

Original article

Cross-cultural adaptation and validation of an ankle instability questionnaire for use in Chinese-speaking population

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Abstract

Background: The Identification of Functional Ankle Instability (IdFAI) is a valid and reliable tool to identify chronic ankle instability; however, it was developed in English, thus limiting its usage only to those who can read and write in English. The objectives of our study were to (1) cross-culturally adapt a Chinese (Mandarin) version of the IdFAI and (2) determine the psychometric properties of the Chinese version IdFAI.

Methods: The cross-cultural adaptation procedures used by the investigators and translators followed previously published guidelines and included 6 stages: (1) initial translation, (2) synthesis of the translations, (3) back translation, (4) developing the pre-final version for field testing, (5) testing the pre-final version, and (6) finalizing the Chinese version of IdFAI (IdFAI-C). Five psychometric properties of the IdFAI-C were assessed from results of 2 participant groups: bilingual ($n = 20$) and Chinese ($n = 625$).

Results: A high degree of agreement was found between the English version of IdFAI and IdFAI-C (intra-class correlation_{2,1} = 0.995). An excellent internal consistency (Cronbach's $\alpha = 0.89$), test–retest reliability (intra-class correlation_{2,1} = 0.970), and construct validity ($r(625) = 0.67$) was also found for the IdFAI-C. In addition, the results of exploratory and confirmatory factor analysis indicated that ankle instability was the only construct measured from the IdFAI.

Conclusion: The IdFAI-C is a highly reliable and valid self-report questionnaire that can be used to assess ankle instability. Therefore, we suggest that it can be used to effectively and accurately assess chronic ankle instability in clinical settings for Chinese-speaking individuals.

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Keywords: Ankle giving way; Ankle sprain; Chronic ankle instability; Identification of functional instability; Mandarin; Translation

1. Introduction

Ankle sprains are one of the most common injuries,¹ as at least 302,000 and 1–2 million sprains occur per year in the UK² and USA,³ respectively. Approximately 40%–80% of sprained individuals go on to develop chronic ankle instability (CAI); that is, they undergo repeated ankle sprains^{4,5} and repeatedly experience feelings of the ankle “giving way”.⁶ Individuals with CAI often also experience residual symptoms of joint pain, weakness, instability, and decreased function.^{6–9}

Although ankle sprains are still perceived by the public to be an insignificant injury,^{10–12} long-term effects on daily life

can be substantial.¹¹ Up to 72% of patients reported being functionally impaired by their ankle sprains up to 7 years post-injury.¹³ Moreover, there is some evidence that an unstable foot-ankle complex potentially can develop degenerative arthritis and concomitant pain.¹⁴

Self-reported questionnaires play an important role in assessing CAI to develop reliable, effective treatment plans for clients. Currently, there are several published self-reported questionnaires used in assessing CAI: Ankle Instability Instrument (AII), Cumberland Ankle Instability Tool (CAIT), Chronic Ankle Instability Scale (CAIS), Foot and Ankle Ability Measure (FAAM), *etc.* However, Donahue et al.¹⁵ observed that among 7 of these questionnaires, no single questionnaire was able to predict whether individuals met the minimally accepted criteria (at least 1 ankle sprain and an episode of

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giving way) for CAI. The combined use of the AII and CAIT was recommended as the best choice for assessing the 2 minimum criteria needed to detect CAI. This group of researchers then developed a one-page questionnaire, the Identification of Functional Ankle Instability (IdFAI), that combined elements of both questionnaires that would have the best test characteristics (e.g., validity) while improving test administration efficiency.¹⁶ Based on the 2 minimum criteria to classify CAI, the questionnaire exhibited a distinct discrimination score of 10 and overall accuracy of 89.6%;¹⁶ and excellent test–retest reliability (intra-class correlation (ICC) = 0.92).¹⁵ Therefore, IdFAI has been suggested as a useful tool to identify CAI.¹⁷

However, this questionnaire was developed in English, thus limiting its usage only to those who can read and write in English. There is a growing trend of multinational and multicultural research, so cross-cultural adaptation of questionnaires is needed.¹⁸ “Cross-cultural adaptation procedures” are usually used to convert the self-reported questionnaires to other languages and to ensure that the content is culturally appropriate.^{5,19–22}

