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## Original Research

## Generic and psychological patient-reported deficits in those with chronic ankle instability: A cross sectional study

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## ABSTRACT

**Objectives:** To quantify differences in generic and psychological patient-reported outcomes (PROs) between those with CAI and uninjured controls. To determine associations between generic and psychological PROs, in those with CAI, to regional PROs and injury history characteristics.

**Design:** Cross-sectional, descriptive.

**Setting:** Sport Medicine Research Laboratory.

**Participants:** Included 45 individuals with CAI and 45 uninjured controls. CAI was defined based on the recommendations of the International Ankle Consortium.

**Main outcome measures:** Two regional PROs (e.g. Foot and Ankle Ability Measure), and several generic and psychological PROs (e.g. SF-36, select PROMIS short forms, Fear Avoidance Beliefs Questionnaire).

**Results:** Those with CAI had worse scores, relative to controls, in PROs related to regional function, generic physical function, pain, ability to participate in social roles and activities, and injury related fear. The number of giving way episodes, CAI severity, and regional PROs associated with generic physical function scales as well as a pain scale.

**Conclusions:** Select generic physical function and psychological scales can detect differences between those with and without CAI. Specific injury history characteristics and regional PROs associate with generic and psychological PROs.

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## 1. Introduction

Lateral ankle sprains are highly prevalent (Cameron, Owens, & DeBerardino, 2010; Herzog, Kerr, Marshall, & Wikstrom, 2019; Hootman, Dick, & Agel, 2007; Shah, Thomas, Noone, Blanchette, & Wikstrom, 2016), costly (Shah et al., 2016; Soboroff, Pappius, & Komaroff, 1984), and 40% result in chronic ankle instability (CAI) (Doherty et al., 2016). Those with CAI are known to have a variety of mechanical, sensorimotor and biomechanical alterations (Gribble, Bleakley et al., 2016; Hertel & Corbett, 2019; Wikstrom & Brown, 2014). These alterations are thought to contribute to the development of ankle posttraumatic osteoarthritis (Saltzman, Salamon et al., 2005; Valderrabano, Horisberger, Russell, Dougall, & Hintermann, 2009) and deleterious changes in patient-reported outcomes (PROs) (Houston, Hoch, Gabriner, Kirby and Hoch (2015); Houston, Hoch and Hoch (2015),

2018; Houston, Van Lunen et al., 2014). PROs evaluate a patient's health-related quality of life, a concept that includes physical, psychological, and social domains (Ware, 1987). To date, a number of discriminative (e.g. Ankle Instability Instrument) and evaluative (e.g. Foot and Ankle Ability Measure) regional instruments have been developed for ankle related injuries (Eechaute, Vaes, Van Aerschot, Asman, & Duquet, 2007; Hale & Hertel, 2005) (Simon, Donahue, & Docherty, 2012). In addition, health related quality of life following ankle injury can be assessed using generic (e.g. SF-36) and psychological instruments (e.g. Fear-Avoidance Beliefs Questionnaire). Generic instruments assess the patient's overall health regardless of where an injury may have taken place while psychological instruments assess mental and/or social function (Valovich McLeod, 2007).

Younger (Houston, Hoch et al. 2015a,b, 2018; Houston, Van Lunen et al., 2014; Kosik et al., 2018) and older adults with CAI (Simon & Docherty, 2018), and those with ankle PTOA (Saltzman et al., 2006; Wikstrom & Anderson, 2013) have demonstrated deficits on a variety of PROs that span physical, psychological, and social domains. However, the vast majority of this research has

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focused on regional PROs. As a result, a recent systematic review demonstrated that those with CAI have conclusive deficiencies in regional PROs (e.g. Foot and Ankle Ability Measure)(Houston, Hoch et al. 2015a,b). However, definitive conclusions cannot be made regarding how CAI influences generic and psychological PROs because of a lack of research. Further, in those with CAI, regional PROs associate with measures of ankle joint laxity and sensorimotor control(Houston, Hoch et al. 2015a,b). However, little is known about how regional PROs or CAI injury history characteristics associate with generic or psychological PROs. Elucidating these relationships could provide further insights into the complex and multi-factorial nature of CAI(Hertel & Corbett, 2019) and how treatment paradigms should be developed to address health related quality of life deficits in those with CAI.

