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Critical Review of Self-Reported Functional Ankle Instability Measures

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ABSTRACT

Background: **Since functional ankle instability (FAI) lacks a "gold standard" measure, a variety of self-reported ankle instability measures have been created. The purpose of this study was to determine which ankle instability measure identifies individuals who meet a minimum acceptable criterion for FAI.** ***Methods:*** **Participants volunteered from a large university population which included 242 participants (104 males, 138 females; 21.4 ± 1.4 years). The predictor variables were seven ankle instability questionnaires: Ankle Instability Instrument (AII), Ankle Joint Functional Assessment Tool (AJFAT), Chronic Ankle Instability Scale (CAIS), Cumberland Ankle Instability Tool (CAIT), Foot and Ankle Ability Measure (FAAM), Foot and Ankle Instability Questionnaire (FAIQ), and Foot and Ankle Outcome Score (FAOS). The outcome variable (MC_FAI) was created based on the minimum acceptable criteria for FAI. This was established as at least one ankle sprain and an episode of giving way. Data were modeled using chi-square and multinomial logistic regression.** ***Results:*** **The regression model revealed all of the questionnaires were more useful at identifying participants who did not meet the minimum criteria for FAI (No MC_FAI = 95.7%, MC_FAI = 55.6%, overall = 84.6%). Based on the Wald criterion, the full model was reduced to the CAIT, AII, and FAAM. The reduced model revealed the CAIT ($X^2 = 8.756$, $p = 0.003$) and AII ($X^2 = 31.992$, $p = 0.001$) as the only variables that had a significant relationship with the outcome variable.** ***Conclusion:*** **The model illustrates no single measure was able to predict if individuals met the minimally accepted criteria for FAI. However, a significantly accurate prediction of ankle stability status was produced by combining the CAIT and AII.** ***Clinical Relevance:*** **Based on the results we recommend that researchers and clinicians use both the CAIT and AII to determine ankle stability status.**

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INTRODUCTION

Clearly defining the condition known as functional ankle instability (FAI) is difficult. No universally accepted definition or gold standard measure currently exists to quantify it. Recurrent ankle injuries and ankle instability has been noted for many years in medical texts, but the term FAI is best associated with the work of Freeman.[5] In his work, he labeled the "tendency for the foot to 'give way' after an initial ankle sprain" as FAI.[5]

Since the 1960's, much research has been conducted on individuals believed to have FAI. In the absence of a unified definition, researchers are left to define ankle instability how they deem appropriate,[1] leading to the creation and repeated application of many subjective criterions. Many of these criteria differ from one another; however, a nearly universal citation of Freeman's work suggests that there is at least some agreement on the basic criteria for FAI. This work established two clear 'pillars' or minimally acceptable criteria that must be met to qualify as FAI. First, an individual must have suffered at least one ankle sprain in the affected limb, and second, that individual must describe symptoms or incidences of 'giving way' in that same limb.[5]

While self-reported instruments are widely used in the literature, many issues exist with relying on them as the sole inclusion criteria for creating FAI participant pools. We believe the absence of universally accepted inclusion criteria creates heterogeneous FAI populations and may play a significant role in the many confounding results found in FAI literature. A recent systematic review of 118 studies identified approximately 90 different inclusion criteria.[1] Most of the current criteria utilize some form of a self-reported ankle questionnaire to establish ankle stability status. The design and original intent of these

questionnaires vary greatly, some are well-established ankle pain/outcome measures and others have been constructed to identify individuals with FAI.[3,4,6−8,10,11]

Seven questionnaires were found in the literature to be repeatedly used as inclusion criteria: Ankle Instability Instrument (AII),[3] Ankle Joint Functional Assessment Tool (AJFAT),[11] Chronic Ankle Instability Scale (CAIS),[4] Cumberland Ankle Instability Tool (CAIT),[6] Foot and Ankle Ability Measure (FAAM),[8] Foot and Ankle Instability Questionnaire (FAIQ),[7] Foot and Ankle Outcome Score (FAOS).[10] While these questionnaires are widely used, it is unclear how accurately each measure predicts a participant's ankle stability or instability status. The purpose of this study was to determine which of these seven widely used self-reported ankle instability measures accurately identifies participants who meet the minimum accepted criteria for FAI.

