Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Cross-cultural adaptation and longitudinal validation of the Simplified Chinese PHOSA-ACLR after anterior cruciate ligament reconstruction: a prospective cohort study

Jie Xu
Sichuan University
Ling Ren
Sichuan University
Jingwen Xiong
Beijing Sport University
Xiaobing Luo
Sichuan Provincial Orthopedics Hospital
Chengqi He
Sichuan University
Hua Guo
2025324020146@stu.scu.edu.cn

Sichuan University

Article

Keywords: Anterior cruciate ligament reconstruction, Kinesiophobia, Cross-cultural adaptation, Validity, PHOSA-ACLR

Posted Date: November 3rd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11005332/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

To cross-culturally adapt the Photographic Series of Sports Activities for Anterior Cruciate Ligament Reconstruction into Simplified Chinese and evaluate its measurement properties and responsiveness after anterior cruciate ligament reconstruction.

Methods

The instrument underwent forward translation, synthesis, back-translation, expert review, and pretesting in nine patients. A prospective longitudinal cohort of 177 patients aged 18 to 55 years undergoing primary unilateral anterior cruciate ligament reconstruction was assessed at one, two, four, and six months postoperatively. Internal consistency, preliminary structural validity, construct validity, floor and ceiling effects, longitudinal responsiveness, and seven- to eleven-day test-retest reliability were evaluated. The twelve-item version was used for primary analyses, with the original ten-item scoring and a clinically homogeneous subgroup examined in sensitivity analyses.

Results

At six months, the twelve-item Simplified Chinese instrument showed excellent internal consistency, with Cronbach alpha and McDonald omega both 0.968, and no substantial floor or ceiling effects. Correlations with kinesiophobia, psychological readiness to return to sport, knee self-efficacy, and knee function were in the prespecified directions. Scores decreased by 17.36 points from one to six months, with a standardized response mean of minus 0.70, compared with minus 0.13 for the seventeen-item Tampa Scale for Kinesiophobia and 0.23 for the Anterior Cruciate Ligament–Return to Sport after Injury scale. Among 168 retested patients, the intraclass correlation coefficient was 0.919, with a standard error of measurement of 7.02 points and a minimal detectable change at the 95% confidence level of 19.47 points. Sensitivity analyses were consistent.

Conclusions

The twelve-item Simplified Chinese Photographic Series of Sports Activities for Anterior Cruciate Ligament Reconstruction demonstrates excellent reliability, expected construct validity, and good early postoperative responsiveness. It may provide clinically useful task-specific information on fear of harm that complements broader psychological measures during rehabilitation.

1. Background

Following anterior cruciate ligament reconstruction (ACLR), restoration of structural stability does not necessarily indicate that a patient is psychologically ready to return to sport. Fear of reinjury, avoidance of high-risk movements, and low knee-related self-efficacy may limit rehabilitation engagement and return to the preinjury level of sport[1–7]. Existing systematic reviews suggest that kinesiophobia, self-efficacy, and psychological readiness are related but nonoverlapping psychological constructs in ACLR rehabilitation. Therefore, relying solely on knee pain or patient-reported functional scores may be insufficient to identify patients who continue to avoid tasks such as running, single-leg jumping, sudden deceleration and stopping, and pivoting or cutting maneuvers[8].

The 17-item Tampa Scale for Kinesiophobia (TSK-17) assesses generalized fear of movement/reinjury, whereas the Anterior Cruciate Ligament–Return to Sport after Injury scale (ACL-RSI) focuses on emotions, confidence in performance, and risk appraisal related to return to sport[9–12]. Both instruments are suitable for characterizing overall psychological status, but neither directly provides a hierarchy of which specific movements are perceived as most concerning. To address this gap, van Lankveld et al.[13] developed the Photographic Series of Sports Activities for Anterior Cruciate Ligament Reconstruction (PHOSA-ACLR). Patients view photographs of sports-related movements and rate the perceived harmfulness of performing each movement with the involved knee on a 0–10 scale, thereby reflecting fear of harm (FoH) associated with specific motor tasks. In the original study, squat and lunge with the involved leg in front were removed because of insufficient discrimination, resulting in a 10-item scale with a Cronbach α of 0.95, a correlation of 0.59 with the Tampa Scale for Kinesiophobia, and a 1-week test-retest intraclass correlation coefficient (ICC) of 0.86. A subsequent item response theory study retained all 12 items and supported a common latent trait[14]. Thus, both the 12-item and 10-item versions have a theoretical basis, but their performance requires re-evaluation in a new linguistic and cultural context.

Although the image-based format of the PHOSA-ACLR reduces the burden of translating lengthy text, its instructions, movement labels, and the concept of perceived “harmfulness” may still be influenced by linguistic and sports-cultural differences. Cross-cultural adaptation is not equivalent to literal translation; it should address semantic, conceptual, and experiential equivalence, assess comprehensibility and content appropriateness through pretesting in the target population, and re-evaluate measurement properties[15–17]. To date, the Simplified Chinese PHOSA-ACLR has not been systematically validated in patients undergoing ACLR in mainland China, nor has it been compared with the TSK-17 and ACL-RSI within the same longitudinal sample.

The aims of this study were to: (1) complete the cross-cultural adaptation of the PHOSA-ACLR into Simplified Chinese; (2) evaluate the internal consistency, item performance, preliminary structural validity, construct validity, and floor/ceiling effects of the 12-item version using 6-month postoperative data, with the original 10-item scoring examined in a sensitivity analysis; and (3) compare the internal consistency and longitudinal responsiveness of the PHOSA-ACLR, TSK-17, and ACL-RSI at 1, 2, 4, and 6 months postoperatively. We hypothesized that PHOSA-ACLR scores would show moderate-to-strong positive correlations with TSK-17 scores and moderate-to-strong negative correlations with ACL-RSI and

with scores on the Knee Self-Efficacy Scale (K-SES), Knee injury and Osteoarthritis Outcome Score (KOOS), and International Knee Documentation Committee 2000 Subjective Knee Form (IKDC 2000). We further hypothesized that, as a task-specific instrument, the PHOSA-ACLR might be more responsive to early postoperative change than the two global psychological measures.

2. Methods

2.1 Study Design and Ethics

This single-center prospective longitudinal cohort study was designed to perform cross-cultural adaptation and validation of the measurement properties of the instrument. Cross-cultural adaptation and evaluation of measurement properties followed relevant Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) methodological recommendations[16,17], and the design and reporting of the observational study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement[18]. The study protocol was reviewed and approved by the Ethics Committee of Sichuan Provincial Orthopedics Hospital (approval no. KY2024-037-01). All patient participants provided written informed consent before enrollment. Written informed consent was also obtained from all seven expert committee members for their participation in the expert review and the use of their expert opinions in the cross-cultural adaptation process.

2.2 Cross-Cultural Adaptation of the Simplified Chinese PHOSA-ACLR

The PHOSA-ACLR was not developed specifically for the present study. It is a previously published instrument originally developed and validated by van Lankveld et al. [13], and its latent structure was subsequently examined using item response theory [14]. The present study translated and culturally adapted this existing instrument into Simplified Chinese and evaluated its psychometric properties in Chinese patients after ACLR. Written permission to translate and culturally adapt the instrument and to use its photographs was obtained from Wim van Lankveld, the copyright holder. The translation was performed according to the cross-cultural adaptation process proposed by Beaton et al. [15]. Two bilingual translators independently completed forward translation from English into Simplified Chinese. One translator was familiar with rehabilitation after ACLR and patient-reported outcomes, whereas the other focused on everyday language. The research team compared the two translations for differences in the instructions, movement labels, and response anchors and, through discussion, produced a synthesized Chinese version. A bilingual translator who had not seen the original instrument then back-translated the synthesized Chinese version into English, and the back-translation was compared with the original instrument.

