [-1.4 to -.1], $p < .05$). There were no other differences between groups.

Multivariable Associations between FAM Subgroup and Outcomes

One (8%) patient in the moderate-to-high FAM risk group returned to their same sport at the same level of effort and performance as before onset of impairment and without pain at 6 months, compared to 9 (24%) patients in the low FAM risk group (Figure 1). Although not statistically significant, the odds of returning to sport at 6 months at each subsequent level of the SPORTS score was 70% lower in the moderate-to-high FAM risk group ($p = .07$) (Table 2).

At 12 months, 2 (18%) patients in the moderate-to-high FAM risk group and 21 (53%) patients in the low FAM risk group were able to return to their same sport at the same level of effort and performance as before onset of impairment and without pain. The odds of returning to sport at 12 months at each subsequent level of the SPORTS score was marginally significant, with 70% lower odds in the moderate-to-high FAM risk group ($p = .05$) (Table 2). Patients in the moderate-to-high FAM risk group reported lower knee function at 6 months ($p = .04$) and 12 months ($p = .001$) and lower quality of life at 12 months ($p = .007$) (Table 3 and Figure 2). Patients in the moderate-to-high FAM risk group also reported marginally lower sports participation at 6 months ($p = .05$). The magnitude of outcome score difference (unstandardized beta in Table 3) between subgroups for 6- and 12-month KOOS subscales and 12-month IKDC exceeded MCID values.

Multivariable Associations between Expectation for Surgical Success and Outcomes

Patients with higher preoperative expectation for surgical success had lower knee function at 6 months ($p = .008$) and marginally lower quality of life at 12 months ($p = .05$) (Table 3). Preoperative expectation was not associated with quality of life at 6 months or return to sport and sports participation at 6 or 12 months ($p > .05$).

DISCUSSION

We examined the association of preoperative FAM risk subgroup status and patient expectation for surgical success and 6- and 12-month outcomes after ACLR. Patients with moderate-to-high FAM risk (24% of sample) had lower odds of return to sport and poorer 6-month sports participation, 6- and 12-month knee function, and 12-month quality of life. We observed an association between preoperative expectation and 6-month knee function and 12-month quality of life. While preliminary, these results suggest preoperative FAM characteristics and expectation are important risk factors to consider in estimating recovery and may suggest a need for targeted strategies.

Overall, 20% of our sample returned to sport at their same effort or performance level and without pain at 6 months, while 45% returned to their sport at this level at 12 months. Return to preinjury sport is estimated between 33% and 66% at or before one year post-operatively (Ardern, Taylor, Feller, & Webster, 2014; Ardern, Webster, Taylor, & Feller, 2011). In another study using the SPORTS score, 32% of participants were able to return to sport at the same level of effort or performance without pain at 5–10 years post-ACL (Blonna et al., 2012). The SPORTS score is designed to assess not only return to sport, but also the level of performance and associated degree of residual impairment. This level of return to sport appraisal provides a more specific assessment of the athlete's return to sport status, however, makes direct comparison with prior reported return to sport rates difficult.

We found 24% of patients exhibited moderate-to-high preoperative FAM risk. Direct comparison to prior ACLR literature is challenging as few studies have reported the proportion meeting high-risk status based on the FAM model. In a small study by Burland et al. (2020), 29% of patients reported high fear of movement/reinjury (TSK scores > 37) at an average of 3.6 years after surgery. The moderate-to-high and low FAM risk subgroups showed improvement in patient-reported outcomes from baseline to 12-months, with significantly less outcome improvement noted in the moderate-to-high risk group over time. This is especially notable when examining the magnitude of difference in outcome scores for the KOOS subscales and IKDC.