Therefore, the purpose of this cross-sectional investigation was to quantify differences in generic and psychological PROs between those with CAI and uninjured controls. The secondary purpose of this investigation was to determine associations between generic and psychological PROs, in those with CAI, to regional PROs and injury history characteristics. Based on the existing literature, we hypothesized that those with CAI would have deficits in both generic and psychological PROs but not all PROs would associate with regional PROs or injury characteristics given the heterogeneous nature of CAI.

## 2. Methods

### 2.1. Design & participants

A total of 90 participants (45 CAI, 45 control) volunteered to participate in larger investigations that required the completion of a series of PROs. All participants with complete datasets and met the inclusion criteria were included in this investigation. Individuals with CAI met the recommendations of the International Ankle Consortium(Gribble, Delahunt et al., 2013). More specifically, all participants had at least one lateral ankle sprain and at least two episodes of giving way within the past 6 months; and an Identification of Functional Ankle Instability (IdFAI) > 11(Gribble, Delahunt et al., 2013; Simon et al., 2012). In addition, participants were required to be between 18 and 35 years of age, free from acute lower extremity and head injuries for at least 3-months prior to testing except for the occurrence of a lateral ankle sprain, free from symptoms from musculoskeletal and head injuries sustained at any time, and free from equilibrium disorders. Uninjured controls, were also required to be between 18 and 35 years of age, have no history of ankle or other significant lower extremity injury, and score <11 on the IdFAI. Written informed consent, approved by the biomedical institutional review board, was provided prior to participation.

### 2.2. Patient reported outcomes

Regional PROs included the Foot and Ankle Ability Measure-Activities of Daily Living (FAAM-ADL) and the FAAM-Sport (FAAM-S). The FAAM-ADL and FAAM-S capture ankle specific function. These scales were scores as previously established (i.e. points accrued divided by the maximum points available) where lower scores (percentage of total possible score) represent greater disability. Both are reliable ( $r = 0.89$  and  $r = 0.87$  respectively) instruments(Echoute et al., 2007; Hale & Hertel, 2005).

The Medical Outcomes Study Short Form-36 (SF-36), select Patient-Reported Outcomes Measurement Information System (PROMIS) questionnaires, and the Fear-Avoidance Beliefs Questionnaire (FABQ) comprised the battery of generic and psychological PROs. The SF-36 (version 1) is a generic health outcomes scale (Ware & Sherbourne, 1992; McKorney, Ware, Rogers, Raczek, & Lu,

1993) with eight sub-scales: Physical Functioning (generic), Role Limitations- Physical (generic), Role Limitations- Emotional (psychological), Vitality/Energy (generic), Mental Health (psychological), Social Functioning (psychological), Pain (generic), and General Health (generic). Raw scores were transformed so that the minimal score was 0 and the maximal score was 100 as originally described(Ware & Sherbourne, 1992). Transformed scores were then normalized to a z-score based on available population norms for adults in the United States(Ware, Kosinski, & Keller, 1994). Lower scores represent worse outcomes and/or greater limitations across all subscales. PROMIS (nihpromis.org) is a system of highly reliable measures of patient-reported physical, mental, social, and global health status(Cella, Riley et al., 2010). PROMIS hard copy short forms included: physical function 20a (generic), ability to participate in social roles and activities 8a (psychological), and mental health (psychological) subscales. Raw scores for each subscale were converted to a T-score based on the distribution within the US population. The FABQ assesses fear-avoidance beliefs (psychological) on two subscales: physical activity and work(Waddell, Newton, Henderson, Somerville, & Main, 1993). Higher scores represent increased fear-avoidance beliefs. To apply the instrument to individuals with CAI, we replaced the word “back” with “injury.”(Houston, Cross et al., 2014) High test-retest reliability (ICC = 0.77–0.90) has been reported for the instrument(Jacob, Baras, Zeev, & Epstein, 2001).

