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Analysis of shortened versions of the Tampa Scale for Kinesiophobia and Pain Catastrophizing Scale for patients following anterior cruciate ligament reconstruction

Steven Z. George, PT PhD[1,3], **Trevor A. Lentz, MPT**[2], **Giorgio Zeppieri Jr., MPT**[2], **Derek Lee, SPT**[1], and **Terese L. Chmielewski, PT, PhD**[1]

[1]Department of Physical Therapy, University of Florida, Gainesville FL

[2]Department of Physical Therapy, SHANDS Rehab, Gainesville FL

[3]Center for Pain Research and Behavioral Health, University of Florida, Gainesville FL

Abstract

Objective—Recent work suggests that psychological influence on pain intensity and knee function should be considered for patients following anterior cruciate ligament reconstruction (ACLR). The Tampa Scale for Kinesiophobia (TSK) and Pain Catastrophizing Scale (PCS) have been used to determine psychological influence in these patients. However, TSK and PCS factor structures have not been described for patients with ACLR. This study investigated 2 groups of patients post-ACLR to determine if the use of shortened questionnaires is warranted.

Methods—This was a cross-sectional study in which patients completed measures during early (n = 105, median days from surgery = 56.0) and late (n = 184, median days from surgery = 195.0) post-operative phases of ACLR rehabilitation.

Results—Shortened questionnaires for fear of pain, fear of injury, and somatic focus were generated for the TSK-11. A shortened questionnaire for magnification/helplessness and rumination were generated for the PCS in the late group only. There were minimal differences in the shortened questionnaires for clinical subgroups based on sex, ACLR graft type, method of injury, or nature of injury. Correlation and regression analyses suggested a shortened version of the TSK-11 for fear of injury was appropriate for use in the early post-operative phase, while the original TSK-11 scale may be appropriate for use in the late post-operative phase. There were no shortened versions of the PCS for consideration in the early post-operative phase, but a shortened version for magnification/helplessness was appropriate for use in the late post-operative phase.

Discussion—Shortened versions of the TSK-11 and PCS may be appropriate for ACLR populations, depending on the post-operative phase. These data may guide future research of psychological factors in ACLR populations so that levels predictive of risk for developing chronic pain and/or inability to return to pre-injury activity levels can be determined.

Correspondence: Steven Z. George PT, PhD, Associate Professor and Assistant Department Chair, PO Box 100154, Gainesville, FL 32615, Phone: (352) 273-6432, Fax: (352) 273-6109, szgeorge@phhp.ufl.edu.

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Keywords

Chronic pain; pain catastrophizing; fear-avoidance; knee function; rehabilitation

Introduction

The fear-avoidance model (FAM) of musculoskeletal pain describes a potential process for the development of chronic pain syndromes.[1] The FAM suggests that following musculoskeletal injury pain catastrophizing and fear of pain are primary psychological factors that determine recovery.[1] When pain catastrophizing and fear of pain are elevated, avoidance and escape behaviors are expected, increasing the likelihood of chronic pain.[1] Although the FAM has been widely studied in patients with low back pain, it is believed to have application for other musculoskeletal pain conditions.[1]

Patients with anterior cruciate ligament reconstruction (ACLR) are a novel population in comparison to clinical chronic pain populations. The ACLR patient model involves trauma as the initial cause of musculoskeletal dysfunction and surgery as treatment for this dysfunction. Surgical recovery focuses on improving motion and strength of the knee joint, while pain relief and amelioration of psychological distress have not been explicitly stressed as important factors in post-operative ACLR rehabilitation. Our recent work has highlighted pain intensity as a detrimental influence on self-report of knee function through all phases of ACLR rehabilitation.[2] These data provided impetus to investigate psychological influence for patients with ACLR as there may be potential to address modifiable factors during rehabilitation.

Several previous studies have investigated FAM variables in ACLR samples. Chmielewski et al[2] reported that fear of pain and re-injury was associated with function in the return to sports phase of ACLR rehabilitation. Kvist et al[3] reported that fear of pain and re-injury was higher and associated with lower knee quality of life for those that had not returned to pre-injury activity levels 3–4 years following ACLR. Pavlin et al[4] reported that pain catastrophizing was predictive of acute post-surgical pain intensity, and was associated with higher pain intensity ratings at rest and with activity. Finally, Tripp et al[5] reported that pain catastrophizing was higher in adolescents following ACLR (when compared to adults) and the difference in catastrophizing was a primary reason for higher pain intensity reports in adolescents. Collectively these studies indicated FAM constructs may influence pain intensity and function following ACLR.