Preoperative FAM risk status was an important predictor of 1-year return to sport, knee function, and quality of life. These findings are in line with studies examining independent associations between preoperative fear of movement/reinjury and self-efficacy and postoperative ACLR outcomes (Ardern, Taylor, Feller, Whitehead, et al., 2013; Thomee et al., 2008). Our study demonstrates that a preoperative composite FAM risk subgroup that includes pain catastrophizing is related to multiple outcomes relevant to recovery. Pain catastrophizing and self-efficacy were the most distinguishing subgroup factors. The sports literature frequently highlights the importance of fear (Nwachukwu et al., 2019), especially for return to sport. Fear of movement/reinjury appears as a common preoperative emotion, while elevated pain catastrophizing is less prevalent and, perhaps, a unique state or trait characteristic among a subset of patients (George, Lentz, Zeppieri, Lee, & Chmielewski, 2012). Conflicting evidence exists for the relationship of pain catastrophizing to post-ACLR outcomes (Baranoff, Hanrahan, & Connor, 2015; Chmielewski & George, 2019; Chmielewski et al., 2011; Jochimsen et al., 2020; Pavlin, Sullivan, Freund, & Roesen, 2005; Tichonova, Rimdeikiene, Petruskeviciene, & Lendraitiene, 2016; Tripp et al., 2007). Some studies have shown early postoperative pain catastrophizing (i.e., at 2 to 4 weeks after ACLR) predicted subsequent knee impairment resolution (e.g. 12 weeks) (Chmielewski & George, 2019) and post-rehabilitation pain, function, and quality of life (Tichonova et al., 2016), while other studies did not show significant relationships (Baranoff et al., 2015; Chmielewski et al., 2011). Pavlin et al. (2005) found preoperative pain catastrophizing predicted acute postoperative pain, while Jochimsen et al. (2020) reported preoperative pain catastrophizing was not associated with 6-month pain or KOOS subscale scores. Additional work is needed to confirm the importance of pain catastrophizing as a psychosocial risk factor relative to other established constructs.

Over 80% of patients expected their surgery to be a success. Prior literature has highlighted a similar proportion who expect nearly normal to normal knee function and a return to their pre-injury sport (Feucht et al., 2016; Webster & Feller, 2019). We did not observe an association between preoperative expectation and return to sport as hypothesized. Sonesson et al. (2017) reported no differences between patients who returned or did not return to sport in their preoperative expectation of length of rehabilitation, time to running/jumping, or time to return to sport. In contrast, Ardern et al. (2013) found athletes who expected a longer time to return to sport had a lower chance of returning to sport. We did find preoperative expectation was associated with the IKDC at 6 months and KOOS quality of life subscale at 12 months. However, the association with 12-month quality of life was marginal and should be interpreted with caution.

Psychosocial factors are important considerations within the decision-making process. Preoperative screening may help identify patients at risk for poor outcomes. Based on our study, subgroup classification using multidimensional screening tools rather than single questionnaires may be useful for predicting poor recovery. Multidimensional measures such as the STarTBack and Optimal Screening for Prediction of Referral and Outcome (OSPRO) tools represent clinically feasible composite risk assessments of multiple psychosocial domains for patients with musculoskeletal pain (Hill et al., 2008; Lentz et al., 2016). Use of multidimensional tools can direct more precise management or tailored screening processes to establish prognosis (Van Wyngaarden, Noehren, & Archer, 2019). Similar work is needed investigating the most important screening questions across FAM domains for determining outcomes or management after ACLR. Currently, most preoperative ACLR programs focus on range of motion or strength impairments, and it is unknown whether a preoperative psychosocial intervention can enhance return to sport. Postoperative psychosocial interventions can improve postoperative quality of life, anxiety, and fear of reinjury (Coronado, Bird, et al., 2018; Cupal & Brewer, 2001; Zaffagnini, Russo, Marcheggiani Muccioli, & Marcacci, 2013). Future efforts examining the efficacy of a combined preoperative and postoperative intervention on return to sport are warranted (Coronado et al., 2020).

Our study is limited by the small sample, which influences the precision of our findings (i.e., width of 95% CIs) and our ability to account for more covariates (e.g., including concurrent meniscal or articular cartilage pathology). Although some of the effect estimates suggest clinically meaningful associations, our results should be considered preliminary and require more robust evidence for validation. All outcomes were patient-reported, and none involved objective physical function or performance measures. Additionally, all patients underwent surgery by a single surgeon and may not generalize to other settings. While all patients were prescribed the same evidence-based physical therapy program, we are unable to report on compliance or details regarding postoperative rehabilitation. Thus, we are unable to account for rehabilitation factors as potential confounders to return to sport or patient-reported outcomes. Additionally, most of our patients reported a high preoperative activity level. We focused on preoperative factors because of our interest in at-risk patient screening before surgery. We did not examine changes in subgroup membership or FAM scores. Future work should examine whether change in subgroup membership may influence postoperative recovery.

CONCLUSION

Twenty-four percent of participants were moderate-to-high risk based on preoperative FAM factor scores. The moderate-to-high FAM risk subgroup showed lower odds of return to sport and poorer patient-reported outcomes up to 12 months. Preoperative expectation was an important predictor of knee function and quality of life. These findings highlight the importance of preoperative multidimensional screening for patients at-risk for poor ACLR outcomes.

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HIGHLIGHTS

- 24% of patients were moderate-to-high risk based on fear-avoidance model (FAM) factors.
- Moderate-to-high FAM risk patients had poorer return to sport and patient-reported outcomes.
- Expectation of surgical success was an important predictor of 6-month knee function.

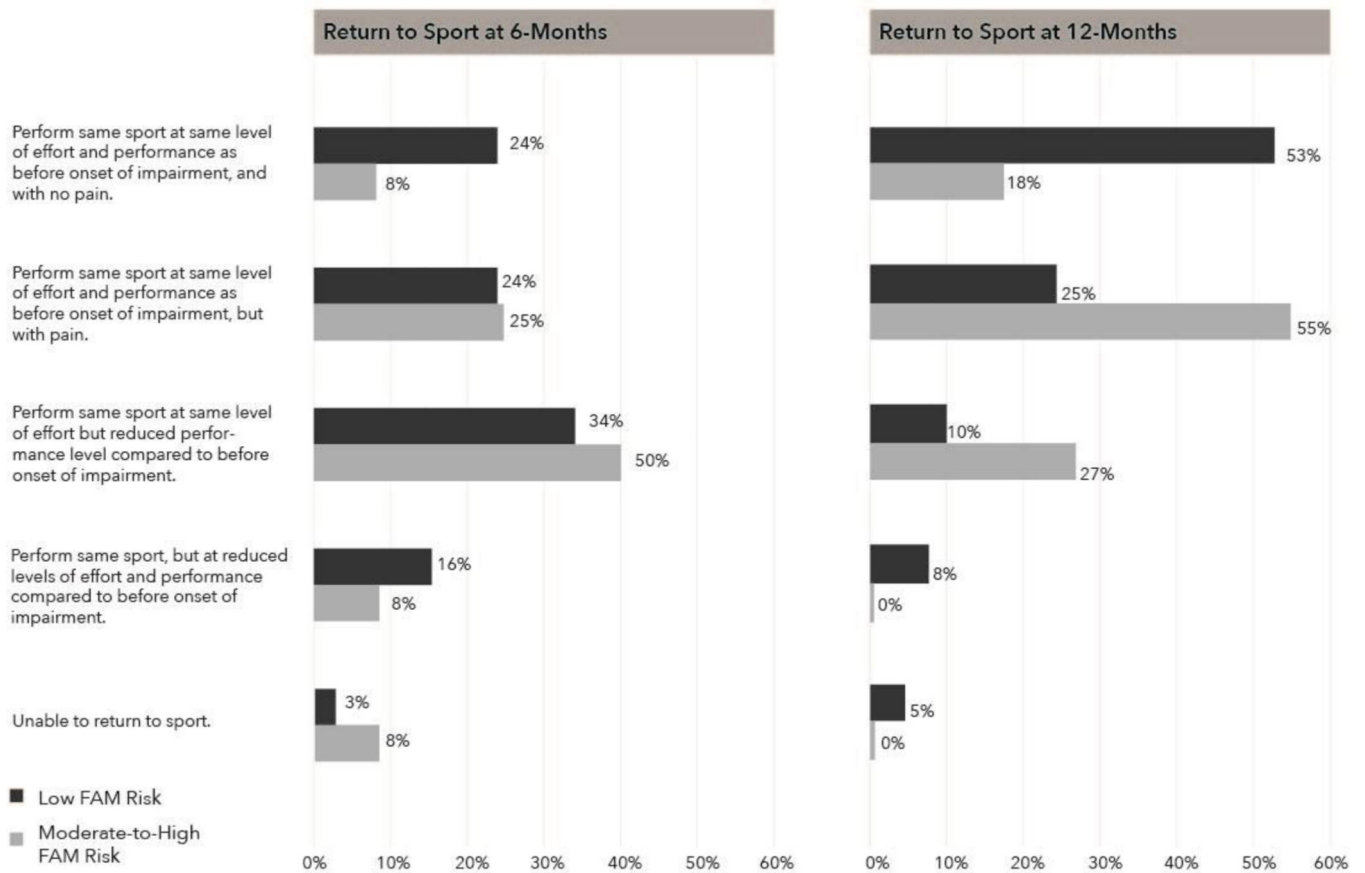


Figure 1. Return to sport at 6 (n =50) and 12 months (n = 51) by preoperative FAM risk subgroup.

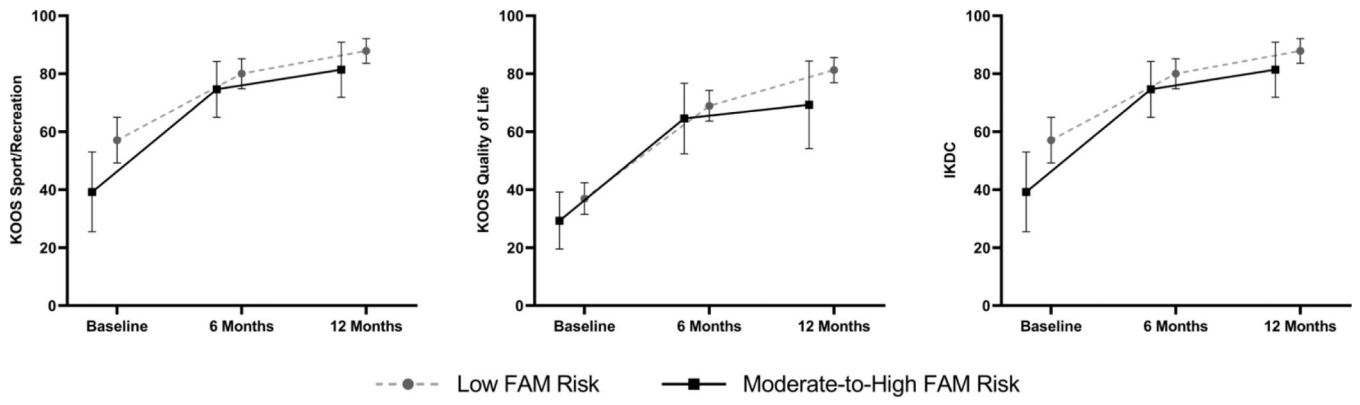


Figure 2. Unadjusted scores for Knee Injury and Osteoarthritis Outcome Score (KOOS) Sports and Recreation and Quality of Life subscales and International Knee Documentation Committee (IKDC) by preoperative FAM risk subgroup. Mean scores are marked, with error bars representing 95% confidence intervals.

Table 1.

Sociodemographic, Surgical, and Psychosocial Characteristics (N=54). Abbreviations: BMI = body mass index, BTB = bone-patellar tendon-bone, TSK = Tampa Scale for Kinesiophobia, PCS = Pain Catastrophizing Scale, K-SES = Knee Self-Efficacy Scale Values are mean [SD] or count (%) unless otherwise noted.

Characteristic	All (N=54)	Moderate-to-High	Low
		FAM Risk (n=13)	FAM Risk (n=41)
Sociodemographic			
Age, in years	19.1 [5.1]	17.6 [3.8]	19.6 [5.4]
Sex, Male	29 (54 %)	6 (46 %)	23 (56 %)
Race, White	46 (85 %)	9 (69 %)	37 (90 %)
BMI, in kg/cm ²	24.6 [4.6]	24.0 [3.5]	24.9 [4.9]
Education, in years	12.0 [3.2]	11.5 [2.8]	12.1 [3.3]
Depression, yes	2 (4 %)	1 (8 %)	1 (2 %)
Marx score, median [IQR]	16 [16; 16]	16 [16; 16]	16 [13; 16]
Sport			
<i>Basketball</i>	14 (26 %)	5 (38 %)	9 (22 %)
<i>Football</i>	13 (24 %)	1 (8 %)	12 (29 %)
<i>Soccer</i>	18 (33 %)	7 (54 %)	11 (27 %)
<i>Other</i>	9 (17 %)	0 (0 %)	9 (22 %)
Level of Sport			
<i>High School</i>	31 (57 %)	10 (77 %)	21 (51 %)
<i>Recreation</i>	8 (15 %)	1 (8 %)	7 (17 %)
<i>Amateur</i>	6 (11 %)	1 (8 %)	5 (12 %)
<i>College</i>	9 (17 %)	1 (8 %)	8 (20 %)
Surgical			
BTB autograft	54 (100 %)	13 (100 %)	41 (100 %)
Medial meniscus treatment			
<i>No tear</i>	33 (61 %)	8 (62 %)	25 (61 %)
<i>Untreated tear</i>	8 (15 %)	2 (15 %)	6 (15 %)
<i>Repair</i>	9 (17 %)	2 (15 %)	7 (17 %)
<i>Excision</i>	4 (7 %)	1 (8 %)	3 (7 %)
Lateral meniscus treatment			
<i>No tear</i>	22 (41 %)	7 (54 %)	15 (37 %)
<i>Untreated tear</i>	9 (17 %)	1 (8 %)	8 (20 %)
<i>Repair</i>	3 (6 %)	1 (8 %)	2 (5 %)
<i>Excision</i>	20 (37 %)	4 (31 %)	16 (39 %)
Articular cartilage chondrosis			
<i>Medial compartment - grade 2</i>	8 (15 %)	1 (8 %)	7 (17 %)
<i>Medial compartment - grade 3</i>	1 (2 %)	1 (8 %)	0 (0 %)
<i>Lateral compartment - grade 2</i>	4 (7 %)	2 (15 %)	2 (5 %)
<i>Lateral compartment - grade 3</i>	1 (2 %)	0 (0 %)	1 (2 %)
<i>Patellofemoral compartment - grade 2</i>	1 (2 %)	0 (0 %)	1 (2 %)

Characteristic	All (N=54)	Moderate-to-High	Low
		FAM Risk (n=13)	FAM Risk (n=41)
Medial collateral ligament injury			
<i>Grade 1</i>	1 (2 %)	1 (8 %)	0 (0 %)
<i>Grade 2</i>	6 (11%)	0 (0 %)	6 (15%)
<i>Preoperative Psychosocial</i>			
Fear of movement/reinjury (TSK)	39.4 [6.2]	44.4 [5.5]	37.8 [5.6]
Self-efficacy (K-SES)	28.8 [9.5]	17.6 [9.3]	31.9 [6.6]
Pain catastrophizing (PCS)	8.7 [7.8]	17.9 [8.5]	5.8 [4.9]
Expectation of surgical success	9.3 [1.0]	8.7 [1.3]	9.4 [0.8]

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Table 2.

Multivariable Proportional Odds Regression Analyses for SPORTS Score at 6 and 12 Months. Abbreviations: FAM = fear-avoidance model, SPORTS = Subjective Patient Outcome for Return to Sports.

	6 Months		12 Months	
	Odds Ratio [95% CI]	p	Odds Ratio [95% CI]	p
<i>SPORTS Score</i>				
Moderate-to-high FAM risk	.3 [.1 to 1.1]	.07	.3 [.1 to 1.0]	.05
Expectation of surgical success	.7 [.4 to 1.3]	.28	.8 [.4 to 1.5]	.51

Models controlled for age, sex, and preoperative Marx score

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Table 3.

Multivariable Linear Regression Analyses for the KOOS and IKDC at 6 and 12 Months. Abbreviations: FAM = fear-avoidance model, KOOS = Knee Injury and Osteoarthritis Outcome Score, IKDC = International Knee Documentation Committee

	6 Months			12 Months		
	Unstandardized Beta [95% CI]	Standardized Beta	p	Unstandardized Beta [95% CI]	Standardized Beta	p
<i>KOOS Sport/Recreation</i>						
Moderate-to-high FAM risk	-9.9 [-20.0 to .2]	-.27	.05	-7.1 [-16.7 to 2.5]	-.21	.15
Expectation of surgical success	-3.7 [-8.1 to .6]	-.23	.09	.4 [-3.6 to 4.4]	.03	.85
<i>KOOS Quality of Life</i>						
Moderate-to-high FAM risk	-9.4 [-21.0 to 2.2]	-.24	.11	-17.5 [-29.9 to -5.0]	-.42	.007
Expectation of surgical success	-3.9 [-8.8 to 1.0]	-.23	.12	-5.1 [-10.1 to .01]	-.29	.05
<i>IKDC</i>						
Moderate-to-high FAM risk	-7.6 [-14.6 to -.5]	-.29	.04	-13.0 [-20.7 to -5.4]	-.47	.001
Expectation of surgical success	-4.1 [-7.1 to -1.1]	-.36	.008	-2.5 [-5.6 to .6]	-.22	.11

Regression models controlled for age, sex, and preoperative outcome score (*Marx used for KOOS Sport/Recreation)