MATERIALS AND METHODS

Participants

Participants were recruited from kinesiology classes at a large Midwestern university. Two hundred forty-two college-aged participants (104 males, 138 females; age, 21.4 ± 1.4 years) volunteered for the study. To include a relatively heterogeneous sample, no specific criteria related to the presence or absence of ankle injuries was identified as inclusion criteria. All participants gave informed consent and the university institutional review board approved this study.

Minimum accepted criteria for FAI (outcome variable)

The outcome variable was created based on the work of Freeman in the 1960's. Freeman described functional ankle instability as "the tendency for the foot to 'give way' after an ankle sprain."[5] Based on this article, the minimum accepted criteria for FAI for the purpose of this study was: first, an individual must have suffered at least one ankle sprain in the affected limb and second, that individual must describe symptoms or incidences of 'giving way' in that same limb.[5] This outcome variable was termed (MC_FAI).

Questionnaires (predictor variables)

All participants completed the following seven surveys: Functional ankle instability; Ankle Instability Instrument (AII); Ankle Joint Functional Assessment Tool (AJFAT); Chronic Ankle Instability Scale (CAIS); Cumberland Ankle Instability Tool (CAIT); Foot and Ankle Ability Measure (FAAM); Foot and Ankle Instability Questionnaire (FAIQ); Foot and Ankle Outcome Score (FAOS); participants also completed a demographic sheet that included the following questions:

1. If you were to kick a ball, you would use which leg?
2. Have you ever sprained your right ankle?
3. Does your right ankle ever give way?
4. Have you ever sprained your left ankle?
5. Does your left ankle ever give way?

The order of the questionnaires was randomized and participants were instructed to complete each questionnaire for their dominant limb, which was established in question #1.

AII

The AII was designed specifically for the detection of FAI. The 16-item questionnaire consists of nine Yes/No questions, six multiple-choice questions, and one open-ended question.[3] Each question was designed to fit into one of three categories: severity of initial ankle sprain (Factor 1), history of ankle instability (Factor 2), and instability during activities of daily life (Factor 3).[3] Participants who answer 'yes' to five or more Yes/No questions were considered to have FAI. This criterion is based on previous articles that have used the AII as their FAI-inclusion criteria.[2,9,13] The AII was proven to have good test-retest reliability (ICC = 0.70 to 0.89).[3]

AJFAT

The AJFAT is a 12-item tool that asks participants to choose the answers that best describes their dominant limb ankle using the following scale: much less than the other ankle, slightly less than the other ankle, equal in amount to the other ankle, slightly more than the other ankle, or much more than the other ankle.[11] Each answer is assigned a point value between 0 and 4, and the maximum score on this assessment tool is 48.[11] The AJFAT has a high test-re-test reliability (ICC = 0.94 and SEM = 1.5 points).[11] Wikstrom et al.[16] stated that participants who have FAI score less than 23 on the AJFAT.

CAIS

The CAIS is a recently developed 14-item patient-assessed instrument. The CAIS includes items referring to impairment, disability, participation problems, and emotion. Each item is scored on a five-point Likert scale, ranging from 4 (best score) to 0 points (worst score).[4] Lower scores indicate a lower degree of ankle function while higher scores are indicative of a higher degree of ankle stability.[4] Authors report the CAIS is a valid and reliable instrument for quantifying patients with chronic ankle instability with test-retest reliability of ICC = 0.84.[4] The mean score reported for participants having chronic ankle instability was 29, which was the score used to identify participants with FAI for this study.