The FAM measures commonly included in these ACLR studies are the Tampa Scale for Kinesiophobia (TSK)[2,3] and Pain Catastrophizing Scale (PCS).[4,5] The psychometric properties of these measures have been investigated in patients with chronic pain syndromes. However, chronic pain populations differ substantially on clinical presentation when compared to patients with ACLR, for example patients with ACLR often have shorter duration of pain, lower overall pain intensity levels and patterns of improvement in pain intensity.[6] Therefore, studies validating the TSK and PCS might not be directly applicable to patients following ACLR. Investigation of the TSK is of special interest because fear of re-injury is a primary reason why patients with ACLR do not return to sport.[7]

The primary purpose of this study was to investigate the TSK and PCS to determine if use of shortened versions of these questionnaires is warranted in patients with ACLR. These questionnaires were developed for use in chronic pain populations and not all items may be relevant for patients with ACLR. For example the TSK has items consistent with constructs for fear of injury, fear of pain, and somatic focus.[8] It is feasible that TSK fear of injury items may be more relevant for patients with ACLR,[7] in comparison to items for somatic focus. Another reason for investigating shortened questionnaires is that fear of re-injury is one of the 3 most common injury related topics discussed with patients in sports medicine settings.[9] Shortened versions of questionnaires assessing these topics would appeal to practitioners working in sports medicine settings because it would allow for standard assessment of psychological factors without the increased time burden of administering an entire questionnaire.

To investigate this purpose we first generated shortened versions of each questionnaire using data from patients with ACLR. Then, we investigated differences in the original and shortened questionnaires for clinically relevant subgroups. Last, we reported associations of the original and shortened questionnaires with commonly used pain intensity and knee function measures. This study investigates whether efficient psychosocial assessment is possible for a novel clinical population, a topic recently highlighted as a priority for these patients.[9] Such an investigation is warranted because patients with ACLR typically don't have psychosocial assessment, but recent research indicates that such assessment may be indicated for FAM constructs. This study also potentially adds to the pain research literature by investigating commonly used fear and catastrophizing measures in a patient population with different injury mechanisms and different clinical presentation of pain intensity in comparison to chronic pain patient populations.[6]

Materials and Methods

Subjects

Patients with an ACLR who were receiving rehabilitation at Shands Rehab Center at the University of Florida & Shands Orthopaedics and Sports Medicine Institute (Gainesville, FL) were eligible to participate in this study. All ACLR surgeries were performed by board-certified orthopedic surgeons. All patients were participating in a standard ACLR rehabilitation at the facility or reporting for routine physician appointments within 12 months of their operation when approached for study participation. Subjects provided written informed consent to study participation on a form approved by the University of Florida Institutional Review Board.

Data Collection

Two study physical therapists (GZ and TAL) supervised recruitment and one time data collection at discrete post-surgical time points. One time data collection was selected so that convenience samples could be generated to compare 2 phases of ACLR rehabilitation. Convenience samples allowed for large enough sample sizes to be generated for the analyses for each phase. For the purposes of this study these phases were operationally defined as "early post-operative phase" (4, 8, or 12 weeks after ACLR) and "late post-operative phase" (6 or 12 months after ACLR). The 4, 8, or 12 week (early) and 6 or 12 month (late) post-operative time points were grouped into phases based on the similarity of rehabilitation goals and activity levels.[10] For example, in the early post-operative phase the rehabilitation goal is to address knee impairments and full activity levels are not appropriate. In contrast, the rehabilitation goal of the late post-operative phase is to transition the patient back to sport activity and higher activity levels are encouraged. FAM measures contribute differently to knee function based on post-operative phase in our previous study,[2] providing further support for separation into these clinical phases. Data were collected on standardized forms and then entered into an electronic database (Microsoft Office Access 2007).

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Demographic and Clinical Data

Demographic and clinical information relevant to ACL injuries was collected. These variables included: age, sex, ACLR graft type (allograft or autograft), method of injury (contact or non-contact), nature of injury (sports related or non-sports related), and duration from surgery to data collection. The method of injury was considered to be "contact" if there was any body contact with another athlete during injury. Nature of injury was categorized as "sports" if the subject was participating in recreational or competitive sports at the time of injury.

