

Validity and Reliability of the Thai Versions of the Lysholm Knee Scoring Scale and Tegner Activity Scale

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Background: Functional or quality of life questionnaires are important tools in clinical investigations. The Lysholm Knee Scoring Scale and Tegner Activity Scale are knee-specific questionnaires that are widely used to assess knee function.

Purpose: To translate both questionnaires into Thai and to assess the validity and reliability of the Thai versions of the Lysholm and adjusted Tegner scales.

Study Design: Cohort study (diagnosis); Level of evidence, 3.

Methods: The Lysholm and Tegner scales were translated into Thai by using the forward-backward translation protocol. Because cultural modifications were made to the sports used to measure activity on the Tegner scale, the authors of this study refer to the Thai version as the “Thai adjusted Tegner scale.” The reliability and validity of the translated scales were evaluated by obtaining the responses of 60 consecutive patients (mean age, 40.5 years; 34 male, 26 female); the patients also completed the Thai version of the International Knee Documentation Committee Subjective Knee Form (IKDC-SKF). Criterion validity was tested by correlating the scores from both translated questionnaires with those from the Thai IKDC-SKF, while reliability was assessed by measuring test-retest reliability and internal consistency.

Results: The Thai Lysholm scale showed a strong correlation with the Thai IKDC-SKF ($r = 0.89$), while the Thai adjusted Tegner scale showed a moderate correlation with the Thai IKDC-SKF ($r = 0.60$). The intrarater and test-retest reliability measures were excellent for the Thai Lysholm (intraclass correlation coefficient [ICC], 0.94 and 0.98, respectively) and moderate to good for the Thai adjusted Tegner (ICC, 0.73 and 0.86, respectively). The internal consistency for the Thai Lysholm was acceptable at all the time points (Cronbach alpha, 0.71–0.73).

Conclusion: The Thai Lysholm and Thai adjusted Tegner scales adequately retained the characteristics of the original versions. They can be considered reliable instruments for Thai patients with knee-related problems.

Keywords: Lysholm Knee Scoring Scale; Tegner Activity Scale; validity; International Knee Documentation Committee Subjective Knee Form; reliability; questionnaire

The knee is one of the most complex joints and is highly vulnerable to injury. The incidence of knee injuries increases with the frequency of physical activities, especially in adolescents and athletes.¹⁶ Internal disturbances in the knee joint can show various manifestations and present with a large range of consequences for an individual's function and quality of life. Evaluations based on both symptoms and examination findings can be used to assess the clinical outcomes of patients with knee injuries. There are a number of questionnaires that have been used to

assess knee function, and these are useful for both clinical practice and research.^{4,13,21,22,25,28,32,35} We commonly use the Thai version of the International Knee Documentation Committee Subjective Knee Form (IKDC-SKF) for the evaluation of general knee injuries in the Thai population.²⁴

The Lysholm Knee Scoring Scale and Tegner Activity Scale are 2 popular patient-reported instruments that measure outcomes in patients with knee-related problems. The Lysholm scale was first published in 1982 and later revised in 1985 to determine patients' functional status after anterior cruciate ligament (ACL) reconstruction.^{25,35} The Tegner scale was subsequently developed as an additional instrument meant to complement the Lysholm and assess the patient activity level based on work and sports

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activities. Both scores have been extensively used. Their reliability, validity, and responsiveness have been established for various knee problems, including ACL or meniscal injuries,^{5,6,15} patellofemoral disorders,^{10,11,14,30} cartilaginous disorders,²³ knee arthroplasty,³⁴ and normal knees.⁷ To date, both questionnaires have been translated, validated, and culturally adapted into various languages, and they have all shown good internal consistency, test-retest reliability, and external validity.

To evaluate patients with knee injuries, we need more than 1 questionnaire. In addition, to our knowledge, no activity level self-reported questionnaire was translated to Thai before. The Lysholm and Tegner scores are the global evaluation tools reflecting overall functional outcome and physical activity level. The official cultural adaptation and Thai translation of the Lysholm and Tegner scales have not yet been provided. When these questionnaires are used in populations with different cultures, it is essential to test the questionnaires' psychometric properties rather than simply translate the content to avoid evaluation errors caused by cultural differences.¹⁸ Thus, the present study aimed to cross-culturally adapt and translate the original English versions of the Lysholm and Tegner scales into the Thai language and assess the validity and reliability of the translated versions in patients with knee injury. We hypothesized that the translated versions would be valid and reliable instruments for assessing the functional status of Thai patients with knee-related problems.