The expert committee consisted of seven members: two orthopedic surgeons specializing in sports-related knee injuries, one sports medicine physician, two rehabilitation therapists, one epidemiologist, and one language professional with experience in medical translation. All seven expert committee

members provided written informed consent to participate in the expert review and for their expert opinions to be used in the cross-cultural adaptation process. The committee focused on the semantic and conceptual equivalence of the Chinese instructions, movement labels, image-text correspondence, and response anchors. Wording that appeared overly literal, ambiguous in Chinese, or potentially capable of altering movement interpretation was discussed until consensus was reached. Because the PHOSA-ACLR is primarily image based, all 12 original photographs and their presentation order were retained without modification. The committee mainly refined instructions and movement labels that could be affected by linguistic expression or sports-cultural differences, prioritizing Simplified Chinese wording commonly used in clinical practice that accurately described the movements shown while preserving the original conceptual meaning. This process yielded the pretest version. Before formal data collection, the pretest was administered to 9 patients with ACLR representative of the target population. They were 22–48 years old; 5 were men and 4 were women. Educational attainment ranged from junior high school or below to postgraduate education. Preinjury exercise frequency included 1–3 times/month, 1–3 times/week, and 4–7 times/week, and injury contexts included ball sports, non-ball sports, non-sport activities, and unclear activity types. Patients independently read the instructions, viewed the 12 sports-activity photographs, and completed the 0–10 ratings. They then provided feedback on the comprehensibility of the general instructions, the distinction between the concepts of “pain” and “harm,” the movement labels, image-text correspondence, and the rating method.

Pretesting focused on whether patients correctly understood that the instrument assessed the perceived harmfulness of each movement to the involved knee rather than the intensity of pain, whether they could correctly identify the movement shown in each image, and whether any movement label was ambiguous or inconsistent with the image. The research team further revised the Chinese wording based on patient feedback and expert committee input, resulting in the final Simplified Chinese PHOSA-ACLR for formal administration. The final version included 12 sports activities: running, landing after a jump, squat, lateral lunge, single-leg jump, sliding, sudden deceleration and stopping, single-leg hop, lunge with the involved leg in front, starting a sprint, landing from a trampoline jump, and pivoting/cutting. For each photograph, participants imagined performing the movement with the involved knee and rated how harmful they believed the movement might be on a 0–10 scale, where 0 indicated “completely harmless” and 10 indicated “extremely harmful.”

2.3 Participants

Participants were drawn from the prospective longitudinal ACLR follow-up cohort established by the Department of Knee Sports Injuries at Sichuan Provincial Orthopedics Hospital. Patients entered the cohort after undergoing ACLR and providing written informed consent and were assessed with patient-reported outcome measures at 1, 2, 4, and 6 months postoperatively according to the predefined protocol. The present study was conducted within this existing prospective ACLR cohort, and the sample for measurement-property analyses was selected according to prespecified age and other eligibility criteria. Inclusion criteria were: (1) age 18–55 years at the time of surgery; (2) clinically and radiologically confirmed unilateral anterior cruciate ligament (ACL) injury treated with primary unilateral ACLR; (3)

Simplified Chinese as the primary language of communication, with the ability to understand the PHOSA-ACLR instructions, identify the images, and independently complete the electronic questionnaire; (4) voluntary participation with written informed consent; and (5) willingness to complete follow-up at 1, 2, 4, and 6 months postoperatively according to the study protocol. Exclusion criteria were: (1) age < 18 or > 55 years; (2) bilateral ACL injury or revision ACLR; (3) other serious lower-extremity injuries likely to substantially affect judgment of sports movements, involved-knee function, or the rehabilitation course; (4) cognitive, language, or visual impairment preventing correct understanding of the instructions, recognition of the images, or independent questionnaire completion; and (5) refusal to continue participation.

The primary measurement-property analyses included cases within the eligible age range with the corresponding item-level data. All patients underwent primary unilateral arthroscopic ACLR. Recorded surgical variables included graft type, concomitant lateral extra-articular tenodesis (LET), and meniscal treatment. Graft types were categorized as ipsilateral hamstring tendon autograft, autograft including the peroneus longus tendon, or contralateral hamstring tendon autograft. Meniscal treatment was categorized as single-stitch meniscal repair, meniscectomy without repair, or no meniscal surgery. Single-stitch meniscal repair did not alter the early weight-bearing or range-of-motion progression protocol used in this study and was therefore retained in the primary analysis. Item-level PHOSA-ACLR, TSK-17, and ACL-RSI responses at 1, 2, 4, and 6 months postoperatively were scored from the original responses, with no statistical imputation for missing items. Graft type, prolonged immobilization after injury, meniscal treatment, acute versus chronic injury, concomitant LET, and injury activity type were not exclusion criteria for the primary analysis cohort; instead, these factors were further screened according to prespecified criteria in the clinically homogeneous sensitivity analysis. The final 177 patients had complete item-level PHOSA-ACLR, TSK-17, and ACL-RSI data at all four postoperative time points, and no statistical imputation was performed. Sample size was considered a priori according to the number of items in the measurement instrument. Using a minimum of 10 participants per item for the 12-item PHOSA-ACLR, at least 120 participants were required for structural validity analysis; the 177 participants in this study met this criterion. The retest sample comprised 168 patients, also exceeding commonly recommended minimum sample sizes for reliability studies.

2.4 Measures and Data Collection

All measures were administered in the same versions at 1, 2, 4, and 6 months postoperatively. The primary instrument was the Simplified Chinese PHOSA-ACLR, which retained all 12 items. The total score for the 12-item version was calculated as the mean item score ×10 and transformed to a 0–100 scale; higher scores indicated greater perceived harmfulness of specific sports movements, that is, greater task-specific fear of harm. The 12-item version was the primary analytical version. In addition, consistent with item selection in the original study, item 3 (squat) and item 9 (lunge with the involved leg in front) were removed to calculate a 10-item score for sensitivity analysis. The 10-item version was likewise calculated as the mean item score ×10 and transformed to a 0–100 scale. Comparator instruments included the Simplified Chinese TSK-17 and ACL-RSI. Construct validity was additionally examined using

the Knee Self-Efficacy Scale (K-SES), the Simplified Chinese IKDC 2000, and all five KOOS subscales. The TSK-17 contains 17 items scored from 1 to 4, with total scores ranging from 17 to 68; higher scores indicate greater kinesiophobia[9]. The ACL-RSI contains 12 items and is transformed to a 0–100 scale, with higher scores indicating greater psychological readiness to return to sport[19]. Higher K-SES scores indicate greater knee-related self-efficacy[20]. IKDC 2000 and KOOS scores were transformed to 0–100 in the standard direction, with higher scores indicating better knee status[21,22]. At each follow-up, research staff contacted patients via WeChat and sent a questionnaire link, which patients completed independently online using Wenjuanxing (Questionnaire Star). After submission, research staff checked completion status and key items; if an omission was identified, the patient was contacted via WeChat for verification. Exported questionnaire data were longitudinally matched by study identification number, followed by range checks, item-level scoring verification, and duplicate-record checks before statistical analysis.