Fear-Avoidance Model Measures

FAM constructs were assessed with previously validated questionnaires. Fear of pain, movement and injury was assessed with the shortened version of the TSK, the TSK-11. The TSK-11 is an 11-item questionnaire that eliminates psychometrically poor items from the original version of the TSK to create a shorter questionnaire that is comparable to the original 17 item version.[11] Items on the TSK-11 are scored from 1 (strongly disagree) to 4 (strongly agree). Thus, total TSK-11 scores range from 11–44 points with higher scores indicating greater fear of pain, movement, and injury. Pain catastrophizing was assessed with the 13-item Pain Catastrophizing Scale (PCS).[12] Items on the PCS are scored from 0 (not at all) to 4 (all the time). Thus, total PCS scores range from 0–52 points with higher scores indicating higher levels of pain catastrophizing.[12] The TSK-11 and PCS were administered with the provided standard instructional sets.

Knee Pain Intensity and Function

Knee pain intensity and function were also assessed with previously validated measures. Knee pain intensity was assessed with an 11-point numeric rating scale (NRS), ranging from 0 (no pain) to 10 (worst pain imaginable).[13] Subjects verbally rated their knee pain intensity in the past 24 hours over 3 different conditions, including highest, lowest, and current (i.e. at time of data collection) pain intensity.[14] These 3 conditions were also summed and then the mean of the 3 conditions was reported as the "composite" pain intensity.[14] Knee function was assessed with the 18-item International Knee Documentation Committee Subjective form (IKDC). [16,15,17] The IKDC includes questions about knee symptoms and functional limitations and has been validated for use in ACLR populations.[16,15,17] We acknowledge the IKDC encompasses multiple constructs but for the sake of brevity we will refer to it as our "functional" measure since the measure was reported as a whole and intended to reflect the impact on overall activity levels. The 18 IKDC items are rated on Likert scales, with most items having 5 levels. These individual responses are then converted to a 0 to 100 scale with higher scores indicating higher levels of knee function.

Data Analysis

Descriptive statistics were generated in the appropriate metric for continuous and categorical variables. All continuous data approximated normal distribution except for duration from surgery, the pain intensity measures, and the PCS.

Development of Shortened Versions of Questionnaires—Principal components analysis (PCA) was performed on the TSK-11 and PCS to determine potential components for the shortened questionnaires. Components extracted from the PCA were given further consideration if they were associated with eigenvalues greater than 1.0 and showed separation from other components based on visual inspection by scree plot. Next, orthogonal (i.e. VARIMAX) rotation with Kaiser normalization was performed to allow co-varying items to be grouped together so that underlying constructs for each component could be better defined. Orthogonal rotation was imposed as there is precedent for its use in the TSK.[8]

Individual items of the shortened questionnaires were evaluated using guidelines from an earlier investigation of the Multidimensional Pain Inventory.[18] Specifically, items with highest loading on each component was retained, unless the absolute item loading was less than 0.45. Any item that loaded on 2 components and had an absolute difference in loading less than 0.25 was further investigated for its appropriateness. Last the shortened questionnaires were evaluated for internal consistency between items. Specifically, the internal consistency of a given factor needed to be greater than 0.70. Overall this analytical approach was consistent with other psychometric analyses for FAM measures.[8,19]

Subgroup Comparisons—The original and generated shortened versions of the TSK-11 and PCS were compared for potentially clinically relevant subgroups using independent t-tests. Sub-groups included sex, ACLR graft type, method of injury, and nature of injury.

Associations with Pain and Function—Pearson r correlations among the original and generated shortened TSK-11 and PCS were reported for knee pain intensity (highest, lowest, current, and composite ratings) and function (IKDC score). Hierarchical regression modeling (controlling for age, sex, and duration from surgery) for the composite pain intensity and knee function was performed with shortened TSK and PCS scales that had high internal consistency and univariate associations with pain intensity and knee function. This analysis would provide information on potential clinical use for each scale by determining whether shortened questionnaires were associated with pain intensity and knee function in a multivariate model.