CAIT

The CAIT is a nine-item questionnaire intended to identify and grade ankle instability. The authors designed the CAIT specifically to not require comparison between limbs as questionnaires like the AJFAT and the FAIQ. Each answer is assigned a point value ranging from 0 to 5, and participants separately score left and right limbs.[6] If an individual scores 27 or less on a limb, they are likely to have functional ankle

instability.[6] Founding authors reported excellent test-retest reliability (ICC = 0.96).[6] Subsequent articles have suggested lowering the FAI threshold to scores less than 24, which was the score used for this study.[12,14]

FAAM

The FAAM was developed from the Foot and Ankle Disability Index (FADI). Both instruments include two subscales: 'activities of daily living' and 'sports' subscales. The only difference between the FAAM and the FADI is that the 'sleeping' item and four 'pain-related' items were deleted on the 'activities of daily living scale' to create the FAAM.[8] The 'activities of daily living scale' contains 21 activity related items; the 'sports' subscale of the FAAM has remained exactly the same as the FADI 'sport' subscale.[8] The lowest potential score of the 'activities of daily living' subscale of the FAAM is 0 points, the highest 84 points.[8] The lowest potential score of the 'sports' subscale of the FAAM is 0 points, the highest 32 points.[8] The scores are then converted to a percentile. A score below 90% on the both subscales signifies FAI in participants.[8] Reliability for the 'activities of daily living' scale revealed ICC = 0.89 and 'sport' scale ICC = 0.87.[8]

FAIQ

The FAIQ is a 10-question survey. Questions include: information related to sensation of weakness, episodes of giving way during daily activity, injury within the past 3 months, and no formal rehabilitation of the affected ankle.[7] To qualify as functional ankle instability, an individual must answer 'yes' to specific questions (3,5,6,7, 9) and 'no' to questions to others (4, 8, and 10).[7] No reliability information has been reported on the FAIQ.

FAOS

The FAOS is a 42-item questionnaire divided into five subscales: pain, other symptoms, activities of daily living, sport and recreation function, and foot and ankle-related quality of life.[10] The 'pain' subscale contains nine items, the 'other symptoms' subscale has seven items, the 'activities of daily living' subscale has 17 items, the 'sport and recreation function' subscale contains five items, and the 'foot and ankle-related quality of life' subscale has four items.[10] Each question was scored on a 5-point Likert scale (0 to 4) and each of the five subscale scores was calculated as the sum of the item included.[10] Raw scores were then transformed to a zero to 100, worst to best score.[10] Content validity was also conducted using 213 patients.[10] Roos et al.[10] concluded that scoring below 75% in three or more categories was indicative of FAI.

Statistical analysis

The independent variables were the scores on the seven ankle instability questionnaires: AII, AJFAT, CAIS, CAIT, FAAM, FAIQ, and FAOS. The dependent variable was created based on the minimum acceptable criteria for FAI. Based on current literature this criterion was established as at least one ankle sprain and at least one episode of giving way (MC_FAI). Data were modeled using chi-square and multinomial logistic regression. Ninety-five percent confidence intervals (CI) were calculated for the resulting odds ratios. Additional statistical analysis included descriptive statistics, frequencies, sensitivity, specificity, odd ratios and relative risk based off of a 2 x 2 contingency table.

RESULTS

Two hundred forty-nine participants agreed to fill out the seven questionnaires. Seven individuals were excluded for filling out the questionnaire incorrectly, having missing questionnaires, or for incomplete questionnaires. Subsequently, 242 participants were available for the data analysis. Limb dominance for the cohort was 226 (93.4%) right limb and 16 (6.6%) left limb dominance. Of the 242 participants 140 (57.9%) had experienced a right ankle sprain and 105 (43.4%) a left ankle sprain. 53.3% ($n = 141$) of participants experienced a dominant limb ankle sprain, and 48.2% ($n = 68$) of participants with a dominant ankle sprain reported at least one episode of giving way. However, of the 242 participants, 91 (37.6%) stated that they experience giving way regardless if they have/have not had an ankle sprain.