2.5 Measurement Hypotheses and Statistical Analysis

Continuous variables were described as mean ± standard deviation (SD) or median (interquartile range [IQR]) according to their distribution, and categorical variables as number (percentage). Data from 6 months postoperatively were used as the primary cross-sectional time point for measurement-property evaluation. Internal consistency was assessed using Cronbach α and McDonald ω, with values ≥ 0.70 considered acceptable; corrected item-total correlations and α if item deleted were also calculated. Suitability for factor analysis was evaluated using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. A one-factor principal axis factoring model based on the correlation matrix was used to evaluate factor loadings and the strength of the common factor. A floor or ceiling score observed in > 15% of participants was defined as a substantial floor or ceiling effect.

Construct validity was evaluated using Spearman rank correlations. A priori, PHOSA-ACLR scores were expected to correlate positively with TSK-17 scores and negatively with ACL-RSI, K-SES, IKDC 2000, and the five standard-scored KOOS subscales. Absolute ρ values of 0.10–0.29, 0.30–0.49, and ≥ 0.50 were interpreted as weak, moderate, and strong correlations, respectively. Longitudinal change across the complete cases at 1, 2, 4, and 6 months postoperatively was assessed using the Friedman test with tie correction. Paired change from 1 to 6 months postoperatively was assessed using the Wilcoxon signed-rank test, and the standardized response mean (SRM; mean change/SD of the change score) was calculated. To further interpret the overall change in TSK-17 scores across the four postoperative time points, supplementary pairwise comparisons between time points were conducted using Wilcoxon signed-rank tests with Holm correction for multiple comparisons. Internal consistency, floor/ceiling effects, and SRMs were compared descriptively among the PHOSA-ACLR, TSK-17, and ACL-RSI at each time point; test-retest reliability was not compared among the three instruments. Statistical significance was set at a two-sided $\alpha = 0.05$.

Longitudinal analyses centered on the PHOSA-ACLR. Scores were described preoperatively and at 1, 2, 4, and 6 months postoperatively, and complete cases across all five time points were analyzed using the Friedman test with tie correction. Paired comparisons between each postoperative time point and the

preoperative assessment were performed using the Wilcoxon signed-rank test with Holm-adjusted P values, and SRMs were also reported. The TSK-17 and ACL-RSI were used only as comparative measurement references from 1 to 6 months postoperatively, whereas the K-SES, IKDC 2000, and KOOS were used primarily to test construct validity at 6 months postoperatively. TSK-17 scores were calculated according to standard scoring rules at the preoperative and all postoperative time points, and total scores were included in the longitudinal analysis. Internal-consistency and item-level analyses were based on item-level data collected at 1, 2, 4, and 6 months postoperatively.

Test-retest reliability was evaluated at 6 months postoperatively, when patients were generally in a relatively stable phase of rehabilitation. The 7–11-day retest window was selected to reduce recall effects while limiting true changes in clinical status. Repeated PHOSA-ACLR assessments were included when both questionnaires were complete and the interval met the prespecified window. A two-way random-effects, absolute-agreement, single-measure intraclass correlation coefficient [ICC(A,1)] was used, and bootstrap 95% confidence intervals (CIs), the standard error of measurement (SEM), the minimal detectable change at the 95% confidence level (MDC95), and Bland-Altman limits of agreement were reported. A clinically homogeneous sensitivity analysis was also performed by excluding patients with a graft including the peroneus longus tendon, prolonged immobilization after injury, any meniscal repair, chronic injury, concomitant ACLR + LET, non-sport injury, unclear injury activity type, or contralateral graft harvest/other graft types. In this sensitivity sample, 6-month postoperative internal consistency and construct validity, postoperative longitudinal change, and 7–11-day test-retest reliability were re-evaluated.

3. Results

3.1 Cross-Cultural Adaptation and Pretest Results

After forward translation, synthesis, back-translation, and expert committee review, the PHOSA-ACLR versions remained conceptually consistent overall. Revisions primarily involved the Chinese wording of the general instructions and selected sports-movement labels; all 12 original movement photographs, their order, and the 0–10 rating format were retained. Nine patients with ACLR participated in pretesting, with a mean age of 31.00 ± 8.97 years (range, 22–48 years); 5 were men and 4 were women. Educational attainment ranged from junior high school or below to postgraduate education, preinjury exercise frequency ranged from 1–3 times/month to 4–7 times/week, and participants represented varied sports and injury backgrounds. All 9 patients correctly identified the 12 movement photographs and completed the 0–10 ratings, with 100% comprehension of the response anchors. Seven patients (77.8%) directly understood the general instructions and the distinction between “pain” and “harm,” whereas 2 (22.2%) required further explanation on first reading. The main issue was that the term “distress” used in the initial translation was associated with the experience of pain during movement (Supplementary Table 1). To emphasize that the PHOSA-ACLR assesses perceived potential harm from a movement rather than pain intensity, the final instruction was clarified as: “Do not consider the degree of pain you imagine; consider only how harmful you believe the movement is to your knee.”

For movement labels, pretest feedback focused primarily on expressions corresponding to “side lunge,” “sliding (similar to a slide tackle in soccer),” “sudden deceleration–stop (abrupt stop),” “hopscotch (side-to-side hopping on the involved leg),” “start sprinting,” “jumping and landing on a trampoline,” and “rotational movement (switching/changing direction)” (Supplementary Table 2). “Hopscotch” generated the most concern: 3 patients (33.3%) felt that the label readily evoked a specific game context. Two patients (22.2%) each considered the expressions for “side lunge,” “sliding,” and “rotational movement” insufficiently clear or likely to introduce additional situational cues. Based on patient feedback and expert committee discussion, these labels were standardized to “lateral lunge,” “sliding,” “sudden deceleration and stop,” “single-leg hop,” “starting a sprint,” “landing from a trampoline jump,” and “pivoting/cutting,” respectively. In addition, “landing after jumping” was standardized to “landing after a jump,” and “lunge-involved leg in front” to “lunge (involved leg in front)” to ensure consistency of movement terminology. All 9 patients completed ratings for all 12 items; no image was unrecognizable, and no need to add or remove image items was identified. Following these linguistic refinements, the final Simplified Chinese PHOSA-ACLR for formal administration was established.

3.2 Participant Flow and Sample Characteristics

A total of 234 patients entered the prospective ACLR follow-up cohort. Outcome data were available for 232, 229, 217, and 198 patients at 1, 2, 4, and 6 months postoperatively, respectively. Of the 198 patients with 6-month data, 21 were excluded because they did not meet the prespecified age range of 18–55 years, leaving 177 patients for the primary measurement-property analyses. The patient screening and analysis flow is shown in Fig. 1. Mean age was 30.15 ± 7.85 years (range, 18–52 years), 122 patients (68.9%) were men, and mean body mass index (BMI) was 24.82 ± 3.65 kg/m². Isolated ACLR was performed in 119 patients (67.2%), and ACLR with concomitant LET in 58 (32.8%). Complete item-level PHOSA-ACLR, TSK-17, and ACL-RSI data were available for all 177 patients at 1, 2, 4, and 6 months postoperatively. Demographic and clinical characteristics are presented in Table 1.