Sample Size Justification

There are no standard methods for determining sample size for investigation of shortened questionnaires. In this study we followed general recommendations for multivariate analysis techniques, in which a minimum sample size has been suggested as 50, with preferred sample size exceeding 100.[20] Another general guideline provided for regression analyses is to have between 5 and 10 subjects per predictor variable.[20] With up to 5 variables potentially included in our planned regression analyses that would suggest a minimum sample size of 50. Therefore our goal was to collect a minimum of 50 subjects for each post-operative phase.

Results

One hundred five patients in the early post-operative phase and 184 in the last post-operative phase were included in this study. Descriptive statistics for these samples are reported in Table 1.

Shortened Versions of the TSK-11

In the early post-operative phase, PCA for the TSK-11 extracted 3 components with a cumulative response variance of 64.3% (Table 2). Eigenvalues of the individual components were 5.6 (41.8% variance), 1.3 (11.8%), and 1.2 (10.7%). Visual inspection of the scree plot suggested minimal difference in slope between the 2nd and 3rd component, but with an additional increase in slope to the 4th component. Therefore a decision was made to retain the 3rd component for further consideration to avoid spurious removal of a potentially useful shortened scale. Orthogonal rotation converged in 5 iterations and items loading less than 0.45 were not retained (Table 2). Further analysis indicated all items on these shortened scales met internal consistency criterion. These analyses suggest that the TSK-11 could potentially be shortened to 3 scales for patients in the early post-operative phase of ACLR including "somatic focus of ACLR" (Items 3, 4, 5 and 8), "fear of pain" (Items 6, 7, 9, and 11), and "fear of injury" (Items 1, 2, and 10).

These scales were referred to as the TSK-SOMFE, TSK-FOPE, and TSK-FOIE respectively for subsequent analyses.

In the late post-operative phase, PCA for the TSK-11 extracted 3 components with a cumulative response variance of 57.7% (Table 2). Eigenvalues of the individual factors were 3.7 (34.2% variance), 1.5 (13.8%), and 1.1 (9.7%). Visual inspection of the scree plot suggested increased slope between the 1st and 2nd components only, so only the first 2 components were considered. Orthogonal rotation converged in 5 iterations and items loading less than 0.45 were not retained (Table 2). Further analysis indicated that only items from the first scale met the internal consistency criterion (Table 2). These analyses suggest that the TSK-11 could potentially be shortened to 1 scale for patients in the late post-operative phase of ACLR including "fear of pain" (Items 6, 7, 8, 9, and 11). This scale was referred to as the TSK-FOPL for the subsequent analyses.

Shortened Versions of the PCS

In the early post-operative phase, PCA for the PCS extracted 1 component with a cumulative response variance of 63.3% (Table 3). Eigenvalue for this component was 8.2, and visual inspection of the scree plot confirmed that only 1 component should be considered. Orthogonal rotation converged in 3 iterations and items loading less than 0.45 were not retained (Table 3). Further analysis indicated that items from this single factor met the internal consistency criterion (Table 3). These analyses suggest that the PCS could not be shortened for patients in the early post-operative phase of ACLR.

In the late post-operative phase only 61 subjects (33.2%) provided PCS data. Those not completing the PCS had similar mean age, sex distribution, and TSK-11 scores ($p > 0.05$) but higher worst, current, and average pain intensity scores ($p < 0.05$). In the late post-operative phase PCA for the PCS extracted 2 components with a cumulative response variance of 70.3% (Table 3). Eigenvalues of the individual factors were 7.6 (58.4% variance) and 1.5 (11.9%). Visual inspection of the scree plot suggested increased slope between the 1st and 2nd components only, so no additional components were considered. Orthogonal rotation also converged in 3 iterations and items loading less than 0.45 were not retained (Table 3). Items #2 and #12 were cross loaded and the difference in loading was less than 0.25 so these items were excluded from further consideration. Further analysis indicated the remaining items met internal consistency criterion (Table 3). These analyses suggest that the PCS could be shortened to 2 scales for patients in the late post-operative phase of ACLR including "helplessness/magnification" (Items 1, 3, 4, 5, 6, 7, and 13) and "rumination" (Items 8, 9, 10, and 11). These scales were referred to as the PCS-HML and PCS-RML respectively for the subsequent analyses.

