

Original Research

An Examination of the Relationship Between Fear of Reinjury and Neuromuscular, Musculoskeletal, and Biomechanical Characteristics at the Time of Return to Sport following Anterior Cruciate Ligament Reconstruction

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Background

Kinesiophobia is linked to reinjury risk, decreased physical performance and a major cause of sport dropout following ACL reconstruction (ACLR). Identifying deficits based on kinesiophobia may help with the development of strategies to improve outcomes and decrease the risk of reinjury.

Purpose

The purpose of this study was to compare individuals with high and low TSK-11 scores across modifiable neuromuscular, musculoskeletal, and biomechanical characteristics at the time of RTS.

Study design: Cross-sectional study

Methods

Participants within two months of RTS clearance were recruited from a single academic institution between August 2018 and December 2019. Kinesiophobia was measured using the TSK-11. Lower extremity strength was evaluated using isometric and isokinetic testing. Dynamic postural stability was assessed with a double leg jump to single leg landing onto force plates, from which a dynamic postural stability index was calculated. Jump-landing biomechanics were assessed using a single leg stop jump (SLSJ), and single leg hop performance was measured with a triple hop test. Participants were categorized into low (<17) or high (≥17) kinesiophobia groups based on TSK-11 scores. Means and SD were calculated for all variables. Comparisons were made between groups in lower extremity range of motion, strength, dynamic postural stability, jump landing and single leg hop performance. Independent sample t-tests and Mann-Whitney U tests were used to compare variables between high and low kinesiophobia groups, with Cohen's d used to estimate effect sizes.

Results

Twenty-seven participants (14 males, 13 females; age = 20.6 ± 6.5; pre-injury Tegner Activity Level = 7.7 ± 1.3) cleared for RTS post-unilateral ACLR volunteered for this study (10 ± 2 months post-ACLR). A significant difference was found between high and low TSK-11 groups for weight-bearing ankle dorsiflexion lunge test (p = 0.011) and single leg

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stop jump task maximum knee valgus angle ($p = 0.007$). There was no significant difference between the two groups for any other variable.

Conclusion

Few differences in neuromuscular, musculoskeletal, and biomechanical function were identified between low and high TSK-11 scores at RTS. Results suggest that athletes in this cohort returning to sport have relatively low TSK-11 scores, and that higher scores may be attributed to other factors. Due to the small sample size and relatively low TSK-11 scores, further research is needed to confirm the relationship between kinesiophobia and variables commonly assessed at the time of RTS following ACLR.

Level of Evidence

3b

INTRODUCTION

Anterior cruciate ligament (ACL) tears are among the most common knee injuries, with approximately 250,000 cases reported annually in the United States.¹ ACL reconstruction (ACLR) is the gold standard treatment following injury, aiming to restore knee stability and enable a return to unrestricted preinjury levels of physical activity. However, not all athletes who undergo ACLR return to sport (RTS). Several factors may contribute to an athlete's inability to RTS or resume previous levels of competition. These include persistent knee pain, fear of reinjury, diminished interest, and non-knee related life circumstances such as family or job demands.^{2,3} One modifiable factor of particular concern is kinesiophobia, which has been associated with both failure to RTS and increased risk of subsequent ACL injury.^{2,4} Kinesiophobia is defined as the fear of recurrent pain or re-injury due to movement.⁶

While many biopsychosocial factors influence post-injury pain and are beyond the scope of this study, fear of pain and reinjury remains an important issue to address in athletes.⁶ Pain and apprehension following ACLR can lead to pain catastrophizing and fear-avoidance behaviors, which may hinder rehabilitation, limit functional outcomes, and ultimately prevent RTS.⁶ Among athletes who do not RTS after ACLR, kinesiophobia is cited as the most common reason, accounting for up to 52% of cases.^{2,4,7} Kinesiophobia is commonly assessed using the Tampa Scale for Kinesiophobia 11 (TSK-11). Existing literature has explored kinesiophobia following ACLR in relation to recovery timelines and its association with wellness and performance metrics. TSK scores tend to be higher in individuals who recently underwent surgery, experienced delays between injury and surgery, or are over the age of 35.⁸⁻¹⁰ As expected, TSK scores generally decrease (improve) as patients progress through rehabilitation.¹¹⁻¹⁴ However, even as overall emotions become more positive during recovery, fear remains a prevalent response at the time of RTS.¹⁵