Note

The parent prospective cohort comprised 234 patients. The primary measurement-property analysis included 177 age-eligible patients. The clinically homogeneous sensitivity sample was obtained after exclusion of prespecified potentially confounding clinical factors. Test-retest analyses were restricted to participants with complete retest assessments performed within 7–11 days. ACLR, anterior cruciate ligament reconstruction; LET, lateral extra-articular tenodesis.

Table 1
Demographic and clinical characteristics of the included patients (n = 177)

Characteristic	Value
Age, years	30.15 ± 7.85
BMI, kg/m²	24.82 ± 3.65
Male, n (%)	122 (68.9)
Education: junior high school or below, n (%)	7 (4.0)
Education: senior high school/technical secondary school, n (%)	15 (8.5)
Education: junior college, n (%)	39 (22.0)
Education: bachelor's degree, n (%)	91 (51.4)
Education: postgraduate or above, n (%)	25 (14.1)
Preinjury exercise 1–3 times/month, n (%)	49 (27.7)
Preinjury exercise 1–3 times/week, n (%)	67 (37.9)
Preinjury exercise 4–7 times/week, n (%)	61 (34.5)
Prolonged immobilization after injury, n (%)	3 (1.7)
Acute injury (≤ 6 months), n (%)	145 (81.9)
Ball-sport injury, n (%)	111 (62.7)
Non-ball-sport athletic injury, n (%)	21 (11.9)
Non-sport injury, n (%)	26 (14.7)
Unclear injury activity type, n (%)	19 (10.7)
Isolated ACLR, n (%)	119 (67.2)
ACLR + LET, n (%)	58 (32.8)
Any meniscal repair, n (%)	38 (21.5)
Meniscectomy without repair, n (%)	60 (33.9)
No meniscal surgery, n (%)	79 (44.6)
Ipsilateral hamstring tendon graft, n (%)	161 (91.0)
Graft including peroneus longus tendon, n (%)	15 (8.5)

Note: Continuous variables are presented as mean ± SD. Non-sport activities included bicycle commuting, walking, stair climbing, lifting or carrying heavy objects, and traffic- or external-force-related events. "Unclear activity type" indicates that the patient reported only a fall, injury from falling, sprain, or similar event, without sufficient information to determine the specific activity type. ACLR, anterior cruciate ligament reconstruction; LET, lateral extra-articular tenodesis.

Characteristic	Value
Contralateral hamstring tendon graft, n (%)	1 (0.6)

Note: Continuous variables are presented as mean ± SD. Non-sport activities included bicycle commuting, walking, stair climbing, lifting or carrying heavy objects, and traffic- or external-force-related events. “Unclear activity type” indicates that the patient reported only a fall, injury from falling, sprain, or similar event, without sufficient information to determine the specific activity type. ACLR, anterior cruciate ligament reconstruction; LET, lateral extra-articular tenodesis.

3.3 Internal Consistency and Preliminary Structural Validity of the 12-Item PHOSA-ACLR

At 6 months postoperatively, the mean score of the 12-item PHOSA-ACLR was 40.32 ± 24.27, with a median of 41.67. Cronbach α = 0.968 and McDonald ω = 0.968. Corrected item-total correlations ranged from 0.755 to 0.911, and α if an item was deleted ranged from 0.963 to 0.967, providing no indication that removal of any single item would meaningfully improve internal consistency. The floor effect was 5.6% and the ceiling effect was 0.6%.

The KMO value was 0.941, and Bartlett’s test of sphericity was significant (χ^2=2649.86, df = 66, P < 0.001), indicating that the data were suitable for factor analysis. Factor loadings for the 12 items in the one-factor principal axis factoring model ranged from 0.775 to 0.931. The first eigenvalue of the correlation matrix was 8.91, explaining 74.2% of the total variance, and the ratio of the first to second eigenvalue was 7.41. These findings support the presence of a dominant common factor; however, because the second eigenvalue was 1.20, strict unidimensionality should be further examined using confirmatory factor analysis (CFA) or item response theory (IRT) in an independent sample.

Table 2
Item analysis of the 12-item PHOSA-ACLR at 6 months postoperatively (n = 177)

Item	Mean ± SD	Corrected item-total r	Factor loading	α if item deleted
1. Running	2.85 ± 2.60	0.800	0.819	0.966
2. Landing after a jump	3.11 ± 2.74	0.849	0.869	0.965
3. Squat	2.84 ± 2.60	0.755	0.776	0.967
4. Lateral lunge	4.51 ± 2.92	0.838	0.849	0.965
5. Single-leg jump	3.88 ± 2.77	0.911	0.931	0.963
6. Sliding	4.69 ± 3.00	0.789	0.797	0.966
7. Sudden deceleration and stop	5.17 ± 2.95	0.828	0.834	0.965
8. Single-leg hop	4.11 ± 2.79	0.894	0.911	0.963
9. Lunge (involved leg in front)	3.08 ± 2.69	0.816	0.836	0.966
10. Starting a sprint	4.25 ± 2.94	0.870	0.883	0.964
11. Landing from a trampoline jump	4.29 ± 2.90	0.869	0.882	0.964
12. Pivoting/cutting	5.60 ± 2.94	0.768	0.775	0.967

Note: Each item is scored from 0 to 10; higher scores indicate greater perceived harmfulness. Factor loadings were derived from one-factor principal axis factoring.

3.4 Construct Validity

At 6 months postoperatively, the total score of the 12-item PHOSA-ACLR showed a strong positive correlation with the TSK-17 (ρ = 0.563) and strong negative correlations with the ACL-RSI (ρ=−0.519), K-SES (ρ=−0.623), and IKDC 2000 (ρ=−0.669). Moderate-to-strong negative correlations were observed with all five standard-scored KOOS subscales, with the strongest correlation for Sport and Recreation Function (ρ=−0.581) and the weakest for Symptoms (ρ=−0.431). All correlations were in the prespecified directions, and all P values were < 0.001.

Table 3
Spearman correlations between PHOSA-ACLR and other patient-reported outcomes at 6 months postoperatively

Comparator	n	12-item ρ	P value	10-item ρ	P value
TSK-17	177	0.563	< 0.001	0.546	< 0.001
ACL-RSI	177	−0.519	< 0.001	−0.520	< 0.001
K-SES	177	−0.623	< 0.001	−0.609	< 0.001
IKDC 2000	177	−0.669	< 0.001	−0.657	< 0.001
KOOS Pain	177	−0.549	< 0.001	−0.535	< 0.001
KOOS Symptoms	177	−0.431	< 0.001	−0.420	< 0.001
KOOS Activities of Daily Living	177	−0.553	< 0.001	−0.528	< 0.001
KOOS Sport and Recreation Function	177	−0.581	< 0.001	−0.575	< 0.001
KOOS Knee-Related Quality of Life	177	−0.519	< 0.001	−0.526	< 0.001

Note: Higher PHOSA-ACLR scores indicate greater fear of harm. Higher ACL-RSI, K-SES, IKDC 2000, and standard-scored KOOS scores indicate better psychological readiness, self-efficacy, or knee status; therefore, negative correlations were expected.