Subgroup Comparison

In the early post-operative phase, differences in questionnaire scores were noted for sex, graft type, and method of injury (p's < 0.05), but not for the nature of injury ($p > 0.05$). Specifically males (mean score = 21.1, sd = 6.4) reported higher TSK-11 scores than females (mean score = 18.4, sd = 5.8). For the TSK-11 and TSK-FOIE patients receiving allografts (mean score = 21.2, sd = 6.3 and mean score = 5.9, sd = 4.8 respectively) reported higher scores than those receiving autografts (mean score = 18.6, sd = 6.0 and mean score = 4.8, sd = 2.1 respectively). Finally, patients with contact injuries (mean score = 3.1, sd = 3.3) reported lower PCS scores than those with non-contact injuries (mean score = 6.4, sd = 9.4).

In the late post-operative phase there were no differences ($p > 0.05$) in the original and shortened TSK-11 or PCS scales for sex, ACLR graft type, method of injury, and nature of injury (p’s > 0.05).

Early Post-Operative Phase Associations with Knee Pain and Function

The correlations among these FAM measures and pain intensity and function measures are reported in Table 4. The TSK-11 and TSK-FOIE had consistent correlations with the pain and function measures. The PCS was not correlated with pain intensity reports, but was correlated with knee function. In the regression analysis the TSK-FOIE and PCS were entered into a model that included age, sex, and duration from surgery. In these models only the TSK-FOIE contributed unique variance to composite pain intensity ($\beta = .25$, $p = 0.02$ vs. $\beta = -.07$, $p = 0.52$) and knee function scores ($\beta = -.26$, $p < 0.01$ vs. $\beta = -.09$, $p = 0.29$).

Late Post-Operative Phase Associations with Knee Pain and Function

The correlations among these FAM measures and pain intensity and function measures are reported in Table 5. The TSK-11 and TSK-FOPL had consistent correlations with the pain intensity and function measures. In contrast to the early post-operative phase, the PCS and its subscales were consistently correlated with pain intensity reports, but not knee function. In the regression analysis the TSK-FOPL and PCS-HML were entered into a model that included sex, age, and duration from surgery. The PCS-HML was the only shortened questionnaire that contributed to the model for composite pain intensity ($\beta = .46$, $p < 0.01$ vs. $\beta = .02$, $p = 0.88$). In the model predicting knee function neither the TSK-FOPL nor the PCS-HML contributed unique variance ($\beta = -.10$, $p = 0.41$ vs. $\beta = -.11$, $p = 0.40$). To determine if either the TSK-11 or PCS contributed to knee function we repeated the regression model with the original questionnaires. In that model the TSK-11 was a stronger contributor ($\beta = -.32$, $p = 0.02$) than the PCS ($\beta = -.04$, $p = 0.74$)

Discussion

This study provides novel information on psychosocial assessment following ACLR. Our previous work has suggested that fear and pain intensity have a detrimental association with knee function.[2] That work spurred further interest in FAM influences on pain intensity and knee function for this particular patient population. The current study has potential clinical relevance by identifying shortened TSK-11 and PCS versions are appropriate for use in ACLR populations. For the TSK-11 our results suggest that it could be shortened to a 3 item fear of injury scale (TSK-FOIE) in the early post operative phase. Shortened versions of the TSK-11 could not be recommended for the late post operative phase due to lack of association with pain and function measures. The PCS was not a candidate for shortening in the early post operative phase, but these data indicate it could be shortened to a 7 item helplessness and magnification scale (PCS-HML) in the late post-operative phase.

These data allow indirect comparisons to previous psychometric studies that report factor structures for patients with chronic pain syndromes.[8,21,24,23,25,22] The shortened versions of the TSK-11 consisted of similar domains (fear of pain, fear of injury, and somatic focus) as have been reported for chronic pain conditions, despite inconsistencies in factor structure.[8,26,25] The shortened PCS scales also consisted of similar domains (magnification, rumination, and helplessness) to psychometric studies reporting factor solutions for patients with chronic pain syndromes.[21,24,23,22] Collectively these data suggest that pain-related fear and catastrophizing may be similarly defined across these populations even though the ACLR patient population differs from chronic pain populations on injury mechanism, duration of pain, and clinical presentation of pain intensity.[6]