Current literature suggests that kinesiophobia in ACLR patients correlates with poor lower extremity strength,^{3,16-18} hop and jump landing biomechanics,^{17,19-21} postural stability,¹³ patient reported outcomes (PRO),^{9,18,22} and level of physical activity following surgery.^{17,23} The extent to which kinesiophobia directly contributes to the risk of reinjury remains unclear. Some research proposes an in-

direct relationship, where kinesiophobia leads to poorer strength and biomechanical outcomes, which in turn increase reinjury risk.²⁰ One challenge in the current body of research is that many studies assess patients two or more years post-surgery,^{16,18-21} making it difficult to draw conclusions about the impact of kinesiophobia at time of RTS (9-12 months post-surgery) for most athletes.

Given the association between kinesiophobia and worse clinical outcomes, and the growing emphasis on incorporating psychological benchmarks into RTS decision-making, there is a need to better understand how commonly used RTS criteria relate to TSK-11 scores. The purpose of this study was to compare individuals with high and low TSK-11 scores across modifiable neuromuscular, musculoskeletal, and biomechanical characteristics at the time of RTS. The variables chosen in this study are based on previous research and testing commonly used for RTS criteria.^{24,25} The authors hypothesized that poorer stability, hop performance, lower extremity strength, range of motion (ROM), and biomechanics would be associated with higher TSK-11 scores. Identifying relationships between kinesiophobia and these variables may help rehabilitation professionals tailor interventions more effectively.

METHODS

This was a cross-sectional study design approved by the university's institutional review board. Informed consent was obtained from each participant prior to all data collection. To ensure consistency and minimize fatigue, assessments were completed in the following order: TSK-11, dynamic postural stability, lower extremity biomechanics (stop jumps), hop tests, isometric strength, ROM, and isokinetic strength.

PARTICIPANTS

Twenty-seven participants (14 males, 13 females) were recruited from a single academic institution between August 2018 and December 2019. All participants met the following criteria: currently post-ACLR, up to two months following RTS clearance for unrestricted activity, ≥ 12 years old, and regularly physically active. Participants were excluded if they had sustained a Grade 2 or higher injury to the MCL, LCL or PCL injury, had a history of ACLR, had undergone

any other major surgery on the ipsilateral leg, or had a current brain injury. Participants with meniscal injuries were included regardless of whether the meniscus was repaired, debrided, or left untreated. All outcome measures were collected during a single testing session lasting approximately 90 minutes. Twenty-six participants completed all testing variables; one participant completed all except the isometric strength testing.

MEASURES

KINESIOPHOBIA

Kinesiophobia was assessed using the TSK-11 for fear of reinjury at the time of RTS. Scores range from 11 to 44, with higher scores indicating greater fear of movement due to pain or reinjury. The TSK-11 is widely used in ACLR populations and demonstrates good validity and reliability.^{3,5,12,13,26-28}

ACTIVITY LEVEL

Activity level was assessed using the Tegner Activity Scale, a single-item tool validated for use in ACL populations to evaluate work and sports participation intensity.²⁹⁻³¹ The scale includes 11 levels ranging from 0 to 10, with higher scores indicating greater levels of physical activity. Scores of 6-10 reflect participation in competitive, recreational, or elite sports; scores of 1-5 represent recreational activities such as jogging and varying degrees of occupational physical demands from heavy labor to sedentary work; and a score of 0 indicates sick leave or disability due to the knee.³¹

LOWER EXTREMITY RANGE OF MOTION

ROM was measured using standardized methods with either a goniometer or digital AccuMASTER inclinometer (Calculated Industries, Henderson, NV). Three trials were recorded to the nearest tenth of a degree and averaged bilaterally for each of the following tests: (1) supine passive straight leg raise (SLR), (2) supine active knee extension (90/90 hamstring extensibility), and (3) weight-bearing ankle dorsiflexion lunge test (high reliability; ICC=0.93–0.99).³²