3.5 Comparative Measurement Performance of the PHOSA-ACLR, TSK-17, and ACL-RSI

Table 4
Scores and internal consistency of the PHOSA-ACLR, TSK-17, and ACL-RSI at each postoperative time point

Time point	n	PHOSA-ACLR	α	TSK-17	α	ACL-RSI	α
1 month postoperative	177	57.69 ± 24.09	0.964	36.88 ± 7.01	0.847	61.45 ± 18.45	0.934
2 months postoperative	177	48.86 ± 21.77	0.955	35.94 ± 7.33	0.862	63.57 ± 18.63	0.954
4 months postoperative	177	44.39 ± 23.92	0.969	36.51 ± 7.25	0.845	63.96 ± 18.62	0.955
6 months postoperative	177	40.32 ± 24.27	0.968	36.06 ± 7.60	0.845	65.24 ± 20.02	0.967

Note: Scores are presented as mean ± SD; n = 177 at each time point. TSK-17 items 4, 8, 12, and 16 were reverse-scored before calculation of the total score. Higher PHOSA-ACLR and TSK-17 scores indicate worse status, whereas higher ACL-RSI scores indicate better status.

Cronbach α ranged from 0.955 to 0.969 for the PHOSA-ACLR, from 0.934 to 0.967 for the ACL-RSI, and from 0.845 to 0.862 for the TSK-17 across time points. Floor and ceiling effects were < 15% for all three instruments at all time points. From 1 to 6 months postoperatively, PHOSA-ACLR scores decreased by a mean of 17.36 points (SRM = − 0.70), TSK-17 scores decreased by 0.81 points (SRM = − 0.13), and ACL-RSI scores increased by 3.79 points (SRM = 0.23). The magnitude of change for the PHOSA-ACLR was moderate to large, whereas changes for the other two instruments were small.

Table 5
Longitudinal trajectory of PHOSA-ACLR scores from preoperative assessment to 6 months postoperatively

Time point	n	Mean ± SD	Median (IQR)	Change from preoperative	SRM
Preoperative	170	55.03 ± 23.96	57.91 (36.88, 73.12)	—	—
1 month postoperative	177	57.69 ± 24.09	60.00 (41.67, 75.00)	3.19	0.15
2 months postoperative	177	48.86 ± 21.77	51.67 (35.83, 64.17)	−5.75	−0.28
4 months postoperative	177	44.39 ± 23.92	49.17 (25.83, 61.67)	−10.39	−0.43
6 months postoperative	177	40.32 ± 24.27	41.67 (20.83, 57.50)	−14.46	−0.57

Note: Complete cases across all five time points, n = 170; Friedman χ^2=107.05, df = 4, P < 0.001. Change from preoperative assessment and SRM were based on paired cases available at each time point. Holm-adjusted P values for postoperative months 2, 4, and 6 versus preoperative assessment were all < 0.01; P = 0.070 at postoperative month 1.

PHOSA-ACLR scores increased transiently by 3.19 points at 1 month postoperatively relative to preoperative scores (SRM = 0.15; Holm-adjusted P = 0.070) and then declined progressively. At 2, 4, and 6 months postoperatively, scores were 5.75, 10.39, and 14.46 points lower than preoperative values, with SRMs of − 0.28, − 0.43, and − 0.57, respectively. The overall difference across the five time points was significant (χ^2=107.05, P < 0.001). This trajectory suggests that perceived harmfulness of specific movements may temporarily increase during the early postoperative protection phase and then decline as rehabilitation progresses. Other patient-reported outcomes were used only for construct-validity assessment and comparative interpretation and were not the primary focus of the longitudinal results.

Table 6
Responsiveness of the three psychological measures from 1 to 6 months postoperatively

Instrument	n	1 month postoperative	6 months postoperative	Mean change	SRM	P value
PHOSA-ACLR	177	57.69 ± 24.09	40.32 ± 24.27	−17.36	−0.70	< 0.001
TSK-17	177	36.88 ± 7.01	36.06 ± 7.60	−0.81	−0.13	0.091
ACL-RSI	177	61.45 ± 18.45	65.24 ± 20.02	3.79	0.23	0.003

Note: P values are from paired Wilcoxon signed-rank tests. Change = 6-month postoperative score − 1-month postoperative score. SRM=mean change/SD of the change score.

Complete-case analysis across the four postoperative time points (n = 177) showed significant change in PHOSA-ACLR scores over time (Friedman χ^2=98.05, df = 3, P < 0.001). The overall time effect for the TSK-17 reached statistical significance (χ^2=8.01, df = 3, P = 0.046), but none of the pairwise Wilcoxon comparisons between time points remained statistically significant after Holm correction (smallest adjusted P = 0.091). The overall time effect for the ACL-RSI was significant (χ^2=11.86, df = 3, P = 0.008). Change in PHOSA-ACLR scores correlated weakly and positively with change in TSK-17 scores (ρ = 0.269, P < 0.001) and weakly and negatively with change in ACL-RSI scores (ρ=−0.293, P < 0.001), indicating that the three instruments captured related but nonidentical changes.

3.6 Sensitivity Analyses

At 6 months postoperatively, the mean score of the 10-item version was 42.47 ± 24.93, with Cronbach α = 0.965, McDonald ω = 0.965, and KMO = 0.930. The directions and magnitudes of correlations with comparator measures were consistent with the primary 12-item analysis. A more conservative sensitivity analysis was then performed according to clinical conditions: 15 patients had grafts including the peroneus longus tendon, 3 had prolonged immobilization, 38 had any meniscal repair, 32 had chronic injuries, 58 underwent ACLR + LET, 26 had non-sport injuries, 19 had unclear injury activity types, and 1 had contralateral graft harvest/another graft type. These conditions overlapped; after excluding the union of these categories, 120 patients were excluded and 57 remained. In this sample, the 12-item version at 6 months postoperatively showed α = 0.977, ω = 0.978, and KMO = 0.911. The correlation with TSK-17 was ρ = 0.480; correlations with ACL-RSI, K-SES, IKDC 2000, and the five KOOS subscales were − 0.410, − 0.533, − 0.629, and − 0.573 to − 0.435, respectively. PHOSA-ACLR scores decreased by 21.21 points from 1 to 6 months postoperatively (SRM = − 0.78), with a significant overall difference across the four time points (χ^2=45.40, P < 0.001). Among 53 patients who completed the 7–11-day retest, ICC(A,1) = 0.928 (95% CI 0.885–0.955). These findings were directionally consistent with the primary analysis (Table 7).

Table 7
Sensitivity analysis of key measurement properties in the clinically homogeneous sample

Metric	Full sample	Post-exclusion sample
Analysis sample size	177	57
Number excluded	—	120
12-item PHOSA-ACLR at 6 months	40.32 ± 24.27	35.32 ± 26.94
Cronbach α (12-item)	0.968	0.977
McDonald ω (12-item)	0.968	0.978
KMO (12-item)	0.941	0.911
Spearman ρ with TSK-17	0.563	0.480
Spearman ρ with ACL-RSI	−0.519	−0.410
Spearman ρ with K-SES	−0.623	−0.533
Spearman ρ with IKDC 2000	−0.669	−0.629
Range of ρ across five KOOS subscales	−0.581 to − 0.431	−0.573 to − 0.435
Change from 1 to 6 months postoperative	−17.36, SRM = − 0.703	−21.21, SRM = − 0.779
Friedman test across four postoperative time points	χ^2=98.05, n = 177	χ^2=45.40, n = 57
ICC analysis sample size	168	53
ICC(A,1), 12-item	0.919 (0.893–0.940)	0.928 (0.885–0.955)
SEM / MDC95, 12-item	7.02 / 19.47	7.30 / 20.22
Cronbach α / ICC(A,1), 10-item	0.965 / 0.920	0.975 / 0.929

Note: ICC analyses were restricted to complete retests performed within 7–11 days.

3.7 Test-Retest Reliability and Measurement Error

Among the 177 age-eligible patients, 4 did not complete retesting and 5 had retest intervals of 12–14 days. Therefore, 168 patients with complete retests performed within 7–11 days were included in the test-retest reliability analysis. Retest intervals of 7, 8, 9, 10, and 11 days were observed in 150, 9, 4, 2, and 3 patients, respectively.

For the 12-item version, mean scores at the initial assessment (T1) and retest assessment (T2) were 40.50 ± 24.40 and 40.81 ± 25.08, respectively, with ICC(A,1) = 0.919 (bootstrap 95% CI 0.893–0.940), SEM = 7.02 points, and MDC95 = 19.47 points. The mean difference between measurements was 0.31

points, and the Bland-Altman 95% limits of agreement were − 19.21 to 19.82 points. For the 10-item version, ICC(A,1) = 0.920 (bootstrap 95% CI 0.895–0.940), SEM = 7.18 points, and MDC95 = 19.91 points, consistent with the 12-item results.

Table 8
Test-retest reliability and measurement error of the PHOSA-ACLR over 7–11 days (n = 168)

Scoring version	T1 mean ± SD	T2 mean ± SD	ICC(A,1)	SEM	MDC95	Mean difference
12-item	40.50 ± 24.40	40.81 ± 25.08	0.919 (0.893–0.940)	7.02	19.47	0.31 (− 19.21 to 19.82)
10-item	42.56 ± 25.04	42.80 ± 25.89	0.920 (0.895–0.940)	7.18	19.91	0.24 (− 19.71 to 20.20)

Note: ICC was calculated using a two-way random-effects, absolute-agreement, single-measure model [ICC(A,1)]. The 95% CIs were obtained using 5,000 participant-level bootstrap resamples. T1 denotes the initial assessment and T2 the retest assessment; mean difference=T2 − T1.

4. Discussion

The principal finding of this study is that the 12-item Simplified Chinese PHOSA-ACLR demonstrated excellent internal consistency, a dominant common factor, no substantial floor or ceiling effects, and construct associations in the expected directions with kinesiophobia, psychological readiness, self-efficacy, and patient-reported knee function at 6 months after ACLR. The PHOSA-ACLR also showed greater responsiveness from 1 to 6 months postoperatively than the TSK-17 and ACL-RSI. Removing the two items excluded in the original study produced very similar results. We therefore retained the 12-item version for the Chinese adaptation and used the original 10-item score as a sensitivity analysis.

The ICC(A,1) was 0.919 for the 12-item version and 0.920 for the 10-item version, both indicating excellent reliability. The mean difference between the two measurements was close to zero, suggesting little overall systematic bias within the 7–11-day interval. For the 12-item version, SEM was 7.02 points and MDC95 was 19.47 points, indicating that, at the individual level, a change approaching 20 points is needed to be reasonably confident that the observed change exceeds random measurement error. At the group level, mean change can instead be interpreted together with its confidence interval. The ICC observed here was higher than the 0.86 reported in the abstract of the original study[13], possibly because of differences in sample size, retest interval, rehabilitation stage, or scoring version.

Internal consistency in the present study was slightly higher than the α = 0.95 reported for the original 10-item version by van Lankveld et al[13]. Corrected item-total correlations were > 0.75 and factor loadings were > 0.77 for all 12 items, indicating that each sports photograph was closely related to the overall fear-of-harm construct. The original study removed squat and lunge with the involved leg in front on the basis of discrimination, whereas a subsequent IRT study retained all 12 items and supported a common latent trait[14]. In the present study, α and ω were slightly lower after these two items were removed, and validity correlations changed very little. Item retention should therefore consider not only

internal consistency, but also the relevance and comprehensibility of the movements for Chinese patients and their usefulness in a clinical fear hierarchy. We therefore retained the 12-item version for the Chinese adaptation and used the original 10-item score as a sensitivity analysis.

The correlation between the PHOSA-ACLR and TSK-17 was 0.563, close to the r = 0.59 reported in the original study[13]. This supports that both instruments capture concerns related to movement-associated harm or reinjury, while operating at different levels of measurement. The PHOSA-ACLR also showed significant negative correlations with the ACL-RSI, K-SES, and knee-function measures, and change in PHOSA-ACLR scores correlated only weakly with changes in TSK-17 and ACL-RSI scores. The weak correlations between longitudinal changes suggest that the three scales capture different aspects of psychological recovery. The TSK-17 reflects generalized fear-avoidance beliefs, the ACL-RSI focuses on confidence, emotions, and reinjury-risk appraisal, whereas the PHOSA-ACLR is anchored to specific sports movements. The cross-sectional correlations support convergent validity, while their moderate magnitude indicates that the PHOSA-ACLR provides task-specific information not fully captured by the other instruments[23,24].

The longitudinal findings further demonstrate the potential clinical value of the instrument. PHOSA-ACLR scores decreased by 17.36 points from 1 to 6 months postoperatively, with an absolute SRM of 0.70, compared with only 0.13 for the TSK-17 and 0.23 for the ACL-RSI. The larger change in PHOSA-ACLR scores does not imply that it is a better measure overall. Its greater responsiveness may instead reflect the rapid changes in patients' perceptions of specific movements as functional exposure increases during early rehabilitation. Generalized kinesiophobia and psychological readiness to return to sport are also influenced by pain, the target sport, appraisal of reinjury risk, and the timing of formal return to sport. Used together, the three instruments can provide complementary information on movement-level fear, global fear, and psychological readiness to return to sport[25].

When preoperative data were incorporated, PHOSA-ACLR scores showed a stage-dependent trajectory rather than a simple linear improvement. Mean scores were slightly higher at 1 month postoperatively than preoperatively, although the difference was not statistically significant; scores fell below preoperative levels by 2 months, with progressively larger reductions at 4 and 6 months. The early postoperative increase may reflect the protection and activity restrictions typical of the initial rehabilitation phase. Scores then declined as patients were progressively exposed to running, jumping, and change-of-direction tasks. PHOSA-ACLR scores should therefore be interpreted in relation to the stage of rehabilitation rather than against a single cross-sectional threshold.

Clinically, the PHOSA-ACLR provides both a total score and a movement-specific fear hierarchy. For example, in this sample, mean harmfulness ratings were higher for pivoting/cutting and sudden deceleration and stopping, whereas ratings were lower for running and squat. Rehabilitation therapists may interpret highly feared movements alongside objective load capacity, pain, and movement quality to support patient education, graded exposure, and stage-specific goal setting. The PHOSA-ACLR should not be used as a stand-alone criterion for clearance to return to sport, nor should a high score

automatically be equated with irrational fear. When graft biology, strength, neuromuscular control, or medical restrictions do not yet permit high-risk movements, cautious appraisal may be adaptive[26].