There is a great need for a Chinese adaptation of IdFAI that is valid, reliable, and culturally appropriate for use among the 1.2 billion Chinese-language speakers around the world. Chinese ranks as the language spoken by the most number of people in the world. Even in English-speaking countries, there are many Chinese immigrants: 4.7 million in the USA (U.S. Census Bureau, 2015; https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_1YR_B02018&prodType=table), 1.5 million in Canada (Statistics Canada, 2011; <http://www.asiapacific.ca/statistics/population/population-2011-census/population-ethnic-origin-province>), 0.9 million in Australia (Australian Bureau of Statistics, 2011; <http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/2071.0main+features902012-2013>), and 0.5 million in UK (Office for National Statistics, 2011; <https://www.ons.gov.uk/help/localstatistics>). Applying estimates of CAI prevalence in Israel⁴ of 1% to these numbers of Chinese-speaking populations, the estimated CAI population of Chinese speakers is about 0.1 billion in the world.

However, to date, among CAI assessment questionnaires, CAIT is the only validated, cross-culturally adapted version in Chinese language²³ (Mandarin, the national language used in education, media, and formal settings in China).¹⁹ However, as described above, CAIT has a lower ability than IdFAI to detect whether a client meets CAI criteria.¹⁵ Therefore, the purposes of our study were to (1) cross-culturally adapt a Chinese (Mandarin) version of the IdFAI and (2) determine the psychometric properties of the Chinese version IdFAI. Examining the psychometric properties is critical to ensure the high quality cross-cultural adaptation because it could not only ensure the statistical structure of the translated version but also indicate the strengths or weaknesses of the translated version in comparison with the original version.²⁴

2. Methods

2.1. Cross-cultural adaptation

The adaptation procedures were performed following published guidelines by Beaton et al.¹⁸ of the 7-stage process of

cross-culturally adapting health-status self-report measures. During all stages (except Stage 5, “testing the pre-final version”), appropriate cultural adaptation as well as language were considered by the investigators and translators.

Stage 1, initial translation: 4 bilingual translators (2 biomechanics and 2 exercise physiologists), whose native language is Chinese, independently forward translated the IdFAI into Chinese.

Stage 2, synthesis of the translations: the translators then met to synthesize their translated versions into the first common translation. Each issue was addressed and resolved by consensus. To make the phrasing of terms easily understandable by the general Chinese population, while preserving the meaning of the terms with the original English version, the translators agreed to translate “ankle sprain” into “崴脚” and “rollover” into “侧翻”.

Stage 3, back translation: 2 bilingual translators, whose native language is Chinese, back translated this first common translation from Chinese into English. These translators, who were professors who teach English at universities in China, and thus not content experts, were blinded to the original English version to avoid any translation-induced items,²⁴ to avoid information bias, and to increase the probability of “highlighting imperfections”.¹⁸

Stage 4, expert committee develops pre-final version for field testing: the investigators and expert panelists then reviewed all the translations and resolved all discrepancies to preserve the “...semantic, idiomatic, experiential, and conceptual equivalence...” with the original version (p. 3188–9).¹⁸ The pre-final version of IdFAI was amalgamated using the synthesis process described above.

Stage 5, testing pre-final version: 20 bilingual participants (described below) completed the pre-final IdFAI and made comments and suggestions on the questionnaire.

Stage 6, finalizing the Chinese version of IdFAI (IdFAI-C) (Appendix 1): investigators and translators generated the final version of IdFAI-C. The only adjustment made was to add a pronunciation note (“wai”) for “崴” so participants would more easily recognize this word. In China, the pronunciation note (Pinyin) is the official phonetic coding system that will facilitate cognition of Mandarin Chinese;²⁵ however, it will not influence the contents of the item in the questionnaire.