A direct logistic regression analysis was performed on FAI status (MC_FAI) as the outcome variable and seven questionnaire predictors: AII, AJFAT, CAIS, CAIT, FAAM, FAIQ, and FAOS. Analysis was performed using PASW Statistics 18.0. The regression model revealed that all questionnaires were better at determining when a participant did not meet the minimum criteria for FAI (no MC_FAI = 95.7%, MC_FAI = 55.6%, overall = 84.6%). A test of the full model with all seven predictors against MC_FAI revealed that only the CAIT ($X^2 = 5.091$, $p = 0.024$) and AII ($X^2 = 26.144$, $p = 0.000$) had a significant relationship with the outcome variable. Table 1 shows regression coefficients, Wald Chi square, odds ratios, and 95% CI for odds ratios for each of the seven predictors. According to the Wald criterion, only the CAIT and AII reliably predicted FAI status.

Based on the Wald criterion the full model was reduced to the CAIT, AII and FAAM. With the reduced the model it was revealed the CAIT ($X^2 = 8.756$, $p = 0.003$) and AII ($X^2 = 31.992$, $p = 0.000$) were the only variables that had a significant relationship with the outcome variable. Table 2 shows regression coefficients, Wald Chi square, odds ratios, and 95% confidence intervals for odds ratios for the reduced model. This confirms the finding that the CAIT and AII were the only statistically significant predictors of FAI status among the seven predictor variables. Sensitivity, specificity, odds ratio and relative risk with confidence intervals was calculated for the significant predictor variables (Table 3). The significant predictor variables included the AII, CAIT, and a combination of the CAIT and AII.

Table 1: Regression Statistics for the Full Model

	B	Wald Chi-Square	Odds Ratio	95% CI for Odds Ratio		Significance
				Lower	Upper	
CAIS	20.50	0.00	7.88	0.01	0.01	0.99
FAIQ	21.62	0.00	2.45	0.01	0.01	0.99
AJFAT	0.33	0.53	1.39	0.57	3.40	0.47
CAIT	0.96	5.09	2.62	1.14	6.03	**0.02***
FAAM	0.83	1.03	2.29	0.46	11.43	0.31
FAOS	0.29	0.15	1.34	0.30	5.87	0.70
AII	2.22	26.14	9.18	3.92	21.46	**0.01***
(Constant)	−2.44	65.07				

*, Significant result ($p < 0.05$).

Table 2: Regression Statistics for the Reduced Model

	B	Wald Chi-Square	Odds Ratio	95% CI for Odds Ratio		Significance
				Lower	Upper	
CAIT	1.18	8.76	3.24	1.49	7.06	**0.01***
FAAM	1.19	3.31	3.29	0.91	11.87	0.07
AII	2.33	31.99	10.31	4.59	23.15	**0.01***
(Constant)	−2.30	69.09				

*, Significant result ($p < 0.05$)

Table 3: Sensitivity and Specificity of Significant Predictor Variables From the Reduced Model

	Sensitivity (95% CI)	Specificity (95% CI)	Odds-Ratio (95% CI)	Risk (95% CI)
AII	0.73 (0.59-0.83)	0.85 (0.79-0.83)	16.10 (7.84-33.02)	6.99 (4.15-11.77)
CAIT	0.56 (0.45-0.67)	0.86 (0.79-0.90)	7.88 (4.18-14.89)	3.20 (2.33-4.65)
AII&CAIT	0.82 (0.66-0.92)	0.82 (0.76-0.87)	21.21 (8.68-51.83)	11.70 (5.4-25.22)