METHODS

To develop this study, we followed the COSMIN reporting guideline for studies on measurement properties.¹⁷ The ethics committee of our university approved this study, and all patients provided written informed consent.

Study Patients

The present study was conducted on patients with various knee-related complaints (eg, ligament injury, patellofemoral disorder, cartilage injury, and meniscal pathology) who were evaluated at the Sports Injury Clinic of our hospital between December 2020 and February 2021. The diagnoses were then confirmed by clinical examination and radiographic studies. The study inclusion criteria were patients younger than 70 years who were Thai-speaking and literate. The exclusion criteria were age younger than

18 years, receiving interventions during the test-retest period, infections, inflammatory arthritis, posttraumatic arthritis, and psychiatric or neurologic conditions. Sixty patients with knee problems met the inclusion criteria and were willing to answer the questionnaire. There were no patients lost to follow-up.

Lysholm and Tegner Scales

The Lysholm scale is an 8-item questionnaire that was initially designed to evaluate knee function after knee ligament injuries. Subsequently, it was also validated for other knee conditions.^{5,7,11,14,23,30,34} The items assessed by the Lysholm scale include pain, type of support, instability, locking, swelling, limping, walking stairs, and squatting. All items are evaluated to obtain 1 score that ranges from 0 to 100, and a high Lysholm score indicates a lower level of symptoms and a higher level of function (91-100 = excellent, 84-90 = good, 65-83 = fair, <65 = poor).³⁵

The Tegner scale is a 1-item instrument that assesses activity levels for competitive or recreational sports and occupational activities. It evaluates the patient's level of work and sports activity on an 11-level scale, with higher scores representing higher physical activity levels. The Tegner scale has been shown to be a valuable complement to the Lysholm scale.³⁵

Translation Procedure

Before starting this study, the original creators of the Lysholm and Tegner scales were contacted and asked for permission to translate and validate the questionnaires. The translation procedure into Thai was performed using the forward-backward translation method described by Guillemin and colleagues,^{3,18} in which a professional translator and an experienced orthopaedic surgeon (T.I.) independently translated the questionnaires from English into Thai (Figure 1). These 2 translations were considered and discussed by the translators until they reached a consensus, and a preliminary Thai translation was completed. Backward translation into English was then performed independently by another professional translator and experienced orthopaedic surgeon (T.T.) using the same method. Next, an expert committee reviewed the preliminary translation. The committee consisted of the professional translator and the orthopaedic surgeon who translated the questionnaires from English into Thai (T.I.), the professional translator and the orthopaedic surgeon who

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Ethical approval for this study was obtained from Chulalongkorn University (reference No. 661/63).

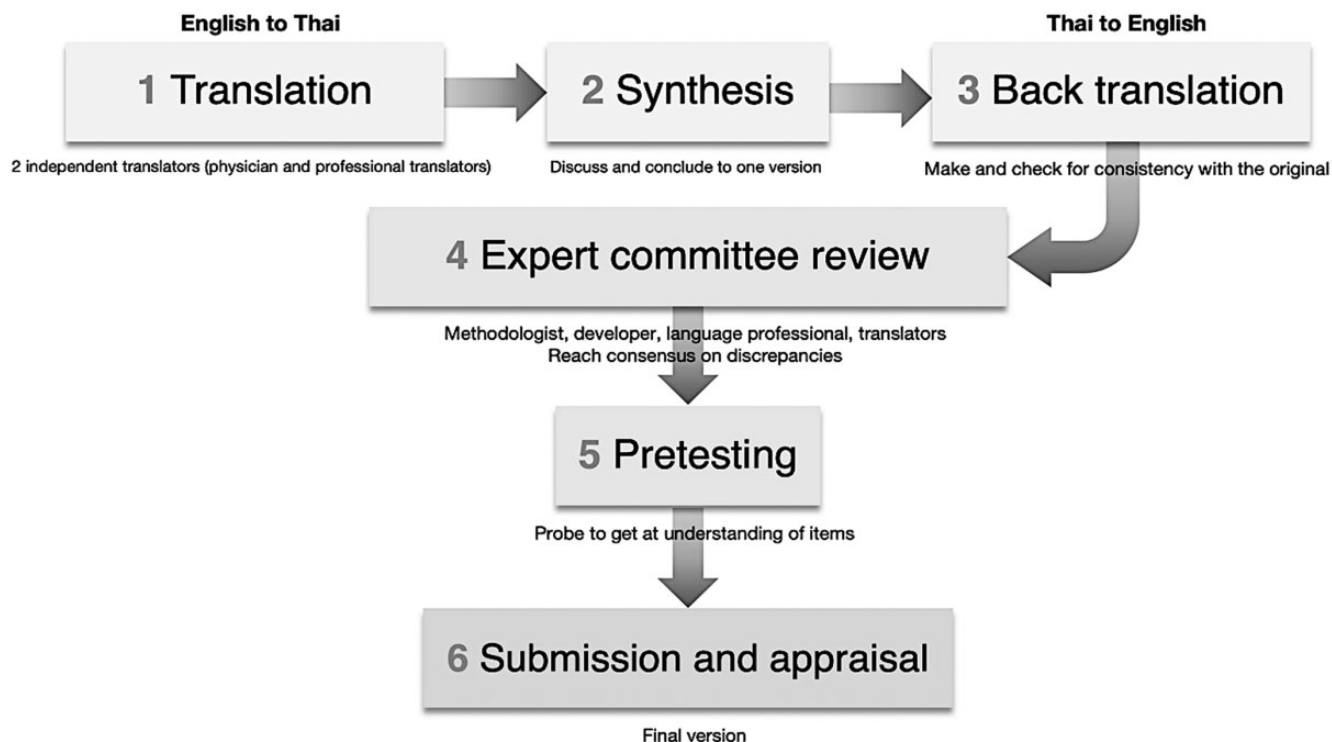


Figure 1. Translation procedure from English to Thai and back-translation from Thai to English.

performed the backward translation into English (T.T.), and another investigator (N.T.) who was not involved in the translation process. Each item was compared and demonstrated to be consistent with the original English version to ensure that the preliminary translation was identical in content to the original English version. Any adjustments by the committee were incorporated into a final version.

The last step of the procedure involved pretesting the final translation on several patients. Each respondent filled out the questionnaire and was then interviewed about what he or she felt each questionnaire item and response signified. The significance of the items as well as the responses was investigated. This ensured that the altered version retained its equivalent in a practical setting. The expert committee looked into questions in which more than 15% of the patients misinterpreted or made a revision.³ Eventually, Thai versions of the Lysholm and Tegner scales were created. Because cultural modifications were made to the sports used to measure activity, the translated version of the Tegner scales was named the “Thai adjusted Tegner scale.”

The IKDC Subjective Knee Form

In addition to the translated Lysholm and Tegner scales, participants also completed the Thai version of the IKDC-SKF.²² The IKDC-SKF was designed to measure symptoms and limitations in function and sports activities due to impairments caused by knee-related problems. The IKDC evaluation system consists of 10 items that evaluate symptoms, function,

and sports activities. The questionnaire is scored by summing the individual item scores and then transforming the sum to a scale ranging from 0 to 100, in which higher scores indicate a lower level of symptoms and a higher functional level. Generally, the IKDC-SKF is a reliable and valid knee-specific measure for patients with a wide variety of knee problems.^{12,19} It has been translated in different cultural settings into many languages and used to assess the validity of other knee scoring systems, including the Lysholm and Tegner scales.^{15,20,29,37} The Thai translation has been validated for Thai patients with knee-related problems.²⁴

Data Collection

The data collection process is shown in Figure 2. The Thai versions of the Lysholm, Tegner, and IKDC-SKF questionnaires were administered to patients via a Google Form in the waiting rooms at the time of their visit to our Sports Injury Clinic. For the Lysholm and IKDC-SKF questionnaires, the patients responded based on their symptoms at the time of their visit (current level). For the Tegner questionnaire, the patients provided responses with respect to their preinjury, current, and expected posttreatment levels. The time taken for completing the questionnaires and any difficulties were recorded for each patient, as recommended by the developers. A research assistant used a smartphone to record how long the patient took to complete the questionnaire.

The distribution of floor and ceiling effects was calculated by examining responses for each item of the Lysholm scale as

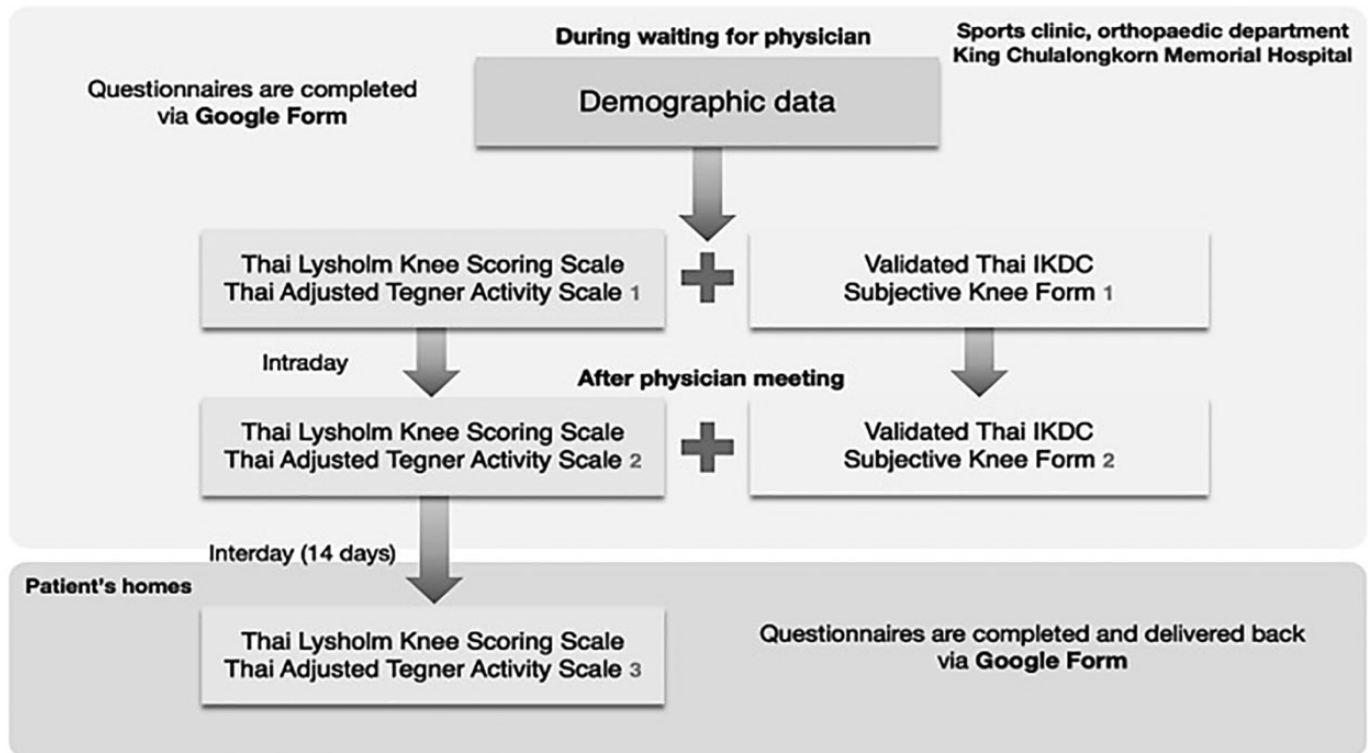


Figure 2. The data collection process. IKDC, International Knee Documentation Committee.

well as the preinjury, current, and posttreatment levels on the adjusted Tegner scale.^{5,6,31} Criterion validity was evaluated by comparing the current Lysholm and Tegner scores with the IKDC-SKF score. In addition, the patient's current Tegner score was compared with IKDC-SKF item 8 (What is the highest level of activity you can participate in on a regular basis?) and item 10 (How would you rate the function of your knee on a scale of 0 to 10 with 10 being normal, excellent function and 0 being the inability to perform any of your usual daily activities which may include sports?).

To evaluate intrarater reliability, all patients were asked to complete a second round of questionnaires (Lysholm, Tegner, and IKDC-SKF) on the same day after meeting with their physicians, and to evaluate test-retest reliability, patients completed a third round of questionnaires (Lysholm and Tegner) after a 14-day interval. We calculated the miss rate of each item, and a miss rate of more than 5% indicated that there was a problem with acceptability.

Statistical Analysis

Statistical analysis was performed using SPSS Version 22 for Mac (IBM Corp). The Pearson correlation coefficient (r) was used to express the correlations among the patients' current Lysholm, Tegner, and IKDC-SKF scores. The correlation was considered to be satisfactory for P values $<.05$ and for r values >0.5 . An r value >0.7 indicated strong correlation,³⁶ and an r value of between 0.5 and 0.7 was regarded as moderate.⁸ The intraclass correlation coefficient (ICC) was used to evaluate intrarater and test-

retest reliability, with ICC values interpreted as excellent (>0.9), good (0.75-0.9), or moderate (0.5-0.75). In addition, the standard error of measurement and the minimal detectable change at 90% confidence (MDC90) were calculated using the method of Chen et al.¹¹ The MDC90 is defined as the smallest change in a measure that may be considered true change beyond measurement error with a confidence level of 90%. Finally, internal consistency for the Lysholm was assessed by calculating the Cronbach alpha (α); an α value between 0.70 and 0.95 indicates good internal consistency according to Terwee et al.³⁶ As the adjusted Tegner scale is a 1-item questionnaire, it was not considered for internal consistency evaluation.

We conducted a power analysis to determine the sample size needed to calculate floor or ceiling effects, reliability, and validity analyses assuming an ICC >0.7 (an ICC of 0.7 is advocated as the minimum benchmark for reliability), according to the power analysis from previous studies.^{8,36} The power analysis was carried out using the formula $n = \frac{16p(1-p)}{w^2}$, where p is the estimated ICC and w is the widest possible 95% CI.³³ In the Spanish translation of the Lysholm score,² p was 0.92 and w was 0.14. The minimum sample size for the current study was calculated to be 60 participants.

RESULTS

Cross-cultural Adaptation and Translation Process

Regarding the Lysholm scale, no significant inconsistencies were found in the forward and backward translation

procedures. The necessary modification in the Thai Lysholm in comparison with the original English version was that the corresponding values marked beside the items and answers were removed. We believe that being able to see the assigned values may affect patient responses. During the pre-evaluation period in 30 patients, 3 of the pretesting patients stated that they struggled to understand the term “giving way,” reflecting the “instability,” “loose,” or “give-out” status of the knees. We did not revise the questionnaire because the misinterpretation occurred in <15% of the patients; however, the expert committee carefully calibrated the simplest Thai language explanation as much as possible. The backward and final translations of the Thai Lysholm scale are demonstrated in questionnaires 1 and 3 of the Supplemental Material (available separately).

Considering the differences in cultures and lifestyles that affect sports activities, we adjusted some sports listed in the Tegner scale, including levels 10 and 9. We added “field hockey” and “sepak takraw” in the list of professional and semiprofessional sports. Sepak takraw is a popular sport in Thailand and Southeast Asia and can be described as a foot volleyball game in which players touch and handle the ball using only their feet, knee, chest, and head. It is a combination of soccer and badminton, categorized in the same knee-loading level as soccer in our consensus discussion with knee orthopaedic sports medicine surgeons. We also included some other combat sports and Asian martial arts (eg, “taekwondo,” “judo,” “boxing,” and “Thai boxing”) at the same level as wrestling and gymnastics in competitive sports. For levels 8 and 7, we omitted “bandy” and “ice hockey” from the lists because these sports are not played in Thailand. We also added “sepak takraw” and “field hockey” to the list of recreational sports in level 7. Other details were minimally adapted and showed similar consistencies to the original. The backward and final translations of the Thai adjusted version of the Tegner scale are demonstrated in questionnaires 2 and 4 of the Supplemental Material (available separately).

Patient Characteristics

The mean age of the 60 study patients was 40.5 years (range, 19-63 years); there were 34 male and 26 female participants. The mean time between injury and evaluation was 3.4 ± 2.1 months (range, 1-10 months). The characteristics of the patients overall and by sex are shown in Table 1.

Feasibility

No significant missing responses or language difficulties for specific questionnaire items were noted. The average time required to complete the questionnaires was 4 minutes (range, 2-6 minutes) for the Lysholm scale and 3 minutes (range, 2-5 minutes) for the adjusted Tegner scale. Patients generally reported that the questionnaire items were relevant to their physical activities and knee status.

Floor and Ceiling Effects

The Lysholm and adjusted Tegner scores both showed acceptable floor and ceiling effects (<15% of participants) at each time point.³⁶ Although some patients received the highest possible scores for each item on the Lysholm, it is the nature of single-question items to allow such high scoring, which represents the patient’s maximal functionality. The distribution of floor and ceiling effects of each questionnaire is demonstrated in Table 2.

Validity

The overall Thai Lysholm score showed a strong correlation with the overall IKDC-SKF score ($r = 0.89$). The adjusted Tegner score showed a moderate correlation with the IKDC-SKF score ($r = 0.60$), particularly regarding item 8 ($r = 0.61$) and item 10 ($r = 0.64$). Table 3 summarizes the data and statistical analysis for the correlations between the Lysholm and adjusted Tegner and the IKDC-SKF scores.

Reliability

The ICC values for intrarater and test-retest reliability are shown in Table 4. Intrarater and test-retest reliability values were high for the Thai Lysholm (ICC, 0.94 and 0.98, respectively) and Thai adjusted Tegner (ICC, 0.73 and 0.86, respectively). Each item of the Lysholm showed good to excellent reliability except item 3, which reflected moderate test-retest reliability (ICC, 0.66), and the current-level Tegner score, which reflected moderate intrarater reliability (ICC, 0.51).

The standard error of measurement and MDC90 were 4.8 and 11.2 for the Lysholm scale and 0.79 and 1.84 for Tegner scale, respectively. This indicated that a patient’s Lysholm and adjusted Tegner scores would have to change by at least 11.2 points (on a scale of 0-100) and 1.84 points (on a scale of 0-10) before the observed change could be considered an actual change of a patient rather than a measurement error.

Internal Consistency

The Cronbach alpha for the Thai Lysholm at baseline ($\alpha = 0.72$), intrarater measurement ($\alpha = 0.73$), and test-retest measurement ($\alpha = 0.71$) indicated good internal consistency of the translated questionnaire.²⁷

DISCUSSION

This study showed that the Thai versions of the Lysholm and adjusted Tegner scales have suitable psychometric parameters in terms of validity and reliability. These scores showed acceptable psychometric performance for Thai patients with various knee disorders, especially in the majority of ligamentous and meniscal injuries. No difficulties were encountered in cross-cultural adaptation and translation of the questionnaires. The back-translations were consistent with the original English versions.

TABLE 1
Patient Characteristics^a

Variable	Male Patients (n = 34)	Female Patients (n = 26)	Total (N = 60)
Age, y, mean ± SD (range)	34.8 ± 13.3 (19-63)	47.8 ± 11.4 (19-63)	40.5 ± 14.0 (19-63)
Age group, y			
<20	3 (8.8)	1 (3.8)	4 (6.7)
20-30	13 (38.2)	1 (3.8)	14 (23.3)
31-40	8 (23.5)	3 (11.5)	11 (18.3)
>40	10 (29.4)	21 (80.8)	31 (51.7)
Body mass index, mean ± SD	24.7 ± 3.3	25.4 ± 4.0	25 ± 3.6
Affected knee			
Right	18 (52.9)	9 (34.6)	27 (45)
Left	14 (41.2)	14 (53.8)	28 (46.7)
Both	2 (5.9)	3 (11.5)	5 (8.3)
Level of sports participation			
Professional	3 (8.8)	1 (3.8)	4 (6.7)
Semiprofessional/recreational	25 (73.5)	12 (46.2)	37 (61.7)
None	6 (17.6)	13 (50)	19 (31.7)
Education			
Primary school	0	1 (3.8)	1 (1.7)
Middle school	1 (2.9)	4 (15.4)	5 (8.3)
High school	2 (5.9)	5 (19.2)	7 (11.7)
Diploma	4 (11.8)	2 (7.7)	6 (10)
Bachelor's degree	21 (61.8)	10 (38.5)	31 (51.7)
Master's degree or higher	6 (17.6)	4 (15.4)	10 (16.7)
Diagnosis			
ACL injuries	18 (52.9)	5 (19.2)	23 (38.3)
Meniscal injuries	6 (17.6)	17 (65.4)	23 (38.3)
Combined ACL and meniscal injuries	7 (20.6)	1 (3.8)	8 (13.3)
PCL and PLC injuries	1 (2.9)	0	1 (1.7)
Patellofemoral disorders	1 (2.9)	3 (11.5)	4 (6.7)
Cartilaginous disorders	1 (2.9)	0	1 (1.7)
Treatment			
Operative	32 (94.1)	24 (92.3)	56 (93.3)
Nonoperative	2 (5.9)	2 (7.7)	4 (6.7)
Time from injury to questionnaire, mo, mean ± SD (range)	3.5 ± 2.3 (1-10)	3.4 ± 2.0 (1-8)	3.4 ± 2.1 (1-10)

^aData are reported as n (%) unless otherwise indicated. ACL, anterior cruciate ligament; PCL, posterior cruciate ligament; PLC, posterolateral corner.

TABLE 2
Score Distribution and Floor and Ceiling Effects of the Thai Lysholm and Adjusted Tegner Scales

Measure	Baseline, mean ± SD	Reported Range	Floor Effect, %	Ceiling Effect, %
Lysholm (0-100 points)	70.7 ± 19.6	13-100	0	5
Item 1: Limp (0-5 points)	3.5 ± 1.5	1-3	10	41.7
Item 2: Support (0-5 points)	4.2 ± 1.5	1-3	3.3	75
Item 3: Locking (0-5 points)	10.7 ± 3.4	1-4	0	31.7
Item 4: Instability (0-25 points)	19.3 ± 6.9	1-6	3.3	45
Item 5: Pain (0-25 points)	17.0 ± 7.1	1-6	6.7	21.7
Item 6: Swelling (0-10 points)	7.3 ± 3.4	1-4	11.7	53.3
Item 7: Stair climbing (0-10 points)	6.1 ± 3.3	1-4	6.7	31.7
Item 8: Squatting (0-5 points)	2.6 ± 2.1	1-4	30	21.7
Adjusted Tegner (0-10 points)				
Preinjury	5.5 ± 2.1	0-10	3.3	1.7
Current	3.5 ± 1.8	1-9	11.7	0
Expected	6.1 ± 1.9	2-10	0	10

However, because of the different climates and cultures, we had to adjust the activity scale in the Thai version of the Tegner scale to harmonize with Thai populations. Our

authors (Y.T. and J.L.) agreed with the adjusted activity level and confirmed that the meaning was the same as the original one.

TABLE 3
Correlation of the Current-Level Thai Lysholm and Adjusted Tegner Scales With the IKDC-SKF^a

Validation	<i>r</i> (95% CI)	<i>P</i>
Lysholm × IKDC-SKF	0.89 (0.83-0.94)	<.001
Adjusted Tegner (current level) × IKDC-SKF	0.60 (0.41-0.74)	<.001
Adjusted Tegner (current level) × IKDC-SKF (item 8)	0.61 (0.42-0.75)	<.001
Adjusted Tegner (current level) × IKDC-SKF (item 10)	0.64 (0.45-0.77)	<.001

^aIKDC-SKF, International Knee Documentation Committee Subjective Knee Form.

TABLE 4
Reliability of the Thai Lysholm and Adjusted Tegner Scales^a

Measure	Baseline	Intrarater	Test-Retest	ICC	
				Intrarater	Test-Retest
Thai Lysholm score	70.7 ± 19.6	70.5 ± 19.7	71.40 ± 18.40	0.94	0.98
Item 1: Limp	3.5 ± 1.5	3.6 ± 1.4	3.50 ± 1.5	0.90	0.89
Item 2: Support	4.2 ± 1.5	4.2 ± 1.5	4.2 ± 1.4	0.79	0.88
Item 3: Locking	10.7 ± 3.4	10.9 ± 3.4	10.8 ± 2.9	0.74	0.66
Item 4: Instability	19.3 ± 6.9	18.9 ± 7.1	19.5 ± 6.8	0.98	0.91
Item 5: Pain	17.0 ± 7.1	17.3 ± 6.8	17.8 ± 6.3	0.86	0.84
Item 6: Swelling	7.3 ± 3.4	7.2 ± 3.5	7.0 ± 3.5	0.99	0.90
Item 7: Stair climbing	6.1 ± 3.3	6.1 ± 3.4	6.1 ± 3.4	0.85	0.90
Item 8: Squatting	2.6 ± 2.1	2.3 ± 2.1	2.6 ± 2.1	0.82	0.86
Thai adjusted Tegner score					
Preinjury level	5.5 ± 2.1	5.8 ± 1.8	6.2 ± 1.9	0.73	0.86
Current level	3.5 ± 1.8	3.6 ± 1.8	3.7 ± 1.8	0.51	0.90
Expected level	6.1 ± 1.9	6.2 ± 1.8	5.8 ± 1.9	0.77	0.92

^aData are reported as mean ± SD unless otherwise indicated. ICC, intraclass correlation coefficient.

The criterion validity of the translated questionnaires was investigated by comparing the Thai Lysholm and Tegner scores with the Thai IKDC-SKF. Similar cultural adaptation studies have used the IKDC-SKF for validation.^{15,20,29,37} The Thai Lysholm showed a strong correlation with the Thai IKDC-SKF ($r = 0.89$), indicating excellent validity comparable to the previously translated Chinese,³⁷ Dutch,¹⁵ and Greek²⁹ versions ($r = 0.60$ - 0.87) in patients with ACL or other knee ligament injuries, meniscal injuries, and patellofemoral disorders. In contrast, the Thai adjusted Tegner showed moderate correlation with the Thai IKDC-SKF ($r = 0.60$) and higher correlation with the IKDC-SKF subscales measuring the level of activities (items 8 and 10), comparable to the previous Chinese, Dutch, and Greek translated versions ($r = 0.56$ - 0.84). These results were consistent with the findings of elementary studies of the validity and reliability of the original Lysholm and Tegner scales by Briggs et al,^{5,6} who concluded that the Tegner would be less specific than the Lysholm for evaluating knee function. The correlation between the Thai adjusted Tegner scale and IKDC-SKF item 10, which asks about general knee function, might indicate the importance of recording activity levels and knee function in clinical practice.

The Thai Lysholm showed acceptable floor and ceiling effects. Although significant ceiling effects were found for 6 of the 8 items of the Thai Lysholm, it is the nature of

single-question items to allow the highest scores, which represent the maximal functionality. The ceiling effect on many of the items suggests that the overall Lysholm score should be used rather than the item subscores.¹⁵

Readmission to the test was performed in 14 days, comparable to the time range used in previous studies (3-14 days).^{2-5,9,10,15,26} This difference in time is long enough to ensure that most patients do not remember or are not influenced by their first set of responses but small enough to avoid quarantine differences in scores. No treatments were provided during this period to reduce the risks of clinical changes, which could affect the reliability evaluations. Moreover, we also conducted an intrarater reliability measurement, which differs from other studies that performed comparisons based on the test-retest reliability. The Thai Lysholm and adjusted Tegner scales showed moderate to excellent intrarater and test-retest reliability overall, consistent with the other reviews.^{1,2,9,26,38,39}

We found that the Thai Lysholm showed acceptable internal consistency in the different time point measures ($\alpha = 0.71$ - 0.73), comparable to previous studies ($\alpha = 0.60$ - 0.91).^{1,2,9,26,38,39} These findings indicate good overall homogeneity of the scores, irrespective of the various knee disorders in the patient sample. The Turkish,⁹ Arabic,¹ and Greek²⁹ translated versions also included respondents with multiple knee disorders and showed results consistent with the current study ($\alpha = 0.68$ - 0.90). Interestingly, 4 studies of

translated German,³⁹ Chinese,³⁷ Dutch,¹⁵ and Spanish² versions that specifically evaluated patients with ACL injuries demonstrated internal consistency similar to ours ($\alpha = 0.70-0.77$).

Culturally equivalent measures allow multicenter studies or meta-analyses to be conducted reliably in different populations. The Lysholm and Tegner scales have been culturally adapted, translated, and validated into several languages. These studies, which involved approximately 900 patients in total, have generally shown acceptable validity and reliability of the 2 scales.^{1,2,9,20,26,29,31,37-39} These data confirm the results of our study.

Limitations

Some limitations of the present study should be noted. First, we did not assess the sensitivity of the Thai Lysholm and adjusted Tegner scales to document changes or responsiveness, which is essential for a complete understanding of the psychometric properties of the translated questionnaires. In future studies, responsiveness should be evaluated during the rehabilitation period to detect clinically relevant changes. Second, the relatively small sample size may not perfectly represent the entire Thai knee injury population. Nevertheless, previous validation studies have used a similar number of individuals, and the sample size was adequate to reach statistical significance.^{1,2,9,26,38,39} Third, Thailand is a multicultural nation, and this study was only performed in the central region. Each minority group speaks their own tongue, which should be noted when applying the questionnaires. Finally, the variability of knee disorders in our group was a constraint. However, more than half of our patients had ACL injuries evaluated by both the initially developed Lysholm and Tegner scales, and the internal consistency was acceptable and comparable to the findings reported in previous studies. We also believe that the Thai Lysholm and adjusted Tegner scales can be applied to Thai patients with different knee pathologies, similar to the original version.

CONCLUSION

In this study, we verified that the Thai Lysholm scale and adjusted Tegner scale show good validity and reliability after translation, corresponding to the original and other translated versions. The questionnaires can be used to assess symptoms, functions, and sports activities of the Thai population with knee-related complaints to collect better data for physicians and researchers.

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