LOWER EXTREMITY STRENGTH

Strength was assessed using both isometric and isokinetic measures. Isometric strength was measured using a hand-held dynamometer (Lafayette Instrument Co., Lafayette, IN), which has demonstrated good to excellent reliability and validity.³³⁻³⁵ Measurements were taken bilaterally for of hip abduction, adduction, internal rotation, and external rotation were collected bilaterally. Each participant performed a practice trial at 50% maximal effort, followed by three trials of five seconds each at 100% maximal effort. Repetitions alternated between limbs to minimize fatigue. The peak force (kg) was recorded for each trial, averaged across three trials, and normalized to body weight (BW).

Isokinetic quadriceps and hamstring strength were measured at 60°/s using a Biodex dynamometer (Biodex Medical, Shirley, NY). Testing began with the uninvolved leg, and participants performed three practice repetitions at 50% maximal effort, followed by five sets of three repetitions at 100% effort. Outcome measures included peak torque normalized to BW for knee flexion and extension and the flexion-to-extension torque ratio. Limb symmetry index (LSI) was calculated for peak flexion and extension torque/body weight using the following equation:

Equation 1. $LSI = 100 * (\text{peak torque involved leg} / \text{peak torque uninvolved leg})$

POSTURAL STABILITY

Dynamic postural stability was assessed using a jump task with high inter-session reliability,³⁶ adapted from protocols by Ross et al.³⁷ and Wikstrom et al.³⁸ Data were collected using Vicon Nexus software (Version 2.8.1, Vicon, Centennial, CO) and AMTI force plates (Advance Medical Technology Inc., type-BP600900 Watertown, Ma) sampling ground reaction forces (GRF) at 1200 Hz. Participants jumped from a distance equal to 40% of their height onto the force plate, clearing a 30cm hurdle placed half the distance. Jumps began from both feet and landed on the uninvolved leg within the confines of the force plate, maintaining single leg balance. Trials were discarded if the participant contacted the hurdle, touched down with the raised foot, stepped on the edge of or outside the force plate, or did not stick to the landing. After three practice attempts, three successful trials were recorded and repeated for the involved leg. The Dynamic Postural Stability Index (DPSI)³⁸ was calculated using GRF variance in anteroposterior, mediolateral, and vertical directions during the first three seconds post-landing. Initial contact was defined as the point when vertical GRF exceeded 5% BW.³⁶ Data were normalized to BW and processed using the MATLAB script (Version 9.5, Mathworks, Natick, MA). A stability index score was calculated for each trial, and an average score was derived per limb.

JUMP LANDING

Single leg jump landing was assessed using a stop jump (SLSJ) test and two single leg triple hop tests. For the SLSJ test, participants jumped off both legs from a distance equal to 40% of their height onto a force plate, landed on the uninvolved leg, and immediately performed a vertical jump with maximal effort, aiming to jump as quickly and as high as possible. After practice trials, three successful trials were recorded for each leg. Trials were discarded and repeated if the participant landed on both legs, stepped on the border or outside the force plate, shifted or hopped, allowed the raised leg to contact the testing leg, or failed to jump straight upwards. GRF data were collected from initial contact to toe-off, defined as the point at which vertical GRF falls below 5% BW. Data were normalized to BW and processed using MATLAB. GRF variables were averaged across conditions for each participant.

Biomechanical measures of kinematics and kinetics were also obtained during the SLSJ task. Motion capture data

were collected at 300 Hz using 16 Vicon Vantage 5 motion cameras (Oxford Metrics, Oxford, UK) and the Vicon Nexus's Lower Body Plug-in Gait model. Eighteen retroreflective markers were placed bilaterally over the posterior superior iliac spine, anterior superior iliac spine, iliac crest, lateral femoral epicondyles, lateral malleoli, posterior aspect of the heel, second metatarsal head, lateral thigh, and lateral shank. Motion analysis data were synchronized with two AMTI force plates sampling GRF at 1200 Hz. Biomechanical variables included: knee flexion angle at initial contact, maximum knee flexion angle, knee valgus angle at initial contact, maximum knee valgus angle, maximum knee flexion moment normalized to BW and height, maximum knee valgus moment normalized to BW and height, maximum tibia shear force normalized to BW, and stance time (from initial contact to toe-off).