Subgroup analyses were performed to determine differences in FAM constructs between potentially clinically relevant factors on the shortened and original questionnaire. These analyses revealed few differences in these subgroups and the differences noted were only in the early post-operative phase. Males had higher fear (by the TSK-11) than females, and this could be because they may be more likely to be involved in sports involving collisions. Patients with allografts also reported higher fear (by the TSK-11 and TSK-FOIE), which was an unexpected finding because higher tissue damage results from autograft tissue harvesting. However, there is some debate about whether increased laxity is associated with allografts, and perhaps this influenced fear reports for these patients. Last, higher pain catastrophizing (by the PCS) was associated with patients experiencing non-contact injuries. Originally we thought this was a paradoxical finding but perhaps having minimal control or explanation for the knee injury resulted in patients having more catastrophic thoughts about pain. The results of these subgroup analyses are interesting, but we stress that these analyses were exploratory and our explanations are speculative. We did not have a priori hypotheses and did not collect data to support our explanations for these findings. Therefore these findings should be consumed with caution and are probably most useful for providing impetus for future research.

In this study a shortened TSK-FOIE scale was associated with pain and function measures for the early post-operative phase after controlling for age, sex, and catastrophizing, while our previous study using the entire TSK-11 found only pain was associated with function in the early phase.[2] This finding could be an indication that the TSK-FOIE is more appropriate for use in the early phase than the entire TSK-11 as the TSK-FOIE was associated with both pain and function in the current study. These associations would seem logical given this population, and some would argue that fear of injury is even appropriately protective in the early post-operative phase of ACLR. However, it should also be noted that in this phase activity and exercises are modified to allow healing. Chance of injury (or re-injury) is quite low and there is potential that the excessive fear of injury is a modifiable factor that may allow for earlier attainment of pain and function outcomes.

The shortened TSK-FOPL for the late post-operative phase was not associated with pain and function measures, while the original questionnaire (TSK-11) was associated with the same measures. The reason for the lack of association for the TSK-FOPL is unknown but we speculate that it could be related to the overall low levels of pain in this population, the expectation that pain is normal part of post-operative recovery, and that activity limitations are protective. The finding that the TSK-11 had association with function in later phases of ACLR rehabilitation is consistent with our previous study,[2] and suggests that the original TSK-11 may be the most appropriate measure for later stages of ACLR rehabilitation.

The TSK has a somatic focus factor[26] but its influence in this patient population appeared to be minimal. A shortened scale was identified in the current sample for the early post-operative phase (TSK-SOMFE) only. However it was not associated with pain and function scores suggesting those interested in specifically quantifying somatic focus should consider assessment with the original TSK-11 because this construct will be missed if only the TSK-FOIE is used.

There was no shortened version of the PCS in the early post operative phase, while the late post-operative phase was distinguished by shortened versions for helplessness/magnification (PCS-HML) and rumination (PCS-RUM). The full version of the PCS was not associated with pain or function in the early post-operative phase, but the PCS-HML was associated with pain intensity in the late post-operative phase. These data support the assessment of pain catastrophizing in patients with ACLR, but only for the late post-operative phase and especially when pain intensity is of interest. However, we did not collect longitudinal data in this study so it is possible that early assessment of pain catastrophizing is still indicated, especially if changes in pain catastrophizing are indicative of favorable outcomes.

When interpreting these data there are some limitations to consider. First, we recruited separate groups of patients for a convenience sample at each post-operative period. We have presented no longitudinal data and predictive conclusions cannot be made from these data. Second, there was noticeable missing PCS data for late post-operative phase. The reason for this missing data is that physical therapists inconsistently offered the PCS to patients in the late post-operative phase, while use of the TSK-11 was part of routine clinical practice. Analyses suggested that the missing PCS data were not biased by differences in age, sex, or TSK-11 score but the group that completed the PCS did have lower pain intensity ratings. Despite a potential pain intensity bias toward lower scores, our minimum sample size requirement was met and the PCS-HML scale was associated with pain intensity in the late post-operative phase. However, these PCS results may be most applicable to patients with lower pain intensity ratings. Finally, while there is not a definite need for normality assumptions to be met[20] in developing shortened questionnaires from the TSK-11 and PCS, only the TSK-11 approximated a normal distribution in this sample. The PCS was positively skewed and its distribution could account for the lack of associations observed in this study.