DISCUSSION

The results of this study reveal that fundamental issues may exist with the singular use of any of the ankle instability measures that are currently in the literature. When utilized alone, none of the questionnaires were able to achieve a statistically significant predictive value otherwise known as the Wald Score (Table 1). In other words, none of the measures alone was able to predict if an individual would meet the minimally acceptable criterion. When data from the CAIT and the AII were modeled in conjunction, an overall prediction of 84.6% was revealed. Even though this appears to be fairly accurate, additional factors should be considered in the interpretation of these results. First, we do not believe that the MC_FAI should be the gold standard for FAI inclusion criteria; however, the existing literature consistently reports that individuals included in FAI populations should at minimum report an initial ankle sprain and a history of "give way" in the same ankle. The minimum criteria (MC_FAI) was constructed based on the working definitions of FAI functional ankle instability present in the existing literature. The use of MC_FAI allowed the comparison of all measures

based on this basic set of symptoms. MC_FAI does not distinguish or rule out other conditions such as mechanical ankle instability, nor does it provide any insight into the severity of FAI. In the conception of this project, we felt that at minimum, any patient self-report questionnaire utilized to identify FAI functional ankle instability should be sensitive to the MC_FAI.

Sensitivity and specificity of clinical diagnostic measures were calculated to establish the overall accuracy of the measure. Specificity identified the proportion of healthy individuals who were correctly identified as healthy or in this study not having FAI; conversely, sensitivity identified individuals who have the condition (FAI) and were correctly identified by the measure. The data presented in Table 3 illustrate that the combination of the AII and CAIT instruments produced the highest sensitivity and specificity (0.82 and 0.82), respectively. We feel that this further supports the reduced regression model indicating the combined use of the AII and CAIT as predictors of ankle stability status.

The intended purpose of this study was not to invalidate any of the questionnaires included in this study, but to investigate the effectiveness of subjective measures as inclusion criteria for FAI research. There are many potential explanations for our findings. During the design and execution of this project many issues were identified with each of the measures. It is likely that some of these issues contributed to the outcome of this study and need to be further investigated. We identified three categories of concern: instrument design, threshold for identification, and burden. These categories were created based on recommendations for quality-of-life instruments set forth by the Scientific Advisory Committee of the Medical Outcomes Trust.[15]

Instrument design

Many of the instruments exist in multiple designs, layouts and versions, some of which contain varying content or item wording from version to version. If researchers are not diligent in searching the literature prior to undertaking a new project they may not utilize the most recent or most appropriate version of their chosen instrument. A number of these instruments were designed to be used in a clinical intake or other various settings, not a research setting. As a result of the variation of intended setting, some instruments were significantly longer than others, ranging from 1 to 4 pages (AII, 1 page; AJFAT, 1 page; CAIS, 2 pages; CAIT, 2 pages; FAAM, 3 pages; FAIQ, 1 page; FAOS, 4 pages;). Some included clear and concise directions while others offered confusing or limited directions to participants. Other measures had complex layouts, which could require further explanation to some potential participants, which is not appropriate or feasible for every study design. These factors result in a number of incidents in which it was clear the participant completed the questionnaire incorrectly or incompletely and as a result their data had to be excluded.

Many of the included measures dealt with limbs differently, some asked participants to complete the same form for each limb (AII, FAIQ, CAIS, FAAM, FAOS), one asked questions with a response item for each limb (CAIT), and another asked participants to answer based on a comparison of their limbs (AJFAT). The variations in the method in which limb is addressed presents various challenges for investigators. Measures, such as the AJFAT, which compare limbs, cannot be utilized for individuals with bilateral ankle symptoms. During data collection it became clear that some participants struggled when asked to answers questions about limbs at the same time. For example, we had some participants who reported ankle sprains or giving way in one limb on the demographic questionnaire but then reported these symptoms in the opposite limb on these instruments, thus their results were excluded.

As previously discussed, a systematic review recently identified that nearly all ankle instability measures mention incidents of "giving way" as one aspect of their inclusion criteria but nearly all fail to clearly define "giving way" or how it should be explained to the participant.[1] Of the measures utilized in this investigation only the CAIT and AII directly ask participants questions about incidents of "giving way" and none provide the participant with a clear or uniform definition of this major symptom of ankle instability. Therefore the participant is left two choices: use his/her own knowledge or ask the investigator for clarification. We feel this is a significant weakness of all the measures utilized in this investigation and is likely a major contributor to the poor outcomes presented. It is simply unacceptable to not to clearly define "giving way" when two vastly different explanations exist for "giving way": one implies a physical motion of the ankle and second describes a subjective sensation that does not require ankle motion. While defining the concept of "giving way" is outside the scope of this investigation, we believe it must be explained to all participants in an investigation in exactly the same manner. This would allow all participants to answer any "giving way" items based on the same definition.