Participants also completed triple hops for distance and triple crossover hops for distance. For the triple hop, participants remained on the same side of the measuring tape throughout the trial. For the crossover hop, participants crossed to the opposite side of the tape with each hop, including the first. Each task began with a practice trial at 50% effort followed by two recorded trials per leg. Trials were discarded if the participant used both legs, shifted or stepped on the measuring tape, or jumped more than twelve inches laterally from the tape. Distance was measured from the heel at landing. LSI was calculated using the average distance for the involved and uninvolved legs.

STATISTICAL ANALYSIS

Participants were divided into two groups based on their TSK-11 scores at RTS, with one group ($n = 19$) representing high fear of re-injury (≥ 17) and the other ($n = 8$) representing low fear of re-injury (< 17). Cutoff scores were based on findings by Chmielewski et al.¹¹ who reported an average TSK-11 score of 17 at RTS.

All statistical analysis was performed using Stata (Version 17, StataCorp, College Station, TX). Demographic data were recorded for all participants. For the involved ACLR leg, analysis included ROM, isometric strength, DPSI in all three motion planes and composite DPSI, as well as all kinematic and kinetic variables from the SLSJ task. Isokinetic quadriceps strength and performance on the triple hop and crossover hop tests were evaluated bilaterally to calculate the LSI. Due to data loss, biomechanical variables from the SLSJ task were available for only 16 participants.

Means and SD were calculated for all variables. Normality was assessed using the Shapiro Wilk test. Independent sample t-tests were used to compare variables between high and low kinesiophobia groups. For non-normally distributed data, Mann-Whitney U tests were applied. Cohen's d was used to calculate effect sizes for between-group mean comparisons across all non-kinematic variables and all biomechanical variables from the SLSJ task. An effect size of 0.2 was interpreted as small, 0.5 as moderate, and values greater than 0.8 as large.

RESULTS

Participant demographics are presented in [Table 1](#). The low TSK-11 group included four males and four females, while the high TSK-11 group included 10 males and nine females. A significant difference in body mass was observed between groups ($p = 0.03$), with the high TSK-11 group weighing slightly more than the low TSK-11 group. This difference may be attributed to the higher proportion of males in the high TSK-11 group compared to the low TSK-11 group.

The average TSK-11 score for the entire cohort was 19.22 ± 4.78 ; and the median score was 19, with a range of 11-28. There was a significant difference in mean scores of the high (mean = 21.68 ± 3.16) and low (mean = 13.38 ± 1.92 ; $p < 0.0001$) TSK-11 groups. Apart from gastrocnemius extensibility measured by the weight bearing ankle dorsiflexion lunge test, there were no significant differences between the high and low TSK-11 groups for measures of ROM, strength, postural stability, or LSI ([Table 2](#)). Effect sizes for most variables were small, indicating minimal differences between groups, while gastrocnemius extensibility demonstrated a large effect size consistent with the statistically significant group difference.

For the subset analysis of biomechanical variables during SLSJ task, maximum knee valgus angle was the only statistically significant difference ([Table 3](#)). Effect sizes for the remaining variables were generally small to moderate, indicating minimal between-group differences. Maximum knee valgus angle demonstrated a large effect size, and maximum tibial shear force also showed a large effect size despite not reaching a statistically significant difference.

DISCUSSION

Kinesiophobia has been linked to both failure to return to pre-injury levels of sport and increased risk of reinjury following RTS.^{2,4,5,7,17} As such, this study aimed to examine the relationship between TSK-11 scores and modifiable neuromuscular, musculoskeletal, and biomechanical characteristics in athletes at the time of RTS. Understanding these relationships may help rehabilitation professionals target variables that could reduce the fear of movement and reinjury.