Our ACLR cohorts differed from those typically studied in TSK and PCS psychometric studies. Thus, our results should not be generalized to chronic musculoskeletal pain populations with different location of pain and higher pain intensity reports. The lower scores reported in this study may lead to the assumption that pain intensity, pain-related fear, and pain catastrophizing are not clinically relevant for this population. However, our analyses indicated that even with the overall low levels of distress reported in this study there were associations with knee outcomes and these psychological factors may merit further investigation in patients with ACLR.

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The shortened versions of TSK-11 and PCS reported in this manuscript are preliminary, and future studies in larger, independent samples are necessary. One of the goals of incorporating FAM measures in the rehabilitation of patients with ACLR is prediction of chronic pain development and inability to return to pre-injury activity levels. This has been done with some success when FAM measures are used to predict outcomes in other chronic pain populations. Therefore, future studies should also consider longitudinal designs and identify what levels of fear and catastrophizing are predictive of poor outcome following ACLR rehabilitation.

Conclusion

This study provides data for those interested in implementing shortened versions of the TSK-11 and/or PCS for psychological assessment following ACLR. Results from the current study suggest potential for shortened questionnaire use in the early post-operative phase (TSK-FOIE) and also the last post-operative phase (PCS-HML). These shortened questionnaires need to be validated in subsequent studies of patients with ACLR that consider their ability to predict the development of chronic pain and return to pre-injury activity levels.

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Table 1

Baseline characteristics of subjects with anterior cruciate ligament reconstruction

Variable	Early Post-Operative (n= 105)	Late Post-Operative (n= 184)
Age, mean (sd)	25.5 (9.9)	24.6 (10.3)
Sex: Female n (%)	43 (41.0%)	66 (35.9%)
ACLR graft, type (%)		
Allograft	55 (52.4%)	111 (60.3%)
Autograft	47 (44.8%)	73 (39.7%)
Method of injury, type (%)		
Contact	32 (30.5%)	23* (12.5%)
Non-contact	70 (66.7%)	58* (31.5%)
Nature of injury, sports related (%)	80 (76.2%)	66 (35.9%)
Duration (days) from surgery		
mean (sd)	54.7 (24.5)	254.5 (97.3)
median (IQR)	56.0 (31.0 – 75.5)	195.0 (174.0 – 345.5)
Highest pain intensity over last 24 hours		
mean (sd)	1.8 (2.5)	1.6 (2.2)
median (IQR)	1.0 (0.0 – 3.0)	1.0 (0.0 – 2.5)
Lowest pain intensity over last 24 hours		
mean (sd)	0.2 (0.7)	0.2 (0.8)
median (IQR)	0.0 (0.0 – 0.0)	0.0 (0.0 – 0.0)
Current pain intensity		
mean (sd)	0.6 (1.3)	0.7 (1.2)
median (IQR)	0.0 (0.0 –.3)	0.0 (0.0 – 1.0)
Composite pain intensity over last 24 hours		
mean (sd)	0.8 (1.4)	0.8 (1.3)
median (IQR)	0.3 (0.0 – 1.0)	0.3 (0.0 – 1.0)
IKDC, mean (sd)	59.5 (15.3)	83.8 (14.4)
TSK-11, mean (sd)	20.0 (6.3)	18.0 (5.4)
PCS, mean (sd)	5.4 (8.1)	3.6* (5.7)

Table Key

sd= standard deviation; IQR = interquartile range, ACLR = anterior cruciate ligament reconstruction; IKDC = International Knee Documentation Committee (IKDC) subjective form; TSK = Tampa Scale for Kinesiophobia (11 item version), PCS = Pain Catastrophizing Scale

* data available for 61 patients

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Table 2

Shortened TSK-11 Scales for Patients with Anterior Cruciate Ligament Reconstruction

	Early Post-Operative Phase			Late Post-Operative Phase		
	TSK-SOMFE	TSK-FOPE	TSK-FOIE	TSK-FOPL	Component 2	Component 3
Eigenvalue	4.6	1.3	1.2	3.8	1.5	1.1
% of variance	41.8%	11.8%	10.7%	34.2%	13.8%	9.7%
Cronbach's Alpha	0.78	0.78	0.76	0.76	0.64	0.58
TSK 1			.870		.573	
TSK 2			.822			.564
TSK 3	.840					.661
TSK 4	.545					.862
TSK 5	.740				.747	
TSK 6		.785		.715		
TSK 7		.622		.491		
TSK 8	.755			.525		
TSK 9		.731		.784		
TSK 10			.597		.793	
TSK 11		.754		.810		