2.2. Participants

In order to test different psychometric properties of the final IdFAI-C, 2 groups of participants were recruited, the bilingual group (20 participants who were bilingual in English and Mandarin Chinese, age = 26 ± 3 years, mean ± SD) and Chinese group (625 participants who were native-speaking Chinese, age = 23 ± 5 years). The bilingual participants are native Mandarin Chinese-speakers but attend English-language schools and can read and speak English fluently; the Chinese group participants are native Mandarin Chinese-speakers and college students in China. All participants were over 18 years old and able to read and follow written directions in both languages (bilingual group) or Mandarin Chinese (Chinese group). No eligibility criteria related to ankle sprain were used for

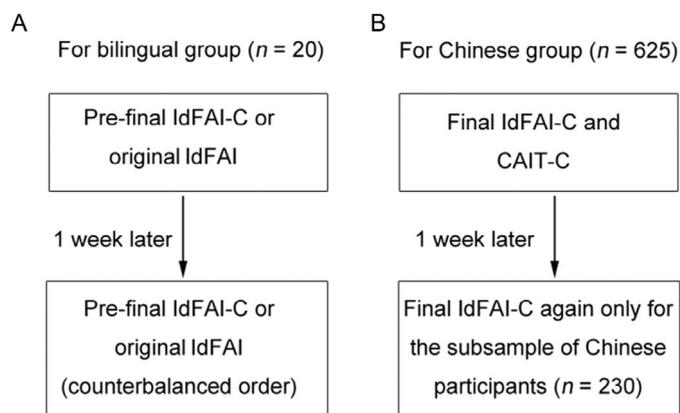


Fig. 1. A flow chart that describes the testing procedures for the bilingual (A) and Chinese group (B). CAIT-C = Chinese version of the Cumberland Ankle Instability Tool; IdFAI = Identification of Functional Ankle Instability; IdFAI-C = Chinese version of the Identification of Functional Ankle Instability.

participation,²⁶ because ankle sprain and CAI were common in general population^{1–4} and were also expected in our large sample ($n = 625$).

2.3. Test procedures

The study was approved by the University of Georgia Institutional Review Board and approval for recruiting students from Shenyang Normal University was obtained from the institution's administration. Written consent form was obtained from each participant before testing. All participants underwent testing during a single session; the bilingual group and a subsample of the Chinese group ($n = 230$, age = 23 ± 4 years) also completed tests during a 2nd session, approximately 1 week later. The participants in the subsample group completed the 1st test session and voluntarily participated the 2nd session. The questionnaires were applied to both ankles. The questionnaires completed by individuals varied by group (Fig. 1). The bilingual group participants completed either the pre-final IdFAI-C or original IdFAI in the 1st week, then the other test during the 2nd week (counterbalanced test order). The purpose of this protocol was to determine the agreement between the English and Chinese versions of IdFAI. The pre-final IdFAI-C was without Pinyin (the pronunciation note “wai”). All bilingual participants had no problem recognizing the character without Pinyin. Therefore, the pre-final and final versions are equivalent for the bilingual participants.

For the Chinese group, all participants completed the final IdFAI-C and the previously validated Chinese version of CAIT (CAIT-C),²³ in order to assess the construct validity of the IdFAI-C. The subsample of Chinese participants described above completed the final IdFAI-C again to assess test–retest reliability.

2.4. Data analysis

The data of right and left ankles were used to perform the analyses. Five psychometric properties of the IdFAI-C were

examined, which included test agreement or equivalence between the scores of original English version and pre-final IdFAI-C and, for final IdFAI-C, internal consistency, test–retest reliability, dimensionality of the test, and construct validity. All the analyses were conducted using the SPSS (Version 22.0; IBM Corp., Armonk, NY, USA) except for the confirmatory factor analysis (CFA). The CFA was performed using marginal maximum likelihood estimation in the Linear Structural Relations procedure of LISREL (Version 8.80; SSI Inc., Skokie, IL, USA). The methods for obtaining the 5 psychometric properties are shown below:

- (1) Test agreement and equivalency between the summary scores of the original English version and pre-final IdFAI-C were assessed using a paired t test and $ICC_{2,1}$. The corresponding 95% confidence intervals (CIs) were used to examine response discrepancies across the 2 measurements.
- (2) Internal consistency of the final IdFAI-C was assessed using Cronbach's α .
- (3) Test–retest reliability for the subsample Chinese group's final IdFAI-C summary scores were tested using $ICC_{2,1}$.
- (4) Both exploratory factor analysis (EFA) and CFA using item scores of each ankle were conducted to assess the dimensionality of the final IdFAI-C and to examine how strongly the measured items were related to the observed construct (i.e., ankle instability). EFA followed by CFA was employed to verify that the factor structure of all measured items exhibited a good fit to ankle instability. Models (1 model for each ankle) were applied to the same factorial structure using right and left ankle self-report data separately for the CFA. Goodness-of-fit of the 2 CFA models was evaluated using chi-square (χ^2), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), standardized root-mean square residual (SRMR), the root-mean square error of approximation (RMSEA), and the 90%CI of the RMSEA (e.g., Hu and Bentler²⁷). Chi-square (χ^2) compares the observed covariance matrix with the reproduced covariance matrix. TLI quantifies the discrepancy between the χ^2 of the hypothesized model and the χ^2 value of the null model, and CFI indicates the discrepancy between the data and the hypothesized model. Both TLI and CFI range from 0.00 to 1.00, and greater than 0.90 indicates a good model–data fit.²⁷ SRMR is defined as the standardized discrepancy between the observed correlation and the predicted correlation, and RMSEA measures the error of approximation. Both SRMR and RMSEA are “badness of fit” indexes, in that higher values represent a worse fit, a value of 0.00 is the best fit, and less than 0.08 indicates acceptable model–data fit.²⁷ The 90%CI of the RMSEA statistic allows researchers to test the null hypothesis more precisely.²⁸
- (5) Last, construct validity was tested via the Spearman correlation coefficient between the summary scores of CAIT-C and IdFAI-C. We chose CAIT-C because it is currently the only validated questionnaire in Chinese Mandarin to assess the ankle instability.

3. Results

3.1. Equivalence and agreement between English and pre-final Chinese versions

Descriptive data for the bilingual group and Chinese group are presented in Table 1. For the bilingual group, as shown in Table 1, the paired *t* test showed that the scores of the English and pre-final Chinese versions of IdFAI were not significantly different ($t = 1.64, p = 0.11$, mean difference = 0.4, 95%CI of mean difference: -0.1 to 0.8), which suggests high test equivalency across the 2 IdFAI versions. A high degree of agreement was found between the English and pre-final Chinese versions of IdFAI, as the $ICC_{2,1}$ was 0.995 (95%CI: 0.991–0.997, $p < 0.001$).

3.2. Internal consistency

The Cronbach’s α of the IdFAI-C was 0.89, indicating that the measurement was highly reliable. Results of the item analyses in Table 2 demonstrated that all items were moderately related to the scale construct of ankle instability. The item-total correlations ranged from 0.46 to 0.80. Cronbach’s α remained stable when any of the items were discarded.

3.3. Test–retest reliability

For test–retest reliability of the IdFAI-C, $ICC_{2,1}$ was 0.970 (95%CI: 0.961–0.980, $p < 0.001$). This indicates that the IdFAI-C was highly stable across testing occasions.

3.4. Dimensionality of IdFAI-C

EFA was performed first to examine the factor structure of the IdFAI-C. The 1st factor explained 62.05% of the total variance, which revealed that all items had strong associations with the 1st factor of the scale. Loadings of each item to the 1st factor ranged from 0.62 to 0.86.

Model–data fit of CFA results are presented in Table 3. TLI and CFI of both models were close to 0.90. *SRMR* of both models were 0.07, indicating plausible model–data fit. *RMSEA* for the right and left ankle models were 0.26 and 0.25, respectively. The standardized factor loadings for the 1-factor model, displayed in Table 4, ranged from 0.34 to 0.94 for the right ankle and from 0.42 to 0.92 for the left ankle. Overall, all items have moderate and strong associations with the scale construct of ankle instability, and very plausible model–data fit is exhibited.

Table 1
Bilingual and Chinese groups’ descriptive results of Chinese and English versions of IdFAI.