Few meaningful differences emerged between individuals categorized as having relatively higher versus relatively lower TSK-11 scores, suggesting that higher scores may be influenced by factors outside the neuromuscular, musculoskeletal, or biomechanical domains. One possible explanation for the limited differences observed is that the average scores in this cohort were relatively low (19.22 ± 4.78) compared with thresholds used in other literature. While there is no universally accepted cutoff for high kinesiophobia, some studies use higher thresholds.^{39,40} For example, Chimenti et al.³⁹ categorized scores ≤ 22 as "minimal" and ≥ 36 as "high" kinesiophobia, while Hidaka et al.⁴⁰ used a cutoff score of 25. Although a majority of participants fell into the "high TSK" group according to the cutoff score used at the time of RTS,¹¹ the terms "high TSK" and "low

Table 1. Participant Demographics

	Total Sample n = 27	Low TSK-11 n = 8	High TSK-11 n = 19	p-value
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	
Age (years)	20.60 $\pm$ 6.50	18.70 $\pm$ 5.30	21.40 $\pm$ 6.90	0.211
Mass (kg)	74.39 $\pm$ 16.48	65.14 $\pm$ 8.69	78.29 $\pm$ 17.57	0.030*
Height (cm)	172.76 $\pm$ 9.98	169.78 $\pm$ 7.85	174.02 $\pm$ 10.70	0.322
Post op (months)	10.00 $\pm$ 2.06	9.75 $\pm$ 1.49	10.11 $\pm$ 2.28	0.690
Pre-injury Tegner	7.74 $\pm$ 1.32	7.63 $\pm$ 0.92	7.79 $\pm$ 1.47	0.774
Current Tegner	7.07 $\pm$ 1.66	7.50 $\pm$ 1.07	6.89 $\pm$ 1.85	0.362

Abbreviations: SD = standard deviation

* statistically significant difference

TSK” in this study represent relative distinctions within a generally low-fear cohort. When applying these alternative cutoffs, the average scores in the current “high TSK” group would still fall below what is typically considered clinically significant kinesiophobia.

TSK-11 scores in this cohort are consistent with those reported in the literature for athletes between RTS and one year post-ACLR.^{11,41–44} Muller et al.⁴³ reported an average score of 19 at seven months post-surgery for athletes who RTS, while Ueda et al.⁴⁴ and Lentz et al.⁴² reported mean scores of 17.2 and 18.23, respectively, at one year post-surgery. Slightly higher scores have been reported around six months post-surgery, but these figures are still below the cutoff scores used by Chimenti et al.³⁹ and Hidaka et al.⁴⁰ At six months post-ACLR, Tajdini et al.⁴⁵ and Rhim et al.⁴⁶ reported average TSK-11 scores of 22, and a score of 19.5 by Kuenze et al.⁴⁷ at seven months. These findings support the notion that athletes who do RTS tend to have relatively low TSK-11 scores, and that higher scores may be more common among those who do not RTS, potentially due to fear of reinjury.

Although causality cannot be established, the relatively lower TSK-11 scores in this cohort may reflect factors such as quality of post-operative care, lower preoperative kinesiophobia, younger participant age, and the inclusion of athletes who had successfully RTS. Studies on chronic pain and injury have reported significantly higher TSK scores, aligning more closely with the cutoff recommendations of Hidaka et al.^{40,48} Additionally, this study did not assess participants’ TSK scores prior to their ACL injury. Preexisting low TSK scores may improve post-surgical outcomes, though evidence is mixed. Ardern et al.⁴⁹ found that psychological responses before surgery and early in recovery were associated with RTS at 12 months, while Chmielewski et al.¹² found no predictive value of baseline psychosocial factors for knee function at 12 weeks post-ACLR. These discrepancies may be due to methodological differences in outcome measures.