This study has several strengths. The same cohort was followed from the preoperative assessment through four postoperative time points, with PHOSA-ACLR, TSK-17, and ACL-RSI assessed at each postoperative visit. The K-SES, all five KOOS subscales scored in the standard direction, and IKDC 2000 were included to test multiple construct relationships. Item-level data allowed standardized rescoring of the TSK-17. Retest data from 168 patients over 7–11 days enabled estimation of both test-retest reliability and measurement error. Conclusions were consistent between the 12-item and 10-item scoring approaches. After excluding eight categories of clinical factors that could affect postoperative recovery trajectories or were insufficiently classified, the internal consistency, direction of validity correlations, and longitudinal responsiveness in the 57-patient clinically homogeneous sample, together with the retest ICC in 53 patients, continued to support the primary findings. Several limitations should also be acknowledged. First, the single-center design and the smaller sensitivity-analysis sample limit external generalizability, and the eight exclusion criteria used for the sensitivity analysis were conservative. Second, follow-up extended only to 6 months postoperatively, precluding evaluation during formal return to pivoting sports and assessment of predictive validity. Third, no external anchor was used to estimate a minimal important change; therefore, MDC95 should not be interpreted as a threshold for clinical importance. Selection bias arising from follow-up and sample screening also cannot be completely excluded.

5. Conclusions

In this study of 177 patients undergoing ACLR (observed age range, 18–52 years), the 12-item Simplified Chinese PHOSA-ACLR demonstrated excellent internal consistency and test-retest reliability, a dominant common factor, construct validity in the expected directions, and good early postoperative longitudinal responsiveness. Sensitivity analyses using the 10-item scoring and a clinically homogeneous sample after exclusion of eight categories of clinical factors supported the robustness of the main findings. Compared with the TSK-17 and ACL-RSI, the PHOSA-ACLR may be more sensitive to early changes in fear of harm associated with specific sports movements; however, the three instruments assess complementary constructs and should not be considered interchangeable.

Abbreviations

ACL
anterior cruciate ligament
ACLR
anterior cruciate ligament reconstruction
ACL-RSI
Anterior Cruciate Ligament–Return to Sport after Injury scale
BMI

body mass index
CFA
confirmatory factor analysis
CI
confidence interval
COSMIN
Consensus-based Standards for the selection of health Measurement Instruments
FoH
fear of harm
ICC
intraclass correlation coefficient
IKDC 2000
International Knee Documentation Committee 2000 Subjective Knee Form
IQR
interquartile range
IRT
item response theory
KMO
Kaiser-Meyer-Olkin
K-SES
Knee Self-Efficacy Scale
KOOS
Knee injury and Osteoarthritis Outcome Score
LET
lateral extra-articular tenodesis
MDC95
minimal detectable change at the 95% confidence level
PHOSA-ACLR
Photographic Series of Sports Activities for Anterior Cruciate Ligament Reconstruction
SD
standard deviation
SEM
standard error of measurement
SRM
standardized response mean
STROBE
Strengthening the Reporting of Observational Studies in Epidemiology
T1
initial assessment
T2

retest assessment
TSK-17
17-item Tampa Scale for Kinesiophobia

Declarations

Ethics approval and consent to participate

The study protocol was reviewed and approved by the Ethics Committee of Sichuan Provincial Orthopedics Hospital (approval No. KY2024-037-01). The study was conducted in accordance with the Declaration of Helsinki and applicable ethical principles. Written informed consent was obtained from all patient participants before enrollment. Written informed consent was also obtained from all seven expert committee members for their participation in the expert review and the use of their expert opinions in the cross-cultural adaptation process.

Clinical trial number

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no financial or non-financial competing interests directly or indirectly related to the work submitted for publication.

Funding

This study was supported by grants from the National Natural Science Foundation of China (grant Nos. 82272599 and 82572959), both awarded to Chengqi He.

Authors' contributions

JX and LR contributed equally to the conceptualization, methodology, data collection, formal analysis, and preparation of the original manuscript. JWX contributed to participant follow-up and data collection. XL contributed to clinical supervision and interpretation of the findings. CH contributed to conceptualization, methodology, funding acquisition, project administration, and supervision. HG contributed to project administration, supervision, interpretation of the findings, and critical revision of the manuscript. All authors critically revised the manuscript and read and approved the final version.

Acknowledgements

The authors thank all participants and the clinical and rehabilitation staff who assisted with participant assessment, postoperative follow-up, and data collection. The authors also gratefully acknowledge Wim van Lankveld, one of the developers of the PHOSA-ACLR, for granting permission to translate and culturally adapt the instrument, for authorizing the use of its photographs, and for his helpful guidance regarding the use of the original 12-item version.

References

1. Sell, T. C. *et al.* Anterior Cruciate Ligament Return to Sport after Injury Scale (ACL-RSI) Scores over Time After Anterior Cruciate Ligament Reconstruction: A Systematic Review with Meta-analysis. *Sports Med Open* **10**, 49 (2024).
2. Xiao, M. *et al.* Patients Who Return to Sport After Primary Anterior Cruciate Ligament Reconstruction Have Significantly Higher Psychological Readiness: A Systematic Review and Meta-analysis of 3744 Patients. *Am J Sports Med* **51**, 2774–2783 (2023).
3. Bullock, G. S. *et al.* Kinesiophobia, Knee Self-Efficacy, and Fear Avoidance Beliefs in People with ACL Injury: A Systematic Review and Meta-Analysis. *Sports Med* **52**, 3001–3019 (2022).
4. Kotsifaki, R. *et al.* Aspetar clinical practice guideline on rehabilitation after anterior cruciate ligament reconstruction. *Br J Sports Med* **57**, 500–514 (2023).
5. Nedder, V. J., Raju, A. G., Moyal, A. J., Calcei, J. G. & Voos, J. E. Impact of Psychological Factors on Rehabilitation After Anterior Cruciate Ligament Reconstruction: A Systematic Review. *Sports Health* **17**, 291–298 (2025).
6. Mir, B. *et al.* Fear of reinjury following primary anterior cruciate ligament reconstruction: a systematic review. *Knee Surg Sports Traumatol Arthrosc* **31**, 2299–2314 (2023).
7. Yensen, K. *et al.* Subjective Causes for Failure to Return to Sport After Anterior Cruciate Ligament Reconstruction: A Systematic Review and Meta-analysis. *Sports Health* **17**, 243–251 (2025).
8. Figueroa, D. *et al.* Return to sport soccer after anterior cruciate ligament reconstruction: ISAKOS consensus. *J ISAKOS* **7**, 150–161 (2022).
9. Wei, X. *et al.* The Chinese version of the Tampa Scale for Kinesiophobia was cross-culturally adapted and validated in patients with low back pain. *J Clin Epidemiol* **68**, 1205–1212 (2015).
10. Webster, K. E., Feller, J. A. & Lambros, C. Development and preliminary validation of a scale to measure the psychological impact of returning to sport following anterior cruciate ligament reconstruction surgery. *Phys Ther Sport* **9**, 9–15 (2008).
11. Ohji, S. *et al.* Kinesiophobia Is Negatively Associated With Psychological Readiness to Return to Sport in Patients Awaiting Anterior Cruciate Ligament Reconstruction. *Arthroscopy* **39**, 2048–2055 (2023).
12. Webster, K. E. & Feller, J. A. Evaluation of the Responsiveness of the Anterior Cruciate Ligament Return to Sport After Injury (ACL-RSI) Scale. *Orthop J Sports Med* **9**, 23259671211031240 (2021).