	Tested ankle (<i>n</i>)	IdFAI score					No. of ankles with IdFAI score ≥ 11 (CAI)
		M	SD	Min.	Max.	Median	
Bilingual group							
Pre-final Chinese version	40	8.2	15.0	0.0	58.0	1.5	8
Original English version	40	7.9	15.0	0.0	58.0	1.5	8
Chinese group							
IdFAI-C result	1250	7.6	9.5	0.0	59.0	4.0	138
IdFAI-C 1st session (subsample group)	460	9.4	10.7	0.0	50.0	6.0	67
IdFAI-C 2nd session (subsample group)	460	9.7	10.8	0.0	48.0	6.0	67

Abbreviations: CAI = chronic ankle instability; IdFAI = Identification of Functional Ankle Instability; IdFAI-C = Chinese version of IdFAI; M = mean; Max. = maximum; Min. = minimum.

Table 2
Item-total correlations of final Chinese version of Identification of Functional Ankle Instability and Cronbach’s α if 1 item was deleted for the Chinese group.

	1	2	3	4	5	6	7	8	9	10
Corrected item-total correlation	0.62	0.66	0.58	0.46	0.73	0.79	0.75	0.66	0.75	0.80
Cronbach’s α if 1 item was deleted	0.87	0.88	0.89	0.88	0.88	0.87	0.87	0.88	0.88	0.87

Note: Item number is the question number in the IdFAI.

Table 3
Goodness-of-fit indices for the one-factor confirmatory factor analysis models tested for the right and left ankle of the Chinese group.

Limb model	Fit indices						<i>RMSEA</i> 90%CI bounds		
	χ^2 statistics			TLI	CFI	<i>SRMR</i>	<i>RMSEA</i>	Lower	Upper
	χ^2	<i>df</i>	<i>p</i>						
Right	1179.21	27	0.00	0.89	0.89	0.07	0.26	0.25	0.27
Left	1057.98	27	0.00	0.86	0.89	0.07	0.25	0.23	0.26

Abbreviations: CFI = comparative fit index; CI = confidence interval; *df* = degree of freedom; *RMSEA* = the root mean square error of approximation; *SRMR* = standardized root-mean square residual; TLI = Tucker-Lewis Index.

Table 4
Standardized factor loadings of all items for both ankles of the Chinese group.

Ankle	1	2	3	4	5	6	7	8	9	10
Right	0.34	0.80	0.74	0.69	0.91	0.94	0.83	0.76	0.88	0.92
Left	0.42	0.76	0.74	0.74	0.88	0.91	0.81	0.76	0.89	0.92

Note: Item number is the question number in the Identification of Functional Ankle Instability.

3.5. Construct validity

In evaluating construct validity, CAIT-C was significantly correlated to the IdFAI-C, $r(625) = 0.67, p < 0.001$. This moderately high correlation infers that ankle instability was the construct measured by IdFAI-C, as intended.²⁹

4. Discussion

The 2 goals of this study were to translate the English version of IdFAI into Chinese and then validate the psychometric properties of this questionnaire to facilitate future ankle-related research focused on improved diagnoses and treatment of individuals with CAI in the Chinese population. Hence, we cross-culturally adapted the IdFAI to assess FAI for use of Chinese-speakers. Twenty bilingual participants took the pre-final and English version of the IdFAI, and 625 native Chinese-speaker participants completed the final IdFAI-C and the CAIT-C.

Nearly all results indicated that the IdFAI-C exhibited good psychometric properties. There was very high agreement ($ICC_{2,1} = 0.995$) and equivalence (mean difference = 0.4, 95% CI of mean difference: -0.1 to 0.8) between the Chinese and English versions of IdFAI for the bilingual speakers. The Chinese version IdFAI exhibited high overall internal consistency (0.89), although it is slightly lower than the 0.96 value of the original English version.¹⁷ The test-retest reliability of the IdFAI-C was excellent (0.97) and very close to that of the original English version (0.92).¹⁷