Individually, many of the variables assessed in this study are known to be associated with RTS criteria and outcomes following ACLR. Prior research has documented deficits in lower extremity strength, postural stability, neuromuscular control, LSI, and patient reported outcomes (PROs).^{43,50–56} To address these deficits and reduce reinjury risk, efforts

are underway to standardize RTS criteria.^{57–59} However, the impact of kinesiophobia on these deficits and RTS outcomes remains unclear. Some studies have reported that kinesiophobia negatively affects lower extremity strength,^{3, 16–18} gait asymmetries,⁴⁵ and hop/jump landing biomechanics.^{17,19,20} In a prospective study, Paterno et al.¹⁷ found that patients with high kinesiophobia were four times more likely to have lower levels of physical activity, six to seven times more likely to exhibit strength and functional asymmetries, and thirteen times more likely to sustain a second ACL injury after RTS. Other research has explored the relationship between kinesiophobia, PROs, and psychological readiness. Given the limited differences found between the high and low TSK groups in this cohort, it is possible that other psychological factors influenced outcomes. However, this study did not assess additional PROs or psychological readiness measures. Previous literature has linked TSK scores to patient satisfaction,⁴⁴ the ACL Return to Sport after Injury (ACL-RSI) inventory,^{22,60} the International Knee Documentation Committee (IKDC) subjective knee evaluation form,^{3,9,42} and quality of life.⁹ Positive psychological traits such as motivation, confidence, and self-efficacy have also been associated with higher RTS rates.¹⁵ However, their influence on TSK-11 scores in ACLR patients remains unclear.

Current recommendations for reducing ACL reinjury risk emphasize the use of both functional and psychological benchmarks in RTS decision-making.⁶¹ Despite this, there is no consensus on which psychological readiness measures should be used. Assessing fear of injury is important, as psychological differences affecting RTS can emerge as early as six months post-surgery.^{11,62} Lentz et al.³ found that patients with higher fear at six months post-surgery continued to experience fear at 12 months and were less likely to RTS. This may also help explain the lack of significant differences in RTS-related variables in the present study, as athletes with substantial kinesiophobia may have chosen not to return to sport and therefore were not represented in this study.

LIMITATIONS

Limitations of this study include a relatively small sample size, the inclusion of athletes who had already been cleared

Table 2. Non-Kinematic Variables

Table 2. Non-Kinematic Variables									
	Low TSK-11 n = 8			High TSK-11 n = 19			p- value	Effect size	95% CI
	Mean	SD	M	Mean	SD	M			
ROM (°)									
Passive SLR	79.19	3.11	79.10	81.29	6.08	81.30	0.364	-0.388	-1.22, 0.45
Active Knee Ext	15.72	10.38	15.85	11.32	10.17	10.40	0.165 ⁺	0.429	-0.41, 1.26
Gastrocnemius Flexibility	7.00	0.95	7.00	4.58	2.40	4.30	0.011 [*]	1.150	0.25, 2.03
Isokinetic Strength (%)									
Peak Ext torque/BW	214.70	55.78	201.20	195.55	56.28	184.20	0.425	0.341	-0.49, 1.17
Peak Flex torque/BW	123.45	26.34	128.65	117.24	43.78	128.40	0.714	0.256	-0.67, 0.98
Peak Flex/Ext torque	59.93	17.96	57.59	58.98	12.59	55.49	0.876	0.066	-0.76, 0.89
Isometric Strength (kg)									
Hip Adduction	59.98	18.19	54.06	58.50	12.21	57.85	0.807	0.104	-0.72, 0.93
Hip Abduction	16.28	6.09	14.80	16.22	5.07	14.80	0.975	0.013	-0.81, 0.84
Hip Internal Rotation	16.56	7.49	18.20	13.22	3.89	13.00	0.136	0.649	-0.20, 1.49
Hip External Rotation	15.04	6.26	13.45	14.09	4.43	14.00	0.659	0.188	-0.64, 1.01
Postural Stability									
DPSI	0.35	0.05	0.34	0.35	0.05	0.34	0.926	-0.040	-0.87, 0.79
APSI	0.14	0.01	0.14	0.14	0.01	0.14	0.783	0.118	-0.72, 0.95
MLSI	0.03	0.01	0.03	0.03	0.01	0.03	0.702	-0.164	-0.99, 0.67
VSI	0.32	0.05	0.30	0.32	0.30	0.31	0.907	-0.050	-0.88, 0.78
LSI (%)									
Crossover Hop	370.65	103.17	363.20	360.19	128.76	347.10	0.841	0.086	-0.74, 0.91
Triple Hop for Distance	412.34	95.81	388.25	409.64	126.53	431.20	0.957	0.023	-0.80, 0.85
Ext Peak Torque/BW	88.36	20.16	93.77	80.30	11.82	75.99	0.204	0.550	-0.29, 1.38
Flex Peak Torque/BW	97.49	6.05	96.65	94.22	15.84	91.80	0.580	0.237	-0.59, 1.06