13. van Lankveld, W. *et al.* Measuring individual hierarchy of anxiety invoking sports related activities: development and validation of the Photographic Series of Sports Activities for Anterior Cruciate Ligament Reconstruction (PHOSA-ACLR). *BMC Musculoskelet Disord* **18**, 287 (2017).
14. Lankveld, W. van, Pat-El, R. J., Melick, N. van, Cingel, R. van & Staal, J. B. Is Fear of Harm (FoH) in Sports-Related Activities a Latent Trait? The Item Response Model Applied to the Photographic Series of Sports Activities for Anterior Cruciate Ligament Rupture (PHOSA-ACLR). *Int J Environ Res Public Health* **17**, 6764 (2020).
15. Beaton, D. E., Bombardier, C., Guillemin, F. & Ferraz, M. B. Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine (Phila Pa 1976)* **25**, 3186–3191 (2000).
16. Prinsen, C. a. C. *et al.* COSMIN guideline for systematic reviews of patient-reported outcome measures. *Qual Life Res* **27**, 1147–1157 (2018).
17. Terwee, C. B. *et al.* COSMIN methodology for evaluating the content validity of patient-reported outcome measures: a Delphi study. *Qual Life Res* **27**, 1159–1170 (2018).
18. von Elm, E. *et al.* The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Ann Intern Med* **147**, 573–577 (2007).
19. Chen, T. *et al.* Translation, cultural adaptation and validation of simplified Chinese version of the anterior cruciate ligament return to sport after injury (ACL-RSI) scale. *PLoS One* **12**, e0183095 (2017).
20. Thomeé, P. *et al.* Self-efficacy, symptoms and physical activity in patients with an anterior cruciate ligament injury: a prospective study. *Scand J Med Sci Sports* **17**, 238–245 (2007).
21. Jia, Z.-Y., Zhang, C., Zou, Y., Huang, X. & Xu, W.-D. Translation and validation of the Simplified Chinese version of International Knee Documentation Committee Subjective Knee Form. *Arch Orthop Trauma Surg* **138**, 1433–1441 (2018).
22. Zhang, Q.-H. *et al.* Reliability, Validity, and Responsiveness of the Chinese Version of the Knee Injury and Osteoarthritis Outcome Score (KOOS) in Patients with Anterior Cruciate Ligament Reconstruction in Mainland China. *Z Orthop Unfall* **157**, 42–47 (2019).
23. Cronström, A., Häger, C. K., Thorborg, K. & Ageberg, E. Factors Associated With Sports Function and Psychological Readiness to Return to Sports at 12 Months After Anterior Cruciate Ligament Reconstruction: A Cross-sectional Study. *Am J Sports Med* **51**, 3112–3120 (2023).
24. van Haren, I. E. P. M. *et al.* Predicting readiness for return to sport and performance after anterior cruciate ligament reconstruction rehabilitation. *Ann Phys Rehabil Med* **66**, 101689 (2023).
25. Caumeil, B., Laboute, E., Verhaeghe, E., Pérez, S. & Décamps, G. Reinjury Anxiety and Return to Sport After Anterior Cruciate Ligament Reconstruction: A Cluster Analysis and Prospective Study Among 162 Athletes. *Am J Sports Med* **52**, 1189–1198 (2024).
26. Isaji, Y., Uchino, S., Inada, R. & Saito, H. Effectiveness of psychological intervention following anterior cruciate ligament reconstruction: A systematic review and meta-analysis. *Phys Ther Sport* **69**, 40–50 (2024).

Figures

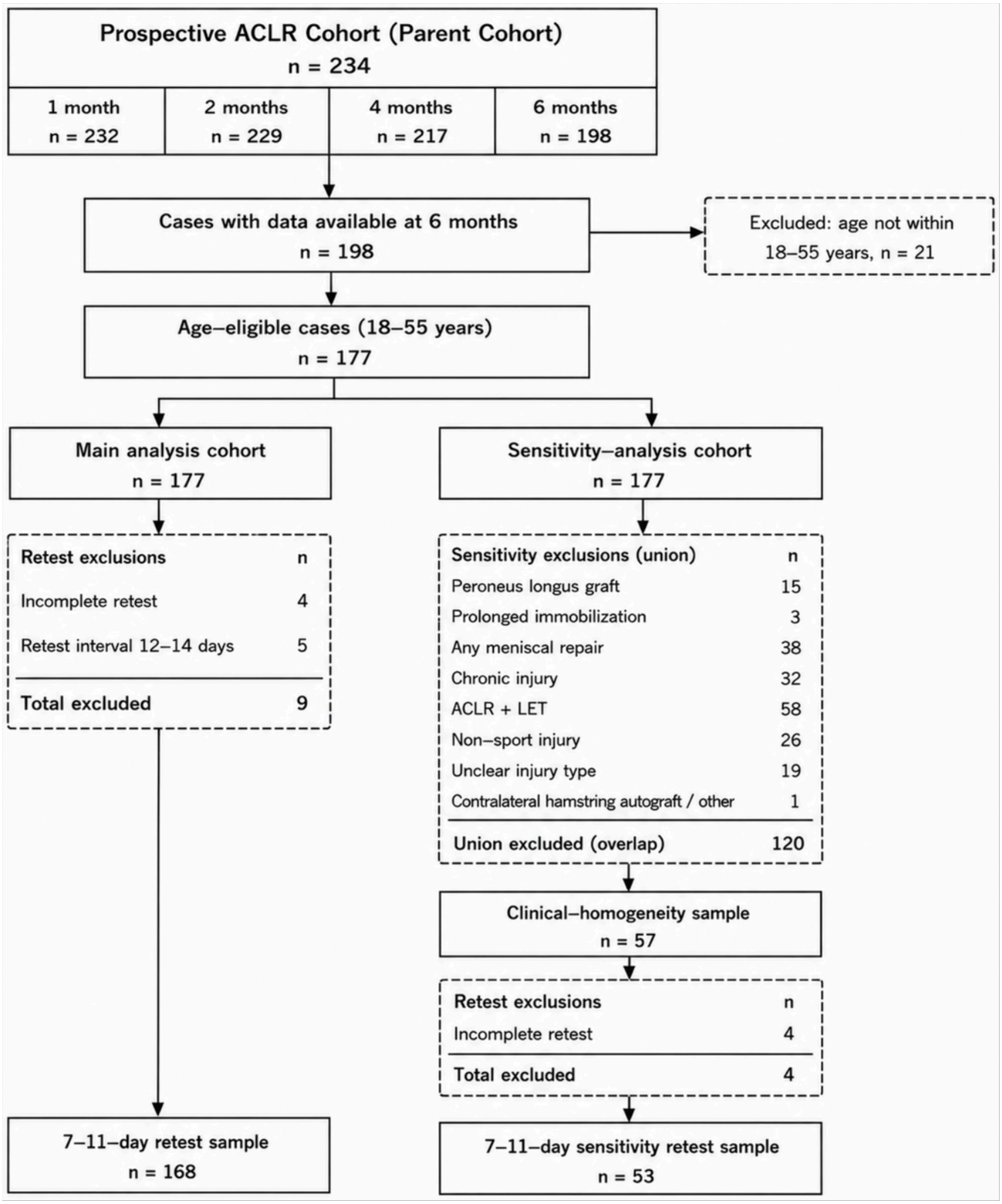


Figure 1

Patient follow-up, screening, and analysis flow

Note: The parent prospective cohort comprised 234 patients. The primary measurement-property analysis included 177 age-eligible patients. The clinically homogeneous sensitivity sample was obtained after exclusion of prespecified potentially confounding clinical factors. Test-retest analyses were restricted to participants with complete retest assessments performed within 7–11 days. ACLR, anterior cruciate ligament reconstruction; LET, lateral extra-articular tenodesis.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementarymaterials.docx
- PHOSAACLRChineseversion.docx