Regarding the dimensionality check outcomes of the EFA and CFA analyses, only 1 construct emerged from the questionnaire, ankle instability, the construct intended to be measured. All items properly loaded on this construct. Moreover, the moderately high correlation (0.67) between the IdFAI-C and the CAIT-C suggests that ankle instability was the construct intended to be measured. In addition, though the correlation displayed between IdFAI and CAIT, IdFAI may have some advantages such as a clear and concise definition of giving way and more accurate prediction for ankle instability.¹⁵

However, *RMSEAs* for the models of both ankles indicated a poor model-data fit (0.25–0.26). Due to our small degree of freedom (27), however, *RMSEA* may not be an appropriate indicator of model fit to identify the desired construct. Kenny et al.³⁰ argued that *RMSEA* may not be a precise indicator of goodness-of-fit when a low degree of freedom is observed.

One potential limitation of the present study is that we used the pre-final IdFAI-C instead of the final IdFAI-C to test agreement and equivalence with the original English version of

IdFAI. However, as the only difference between the versions was the addition of 1 pronunciation note (Pinyin), we believe that the 2 versions were equivalent for assessing CAI.

5. Conclusion

The cross-culturally adapted IdFAI-C is a highly reliable and valid self-report questionnaire that can be used to assess ankle instability. Therefore, it can be used in clinical settings to effectively and accurately assess CAI of Chinese-speaking individuals.

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Authors' contributions

YL contributed to research idea development, study design, data collection, data analysis, and manuscript writing; LG contributed to study design, data analysis, and manuscript editing; JK contributed to research idea development and study design; SZ contributed to data collection and data analysis; CNB and KJS contributed to study design and manuscript editing. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

Appendix 1. Chinese version of Identification of Functional Ankle Instability (IdFAI)

踝关节功能性不稳定鉴定表

说明：此表格将用于评价您的踝关节稳定性状态并进行归类。左右踝关节各使用一张表格。请您完整填写此表格，如有问题请与管理人员联系。感谢您的参与。

请仔细阅读以下陈述：

“让位”是指踝关节出现的暂时性不稳定者将要崴(wǎi)脚动作(侧翻)的失控感觉。

此表格用于我的右/左脚踝关节(圈选一个)。

- 1) 您曾经崴(wǎi)伤过几次脚踝(huái)? _____
- 2) 您上一次踝关节崴伤是什么时候? ()
 - a. 从来没有 b. > 2年前 c. 1–2年 d. 6–12个月 e. 1–6个月 f. < 1个月

- 3) 如果您曾看过运动伤害防护师, 医生或者其他健康从业人员, 他们是如何对您最严重的一次崴伤分类的? ()
 - a. 未曾看过 b. 轻微 (一级) c. 中度 (二级) d. 严重 (三级)
- 4) 您此前因为脚踝崴伤而使用多长时间的拐杖或其他辅助工具? ()
 - a. 从未使用过 b. 1-3 天 c. 4-7 天 d. 1-2 周 e. 2-3 周 f. >3周
- 5) 您上次出现踝关节“让位”是什么时候? ()
 - a. 从来没有 b. > 2 年前 c. 1-2 年 d. 6-12 个月 e. 1-6 个月 f. <1 个月
- 6) 这种踝关节出现“让位”的频率如何? ()
 - a. 从未出现过 b. 一年一次 c. 一月一次 d. 一周一次 e. 一天一次
- 7) 当踝关节出现将要崴脚的动作 (侧翻) 时您能停止它吗? ()
 - a. 从未出现过 b. 立刻 c. 有时候 d. 无法停止
- 8) 当您的踝关节出现侧翻后, 多久可以恢复正常? ()
 - a. 从未出现过 b. 立刻 c. 一天以内 d. 1-2 天 e. >2天
- 9) 在日常活动中, 您感到踝关节不稳定的频率是多少? ()
 - a. 从未出现过 b. 一年一次 c. 一月一次 d. 一周一次 e. 一天一次
- 10) 在体育活动中, 您感到踝关节不稳定的频率是多少? ()
 - a. 从未出现过 b. 一年一次 c. 一月一次 d. 一周一次 e. 一天一次

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