Abbreviations: M = Median, Ext = Extension, Flex = Flexion, BW = Body weight, DPSI = Composite DPSI Score, APSI = Anteroposterior DPSI, MLSI = Mediolateral DPSI, VSI = Vertical DPSI

^{*}Statistical significance

⁺ Non-normally distributed data

for RTS, the absence of longitudinal data on TSK score changes, and the limitations associated with the cutoff score used to classify kinesiophobia. Although the cutoff score aligns with prior work, it is not a universally accepted standard, and substantial variability exists across the literature regarding what constitutes clinically meaningful kinesiophobia. Monitoring TSK-11 scores throughout reha-

bilitation could provide valuable insights into recovery trajectories, likelihood of successful RTS, and the need for targeted support. Additionally, analysis of the SLSJ task was characterized by a substantial loss of usable data, resulting in a smaller sample size for these specific analyses compared to the primary study outcomes. While an a priori power analysis was not conducted, effect sizes were re-

Table 3. SLSJ Task Biomechanics

	Low TSK-11 n = 5			High TSK-11 n = 11			p-value	Effect size	95% CI
	Mean	SD	M	Mean	SD	M			
Initial Knee Flex	14.54	5.11	11.68	17.66	6.66	18.28	0.372	0.499	-0.57, 1.57
Max Knee Flex	64.83	4.12	65.01	57.94	8.77	54.11	0.121	-0.891	-1.99, 0.21
Initial Knee Valgus	-0.42	4.02	0.63	2.46	5.86	1.89	0.339	0.533	-0.54, 1.61
Max Knee Valgus	-10.60	5.82	-12.94	-1.70	5.04	-2.19	0.007*	1.687	0.48, 2.90
Max GRF/BW	32.70	8.95	26.90	30.36	6.19	28.76	0.551	-0.330	-1.39, 0.73
Max Post GRF/BW	8.06	1.99	8.18	7.93	2.51	7.14	0.920	-0.055	-1.11, 1.00
Max Knee Flex Moment/BW/Ht	1.80	0.62	1.52	2.48	0.93	2.26	0.161	0.797	-0.30, 1.89
Max Knee Valgus Moment/BW/Ht	-0.16	0.09	-1.40	-0.18	0.07	-0.19	0.789	-0.262	-1.32, 0.80
Max Tibia Shear Force/BW	11.63	4.43	8.51	18.16	7.01	17.28	0.079	1.023	-0.09, 2.14
Stance Time (sec)	0.51	0.12	0.47	0.43	0.13	0.40	0.256	-0.629	-1.71, 0.45

Abbreviations: M = Median, Flex = flexion, GRF = ground reaction force, BW = body weight

*Statistical significance

ported for all comparisons to allow interpretation of the magnitude of the observed effects independent of statistical significance. However, given the reduced cohort size, these analyses are likely underpowered to detect smaller effects, increasing the risk of Type II errors. Consequently, the findings associated with the SLSJ task should be interpreted as exploratory and are presented to provide preliminary evidence to inform the design of future, more highly powered investigations.

CONCLUSION

Few differences in neuromuscular, musculoskeletal, and biomechanical function were identified between subjects with low and high TSK-11 scores at RTS. The findings suggest that athletes who do return to sport tend to have relatively low levels of kinesiophobia, and that elevated TSK-11 scores may be influenced by factors beyond physical function. However, these results should be interpreted with caution due to the small sample size and a population of athletes cleared to RTS. Further research is needed to clarify the relationship between kinesiophobia and commonly assessed RTS variables following ACL reconstruction (ACLR),

and to determine whether psychological assessments like the TSK-11 should be integrated into RTS decision-making.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to report.

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