Table Key

TSK = Tampa Scale for Kinesiophobia (11 item version)

TSK-SOMFE = TSK subscale somatic focus of ACLR (Items 3, 4, 5, 8)

TSK-FOPE = TSK subscale fear of pain in early phase (Items 6, 7, 9, 11)

TSK-FOIE = TSK subscale fear of injury in early phase (Items 1, 2, 10)

TSK-FOPL = TSK subscale fear of pain in late phase (Items 6, 7, 8, 9, 11)

Shaded area represents data from components not considered for shortened scale

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization (rotation converged in 5 iterations)

Items with loadings of less than 0.45 were suppressed from the table for ease of interpretation

Table 3

PCS Factor Solution for Patients with Anterior Cruciate Ligament Reconstruction

	Early Post-Operative Phase	Late Post-Operative Phase	
	PCS	**PCS-HML**	**PCS-RML**
Eigenvalue	8.2	7.6	1.5
% of variance	63.3%	58.4%	11.9%
Cronbach's Alpha	0.95	0.90	0.85
PCS 1	.824	.761	
PCS 2	.832	**.553**	**.489**
PCS 3	.846	.868	
PCS 4	.851	.844	
PCS 5	.871	.826	
PCS 6	.789	.681	
PCS 7	.618	.750	
PCS 8	.727		.730
PCS 9	.838		.868
PCS 10	.877		.880
PCS 11	.879		.909
PCS 12	.674	**.655**	**.555**
PCS 13	.653	.503	

Table Key

PCS = Pain Catastrophizing Scale

PCS-HML = PCS subscale helplessness/ magnification in late phase (Items 1, 3, 4, 5, 6, 7, 13)

PCS-RUML = PCS subscale rumination in late phase (Items 8, 9, 10, 11)

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization (rotation converged in 3 iterations)

Items with loadings of less than 0.45 were suppressed from the table for ease of interpretation

Bold font indicates cross loaded items (not included in shortened scales)

Table 4

Pearson Correlations for Pain-Related Fear Measures with Pain Intensity and Function - Early Post-Operative Phase

	Highest Pain Intensity	Lowest Pain Intensity	Current Pain Intensity	Composite Pain Intensity	IKDC
TSK	.180	.298**	.216*	.229*	−.319**
TSK-SOMFE	.169	.280**	.276**	.238*	−.233*
TSK-FOPE	.001	.174	.035	.041	−.153
TSK-FOIE	.302**	.286**	.237*	.309**	−.424**
PCS	.174	.170	.172	.190	−.298**

Table Key

TSK = Tampa Scale for Kinesiophobia (11 item version)

TSK-SOMFE = TSK subscale somatic focus of ACLR (Items 3, 4, 5, 8)

TSK-FOPE = TSK subscale fear of pain in early phase (Items 6, 7, 9, 11)

TSK-FOIE = TSK subscale fear of injury in early phase (Items 1, 2, 10)

IKDC = International Knee Documentation Committee subjective form

PCS = Pain Catastrophizing Scale

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed).

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Table 5

Pearson Correlations for Pain-Related Fear Measures and Pain – Late Post-Operative Phase

	Highest Pain Intensity	Lowest Pain Intensity	Current Pain Intensity	Composite Pain Intensity	IKDC
TSK	.404**	.255**	.428**	.425**	−.479**
TSK-FOPL	.253**	.198*	.329**	.294**	−.250**
PCS	.369**	.338**	.312*	.381**	−.180
PCS-HML	.439**	.480**	.400**	.483**	−.245
PCS-RUML	.261*	.126	.193	.231	−.090

Table Key

TSK = Tampa Scale for Kinesiophobia (11 item version)

TSK-FOPL = TSK subscale fear of pain in late phase (Items 6, 7, 8, 9, 11)

PCS = Pain Catastrophizing Scale

PCS-HML = PCS subscale helplessness/ magnification in late phase (Items 1, 3, 4, 5, 6, 7, 13)

PCS-RUML = PCS subscale rumination in late phase (Items 8, 9, 10, 11)

IKDC = International Knee Documentation Committee subjective form

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed).