BACKGROUND: The Cumberland Ankle Instability Tool (CAIT) is a valid and reliable patient reported outcome used to assess the presence and severity of chronic ankle instability (CAI). The CAIT has been cross-culturally adapted into other languages for use in non-English speaking populations. However, there are no valid questionnaires to assess CAI in individuals who speak Korean.

PURPOSE: The purpose of this study was to translate, cross-culturally adapt, and validate the CAIT, for use in a Korean-speaking population with CAI.

STUDY DESIGN: Cross-cultural reliability study.

METHODS: The CAIT was cross-culturally adapted into Korean according to accepted guidelines and renamed the Cumberland Ankle Instability Tool-Korean (CAIT-K). Twenty-three participants (12 males, 11 females) who were bilingual in English and Korean were recruited and completed the original and adapted versions to assess agreement between versions. An additional 168 national level Korean athletes (106 male, 62 females; age = 20.3 ± 1.1 yrs), who participated in ≥ 90 minutes of physical activity per week, completed the final version of the CAIT-K twice within 14 days. Their completed questionnaires were assessed for internal consistency, test-retest reliability, criterion validity, and construct validity.

RESULTS: For bilingual participants, intra-class correlation coefficients (ICC2,1) between the CAIT and the CAIT-K for test-retest reliability were 0.95 (SEM = 1.83) and 0.96 (SEM = 1.50) in right and left limbs, respectively. The Cronbach’s alpha coefficients were 0.92 and 0.90 for the CAIT-K in right and left limbs, respectively. For native Korean speakers, the CAIT-K had high internal consistency (Cronbach’s α = 0.89) and intra-class correlation coefficient (ICC2,1 = 0.94, SEM = 1.72), correlation with the physical component score (rho = 0.70, p = 0.001) of the Short-Form Health Survey (SF-36), and the Kaiser-Meyer-Olkin score was 0.87.

CONCLUSIONS: The original CAIT was translated, cross-culturally adapted, and validated from English to Korean. The CAIT-K appears to be valid and reliable and could be useful in assessing the Korean speaking population with CAI.

KEYWORDS: Ankle sprain, Patient Reported Outcome, Ankle Injury
INTRODUCTION

The ankle is the most common site for a joint sprain to occur, during all types of sporting activities. According to the National Collegiate Athletic Association (NCAA), approximately 15% of athletes have experienced an ankle sprain.¹ Significant health issues caused by traumatic lateral ankle sprains include the initial symptoms of acute pain, swelling, and loss of function and a high rate of recurrence. An estimated 75% of athletes report recurrent ankle sprains with over half of them experiencing significant disability and persistent symptoms which may result in Chronic Ankle Instability (CAI).² ³ CAI is characterized by the sensation of “giving way” and a history of recurrent sprain is the main predisposing factor for CAI.² ³

Currently, patient reported outcome (PRO) questionnaires are primarily used to determine the presence of CAI in clinical assessment and research.² Gribble et al² advocated the use of validated ankle instability PRO questionnaires with specific cutoff scores in order to determine the presence of self-reported ankle instability. Professional organizations, such as the National Athletic Trainers' Association (NATA), recommend the use of PRO questionnaires as one criterion used to identify patients' perception of ankle instability for return-to-play decision making in the management of ankle sprains.⁵

The Cumberland Ankle Instability Tool (CAIT), developed by Hiller et al,⁶ is recommended and widely used to identify patients with CAI.² ⁵ The CAIT was originally developed in English. Previous authors⁷,⁸ have translated and cross-culturally adapted the CAIT into Spanish and Brazilian-Portuguese to provide non-English speaking populations valid and reliable versions of the tool. The previous cross-cultural adaptation and validation studies showed high internal consistency (Cronbach’s α Spanish = 0.77; Brazilian-Portuguese = 0.86) and reliability (intra correlation coefficient Spanish = 0.98; Brazilian-Portuguese = 0.95), correlation with the original English CAIT (rho = 0.24, p = 0.012) in the Spanish version, and good responsiveness, respectively.⁷,⁸ Currently, there is no valid self-report CAI questionnaire for use in Korean speaking populations.

Therefore, the purpose of this study was to translate, cross-culturally adapt, and validate the Cumberland Ankle Instability Tool-Korean (CAIT-K) for use in a Korean-speaking population with CAI. All validation was performed according to the guidelines for cross-cultural adaptation of self-report measures.⁹ ¹⁰

METHODS

The Cumberland Ankle Instability Tool (CAIT)

The original CAIT⁶ consisted of nine items to describe the severity of CAI. The items evaluate the degree of difficulty experienced when performing various activities of daily living and other physical activities. The maximum score is 30 with a lower score indicating decreased ankle function. Severity of ankle disability is thought to increase as the score decreases. The original study established a cutoff score of ≤ 27 to identify those with CAI.⁶ Subsequent studies have used a range of cutoff scores from 24 to 27,¹¹,¹² including a recently advocated optimal cutoff score of ≤ 25.¹³ The original CAIT showed excellent test-retest reliability with the intra-class correlation coefficient (ICC₂,₁ = 0.96) and construct validity and internal consistency (α = 0.83).⁶

Cross-cultural adaptation procedure

The English version of the CAIT was adapted for Korean use (CAIT-K) according to the six-step guidelines established for cross-cultural adaptation of self-report measures.¹⁰ In addition the accuracy of wording and item understanding were tested among participants bilingual in English and Korean. Korean is a relatively homogeneous language, with little regional dialect differences, thus one standard was applied.¹⁴

Step I: One independent native-speaking Korean (the co-investigator and certified athletic trainer) translated the CAIT into Korean.

Step II: Four expert panelists who were native-speaking Koreans (two certified athletic trainers, one sport biomechanist, and one physical educator) reviewed and proofread the first translation of the CAIT-K. These expert panelists and investigators synthesized the first translated version to a preliminary CAIT-K version through a consensus review.
Step III: Two additional people who were native English speakers and raised in Korean speaking homes translated the preliminary CAIT-K back into English. These people were blinded to the concept and had no medical background.

Step IV: Investigators and expert panelists reviewed all the translations, semantic, idiomatic, and experiential equivalencies to resolve all discrepancies. The pre-final version of CAIT-K was amalgamated through this process.

Step V: The original English and CAIT-K were administered to 23 people who were bilingual in English and Korean who were enrolled in, or working at, a large university as a student or faculty member. The accuracy of wording and item understanding for both the CAIT and CAIT-K were tested. Feedback from participants was incorporated into a final version of CAIT-K after review and agreement among the developers (investigators and expert panel).

Step VI: The reliability and validity (construct and criterion) of the final CAIT-K were tested using 168 participants with and without chronic ankle instability at large university in Seoul, Republic of Korea.

Participants
Informed consent was obtained from each participant as approved by the Institutional Review Board (IRB) at the University of Georgia in English for US participants and in Korean for Korean participants.

Bilingual speakers
Twenty three participants between 18 and 65 years of age who were bilingual in English and Korean were recruited. They must have had completed or been enrolled at the time of the study in a bachelor's or higher degree program at an accredited college or university in the United States. Participants were not required to have a history of ankle sprain or residual complaints of instability. For reliability testing, two test sessions were scheduled to complete the pre-final version of CAIT-K in English and in Korean in randomized order. The second test was completed one week after the first administration.

Native Korean speakers
National level athletes in multiple Olympic sports (168 total; 21 boxing, 19 fencing, 13 wrestling, 19 judo, 23 filed hockey, 18 taekwondo, 26 weightlifting, 10 track, 19 swimming) were recruited for reliability testing of the final CAIT-K (Figure 1). Participants had to be 18 to 35 years of age, speak Korean as a first language, and participating in ≥ 90 minutes of physical activity per week. The average number of hours participating in sports was 36.95 ± 13.45 hours per week. Exclusion criteria included: 1) bilateral ankle instability 2) lower leg disorders caused by surgery and/or fracture 3) any type of other lower extremity injury in the previous three months and 4) diagnosis of vestibular disorder, Charcot-Marie-Tooth disorder, Ehlers-Danlos, or other hereditary nerve, balance or connective tissue disorder. Participants were initially classified as “healthy” or “unstable ankle” based upon the results of an ankle injury history questionnaire that incorporated the inclusion/exclusion criteria. The unstable ankle group had a CAIT ≤25 indicating decreased function, self-reported ≥1 moderate-severe sprain that resulted in partial or non-weight bearing for ≥3 days, reported “giving way” of the ankle with activity, and had ≥2 sprains or episodes of giving way in the last year.2 All participants were screened based on the inclusion and exclusion criteria before they completed the final CAIT-K and classified into groups of healthy (n=107) and unstable ankles (n=61). Two test sessions were scheduled with each participant. Participants completed the CAIT-K in the first session and within one week after the first meeting participants completed the CAIT-K again. When the CAIT-K was administered, 100 participants were in-season, 45 participants were in pre-season phase, and 23 participants were in post-season (off-season) phase. For testing construct validity, all participants in the study (n = 168) completed the CAIT-K as well as the 36-item short-form health survey (SF-36) questionnaire in Korean (Figure 1).15,16

One researcher completed all data collection procedures independently. The researcher was blinded to the scores of the CAIT-K, CAIT, and SF-36 until the end of data collection. All procedures from recruitment to survey completion were done between July 2013 and January 2014.

Statistical analysis

Bilingual speakers
For bilingual participants, Intra-class Correlation Coefficients (ICC2,1) between the English and Korean
version of the CAIT were utilized to determine the test-retest reliability.\textsuperscript{17} Cronbach’s alpha coefficients were used to determine internal consistency within the Korean version of CAIT in right and left limbs, respectively.\textsuperscript{18}

**Native Korean speakers**

For the 168 native Korean speaking participants, descriptive statistics were calculated for mean, standard deviation, and 95% confidence interval (CI). Internal consistency of the CAIT-K was assessed with Cronbach’s alpha (\(\alpha\)) coefficient.\textsuperscript{18} ICC\textsuperscript{(2,1)} was calculated to determine test-retest reliability between the first and second CAIT-K measures.\textsuperscript{17} Criterion validity was also calculated by Spearman’s rank correlation coefficient between CAIT-K and SF-36.\textsuperscript{7} Construct validity was examined using exploratory factorial analysis with the score of the first CAIT-K.\textsuperscript{7} Demographics and CAIT-K scores were compared between groups using independent samples t-tests (\(\alpha<0.05\)). All statistical analyses were performed through the Statistical Package for the Social Sciences\textsuperscript{™} 22.0 (SPSS, Inc., Chicago, IL, USA).

**RESULTS**

Of the original 289 enrolled participants, 5.2% (15/289) of participants met exclusion criteria and were not included in the study. Approximately nineteen percent (52/274) of participants were lost to follow up or injured during the timeframe of data collection after the first administration of the CAIT-K. Additionally, 24.3% (54/222) of participants were lost due to incomplete questionnaires. Therefore, a total of 168 (58.1%) of 289 participants successfully completed all procedures during the study period. A total of 61 (36.3%) participants were classified into the unstable ankle group and 107 (63.7%) were classified into the control group (Figure 1). There were no significant differences in age and gender between control and CAI participants (Table 1) (\(p<0.05\)). The

![Flow chart of eligible native Korean participants](image-url)
CAI individuals presented with significantly lower mean CAIT-K scores compared to the control group during both test sessions \((p=0.001)\) (Table 1). No participants experienced adverse events during the time of the study.

Reliability

For bilingual participants, intra-class correlation coefficients \((ICC_{2,1})\) between the English and Korean version of the CAIT for test-retest reliability were 0.95 (standard error of measurement \([SEM]=1.83\)) and 0.96 \((SEM=1.50)\) in right and left limbs, respectively. The Cronbach's alpha coefficients were 0.92 and 0.90 for the CAIT-K in right and left limbs, respectively. For native Korean speaking participants, the intra-class correlation coefficient \((ICC_{2,1})\) between the first CAIT-K and second CAIT-K was 0.94 \((SEM=1.72)\). The Cronbach's alpha for the score of the CAIT-K in the first measurement was 0.89. There was no statistically significant improvement in Cronbach's alpha when a particular item was deleted from the scale during the data analysis. However, a slight increase in the alpha value was observed when the item numbers 4, 5, and 9 were omitted (Table 2).

Criterion and Construct Validity

The CAIT-K showed statistically significant Spearman correlation \((\rho=0.70, \ p=0.001)\) with the physical health component of the SF-36, but no statistical relationship \((\rho=-0.06, \ p=0.48)\) with the mental health component.

The Kaiser-Meyer-Olkin score that measures sampling adequacy was 0.87. The Bartlett test of specificity \((p<0.0001)\) indicated the suitability of the sample for exploratory factor analysis. The total variance explained was 74.4% (Table 2). Two factors were identified as a component matrix. Six items were classified into the first factor while item 4, 5 and 9 were classed as the second factor (Table 3).

**DISCUSSION**

The CAIT-K was successfully cross-culturally adapted and the results indicate that the adaptation is reliable, valid, and appropriate for use in a Korean speaking population.

The translation adequately corresponded with the original version. No modifications were included, the meaning of the items were preserved, and there was

<table>
<thead>
<tr>
<th>Table 1. Subject Demographics Mean and Standard Deviation of the Korean Version of the Cumberland Ankle Instability Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Subjects (%)</td>
</tr>
<tr>
<td>Subjects (%)</td>
</tr>
<tr>
<td>CAI</td>
</tr>
<tr>
<td>Control</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

CAIT-K= The Korean version of Cumberland Ankle Instability Tool

**Table 2. Internal consistency and total variance explained through exploratory factor analysis of the CAIT-K**

<table>
<thead>
<tr>
<th>Component</th>
<th>Corrected item:</th>
<th>Cronbach’s α if item was deleted</th>
<th>Total</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>% of Variance</td>
<td>Cumulative %</td>
<td>Total</td>
</tr>
<tr>
<td>Item 1</td>
<td>0.80</td>
<td>0.86</td>
<td>4.93</td>
<td>54.76</td>
<td>4.93</td>
</tr>
<tr>
<td>Item 2</td>
<td>0.85</td>
<td>0.86</td>
<td>1.77</td>
<td>19.69</td>
<td>270.45</td>
</tr>
<tr>
<td>Item 3</td>
<td>0.90</td>
<td>0.85</td>
<td>0.71</td>
<td>7.92</td>
<td>54.76</td>
</tr>
<tr>
<td>Item 4</td>
<td>0.39</td>
<td>0.90</td>
<td>0.53</td>
<td>5.91</td>
<td>88.28</td>
</tr>
<tr>
<td>Item 5</td>
<td>0.40</td>
<td>0.90</td>
<td>0.41</td>
<td>4.54</td>
<td>92.82</td>
</tr>
<tr>
<td>Item 6</td>
<td>0.70</td>
<td>0.87</td>
<td>0.25</td>
<td>2.81</td>
<td>95.64</td>
</tr>
<tr>
<td>Item 7</td>
<td>0.85</td>
<td>0.86</td>
<td>0.15</td>
<td>1.66</td>
<td>97.29</td>
</tr>
<tr>
<td>Item 8</td>
<td>0.60</td>
<td>0.88</td>
<td>0.14</td>
<td>1.54</td>
<td>98.83</td>
</tr>
<tr>
<td>Item 9</td>
<td>0.32</td>
<td>0.90</td>
<td>0.11</td>
<td>1.17</td>
<td>100.00</td>
</tr>
</tbody>
</table>

CAIT-K = The Korean version of Cumberland Ankle Instability Tool

SD = Standard Deviation
complete consensus about the final version among the expert panelists. In the native Korean speakers, the Cronbach’s $\alpha$ of the questionnaire ranged from 0.85 to 0.90, which demonstrated a high internal consistency.\textsuperscript{19} In the original version of the CAIT, the Cronbach’s $\alpha$ was 0.83, similar to that obtained in the present study.\textsuperscript{6} Additionally, the current Cronbach’s is similar to, or higher than, other cross-cultural adaptation studies of the CAIT in Spanish (Cronbach’s $\alpha$ = 0.77) and Brazilian-Portuguese (Cronbach’s $\alpha$ = 0.86 for right ankles and 0.88 for left ankles).\textsuperscript{7,8} For native Korean speakers, Intra-class Correlation Coefficients (ICC\textsubscript{2,1}) of the CAIT-K were 0.94 with $p_{\text{critical}}=0.001$ (standard error of measurement [SEM] = 1.72), very similar to the value (0.95) of the original version of CAIT.\textsuperscript{6} The CAIT-K retained a similar test-retest reliability and internal consistency compared to previous adaptations of the CAIT in Spanish (ICC\textsubscript{2,1} = 0.98) and in Brazilian-Portuguese (ICC\textsubscript{2,1} = 0.95).\textsuperscript{7,8} The test-retest reliability and internal consistency of the CAIT-K are considered excellent and presented a high level of reliability. These data confirm that the CAIT-K may be considered as a reliable and stable instrument for the assessment of CAI in Korean speakers.

Criterion validity was assessed using the Spearman correlation coefficient between the SF-36 summary components and the CAIT-K. The results in the present study showed a stronger correlation with the physical components than with mental component of the SF-36. This supports other studies, which suggests that physical function and pain dimensions of SF-36 seem to be most pertinent in patients with musculoskeletal conditions.\textsuperscript{7,20} In the Spanish version of the CAIT, the Spearman correlation coefficient with the physical component summary was a lower ($\rho_{\text{ritical}}=0.24$, $p_{\text{critical}}=0.012$) than the present study ($\rho_{\text{ritical}}=0.70$, $p_{\text{ritical}}=0.001$), albeit statistically significant.\textsuperscript{7} However, the Brazilian-Portuguese version did not attempt to assess criterion validity.\textsuperscript{8} To evaluate the construct validity, an exploratory factor analysis was utilized and two components were extracted that explained 74.5% of the total variance. From nine total items, six loaded in one factor, and items 4, 5, and 9 loaded in the other factor (Table 3). The Cronbach’s $\alpha$ discussed above was slightly increased when items 4, 5, and 9 were deleted. No factorial analysis was performed in the original version of the CAIT,\textsuperscript{6} however, a previous cross-cultural adaptation study\textsuperscript{7} also assessed construct validity using exploratory factorial analysis and three components were identified that accounted for 66.4% of the total variance. The authors reported three factors: usual/daily activities, single leg stance (item 5) and lateral hopping (item 6). The exploratory factor analysis in the current study demonstrated slightly different results for items 4, 5, 6, and 9. In the current sample, unstable feelings with single leg stance (item 5) was classified into a separate factor from the usual and daily activities factor, similar to the previous study. Unstable ankle feelings with hopping (item 6) could be perceived differently depending on the physical ability of participants. Sport training in national-level athletic participants could require agility drills with hopping performance as a part of daily warm-up and practice. Thus, hopping is a daily activity for them and loaded differently than less highly trained participants in other studies.

Table 3. Component Matrix: Factor Loadings

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 3 Sharp Cuts</td>
<td>0.931</td>
<td>-0.112</td>
</tr>
<tr>
<td>Item 7 Surface</td>
<td>0.910</td>
<td>-0.205</td>
</tr>
<tr>
<td>Item 2 Activity</td>
<td>0.902</td>
<td>-0.241</td>
</tr>
<tr>
<td>Item 1 Pain</td>
<td>0.867</td>
<td>-0.292</td>
</tr>
<tr>
<td>Item 6 Hopping</td>
<td>0.789</td>
<td>-0.038</td>
</tr>
<tr>
<td>Item 8 Rolling</td>
<td>0.686</td>
<td>-0.213</td>
</tr>
<tr>
<td>Item 4 Down Stairs</td>
<td>0.455</td>
<td>0.785</td>
</tr>
<tr>
<td>Item 5 Single leg stand</td>
<td>0.463</td>
<td>0.741</td>
</tr>
<tr>
<td>Item 9 Response to rolling</td>
<td>0.392</td>
<td>0.602</td>
</tr>
</tbody>
</table>

Note: Values are listed in decreasing order of magnitude for each component, as they are presented in previous literature (Spanish CAIT). These factor loadings indicate correlation between the variable and the factor, and so could range from -1 to +1.
in the current study was 2.0±1.3, which indicated they returned to normal within one day after injuring their ankle. This rapid response and altered perception may be attributable to better medical care or higher pain tolerance than other studies’ participants. Elite athletes may have different perceptions and expectations of ankle function and pain. The authors believe that item 4 (perception of ankle instability while going down the stairs) may not be taxing to the current participants because it is more likely to fall into usual and daily activity. Most items were in agreement with responses compared to a previous study,[7] however, a few items differed due to the sample populations who performed alternative activities of daily living.

**Study Limitations**

There was some loss of participants due to exclusion criteria, loss to follow up, and incomplete questionnaires, but the overall sample appears to be adequately powered based on the results. The majority of participants were highly trained athletes who usually competed at the national level, and thus the findings may not apply to a more general population. Additional participants from a variety of backgrounds and activity levels are necessary in future research to test the CAIT-K for reliability and validity beyond this population. The CAIT-K was designed using a Seoul-dialect which has been the national standard for centuries and is still broadly intelligible for the entire Korean-speaking population. The Korean language is relatively homogeneous and the dialects from different geographical regions can be mutually intelligible.[14] Thus, we believe dialects and regional differences do not affect the generalizability of the CAIT-K, but these results should be validated with geographically distinct Korean groups.

**CONCLUSIONS**

Overall, the CAIT-K demonstrated good psychometric properties and is comparable to the English original version and other adaptations in other languages.[7,8] The CAIT-K could be a useful tool in international CAI research and treatment. The authors recommend the CAIT-K for use by Korean clinicians and researchers with Korean speaking populations. Future research should examine cutoff scores and minimum detectable change (MDC) values for the CAIT-K based on various physical levels. Developing cutoff scores and MDC values for the CAIT-K will enhance the usefulness of this tool for clinicians and researchers.

**REFERENCES**

12. Rosen AB, Ko J, Brown CN. Diagnostic accuracy of instrumented and manual talar tilt tests in chronic