Threshold for identification

In the Methods section, we provided the criteria required for identification of ankle instability for each of the included measures. It became clear during the design phase of this project that this aspect of the included self-reported subjective measures was going to be a major limitation. While a criteria or threshold of detection can be found in the literature for each of these measures, the origin, validity and universal application is simply not documented for all measures. While many of these measures are repeatedly cited throughout the literature it is obvious that most criteria are simply based on existing literature. This is certainly acceptable but many times the articles cited are not articles that established or validated this criteria; they are simply articles that utilized the same criteria. More than once

it appears that limited effort was put into ensuring the appropriate criteria was utilized as older criteria was applied to a newer version of the measure or newer references which revised the criteria were not cited and as a result the old criteria was applied. The criterion used in this investigation was a result of an extensive literature search and in some cases by contacting the authors of the measures.

Burdens

Two major recommendations for the design of quality-of-life instruments pertain to the burdens placed on both the participants (respondent) and administrator.[15] The recommendations defined a burden as the time, effort and other demands placed on the respondent and administrator.[15] Some of the included measures have comparatively high respondent and administrative burdens. Long and potentially confusing measures place a significant burden on both the participant and administer and may result in more incorrect or incomplete responses that can affect data. In this investigation, the order in which the measures were completed was randomized and participants were given sufficient time and motivation to complete all included measures. Yet some participants still chose to skip pages or entire measures; it appeared this was more common with the longer measures.

When evaluating the administrative burden of a quality-of-life assessment, there are a few factors other than time to administer that must be taken into account. Specific attention was paid to the resources required to administer (paper, number of copies) and the amount of training or education necessary to "score" them measures. While no specific instrument took participants an unreasonable amount to time to complete, some of the measures took investigators significantly longer to "score." One specific measure had two vastly different scoring methods present in the literature (AJFAT), two measures had nominal scoring methods (AII, FAIQ) that required conversion to a binary outcome, while others required the application of a mathematic formula to establish a final score (FAOS, FAAM). While none of these criteria are unreasonable, they certainly increase the possibility for confusion, variation between research groups and miscalculation. These factors should be considered when selecting a measure. It should also be pointed out that multiple page measures may place increased administrative burden on investigators in the production and storage of the measures depending on the setting and sample size of the investigation.

CONCLUSION

Nearly all ankle instability research utilizes some form of subjective self-reported measure to identify participants with FAI. The intent of this investigation was not to address the faults of specific measures but to highlight the issues surrounding the identification of ankle instability. Furthermore, we were not attempting to advocate the use of MC_FAI as a gold standard or sole inclusion criteria. It was a simple starting point to begin the process of creating a universally accepted definition of FAI.

Based on the data presented in this investigation, the results can be summarized in the following manner: first, prior to undertaking a new ankle instability project investigators should determine what they feel is an appropriate definition of "giving way." This definition should be presented to all participants prior to completing any subjective self-reported measure to ensure all participants are completing that measure based on the same definition. Ideally, a universally accepted definition for "giving way" will come to fruition. Second, those investigating FAI should utilize the CAIT and the AII together when forming FAI populations for research. The data presented in this paper illustrate that when used in conjunction, the CAIT and the AII are sensitive to identifying the two 'pillars' of FAI (an initial ankle sprain and giving way). Additionally, based on existing literature related to these two instruments, they can also be used to establish severity of FAI. Subsequently, only participants who score less than 24 on the CAIT and answer "yes" to at least 5 questions on the AII should be included in FAI populations.

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