Independent t- or Mann-Whitney U tests assessed between group differences for (i) participant demographics, (ii) injury history characteristics, and (iii) regional, generic, and psychological PROs based on equality of variances between the groups. Between group bias corrected Hedge's g effect sizes and 95% confidence intervals (CIs) were also calculated to confirm group differences given the number of comparisons run. Effect sizes were interpreted as small (<0.4), moderate (0.41–0.7), and large (>0.71)(Cohen, 1988a, 1988b). Associations between injury history characteristics and regional-PROs with generic-, and psychological PROs were determined using either Pearson Product Moment Correlations or Spearman's Rho Correlations based on the normality of the variables within the CAI group. Correlations were interpreted as weak with a correlation coefficient from 0.01 to 0.39, moderate from 0.40 to 0.69, and strong from 0.70 to 1.00(Cohen, 1988a, 1988b). An a priori p value of 0.05 was considered statistically significant for all analyses.

## 3. Results

Preliminary analyses identified 3 and 2 outliers (i.e. greater 3 standard deviations) within the CAI group for giving way episodes and FAAM-S scores respectively. These data were removed and not replaced for these variables alone. Means, standard deviations, and calculated effect sizes for all variables can be found in Table 1. Age and height did not differ between groups. Weight was not statistically different, but the 95%CI of the calculated effect size did not cross zero, suggesting a group difference. Injury history characteristics were higher ( $p < 0.001$ ) while regional PROs were worse ( $p < 0.001$ ) in the CAI group. Those with CAI also had deficits in some but not all generic and psychological PROs ( $p \leq 0.018$ ) relative to the uninjured control group. These deficiencies were associated with moderate to large effect sizes with 95%CIs that did not cross zero.

Significant associations between generic and psychological PROs with regional PROs and CAI injury history characteristics can be found in Table 2. In brief, select injury history characteristics (i.e. giving way episodes and IdFAI) demonstrated weak to moderate negative associations with generic physical function scales (SF-36 and PROMIS) indicating that as injury frequency/severity increased,

**Table 1**

Participant demographics, injury characteristics, and self-reported function on regional patient reported outcomes (PROs). Means, standard deviations, and effect sizes with 95% confidence intervals (CI) are reported.

	Control	CAI	Effect Size (95% CI)
<b>Demographics</b>			
Age (years)	20.77 ± 2.35	20.07 ± 2.07	-0.31 (-0.73 to 0.10)
Height (cm)	169.37 ± 8.34	169.85 ± 7.43	0.06 (-0.35 to 0.47)
Weight (kg)	67.22 ± 13.12	72.65 ± 14.64	0.55 (0.13–0.97)
<b>Injury History</b>			
IdFAI*†	0.28 ± 0.72	22.37 ± 4.68	6.54 (5.50–7.58)
Number of ankles sprains*†	–	4.24 ± 3.86	1.54 (1.07–2.01)
Number of giving way episodes in the past 6-months*†	–	6.45 ± 5.07	1.82 (1.32–2.32)
<b>Regional PROs</b>			
FAAM-ADL*†	99.94 ± 0.24	86.98 ± 10.48	-1.73 (-2.22 to -1.25)
FAAM-S*†	100.00 ± 0.00	76.33 ± 15.66	-2.14 (-2.67 to -1.62)
<b>Generic PROs</b>			
SF-36 PF*	56.25 ± 1.18	53.13 ± 4.65	-0.92 (-1.34 to -0.48)
SF-36 RLP†	54.90 ± 3.08	53.75 ± 5.71	-0.25 (-0.66 to 0.17)
SF-36 Vitality	55.27 ± 11.1	54.87 ± 9.56	-0.04 (-0.45 to 0.37)
SF-36 Pain*	53.04 ± 7.57	48.35 ± 7.30	-0.63 (-1.05 to -0.20)
SF-36 GH	54.57 ± 7.18	52.54 ± 8.02	-0.26 (-0.68 to 0.15)
PROMIS PF20a*†	61.78 ± 2.45	55.21 ± 6.28	-1.37 (-1.83 to -0.91)
<b>Psychological</b>			
SF-36 RLE	52.61 ± 6.64	51.44 ± 7.67	-0.16 (-0.58 to 0.25)
SF-36 MH	51.79 ± 6.78	49.80 ± 7.23	-0.28 (-0.70 to 0.13)
SF-36 SF	54.30 ± 6.95	52.81 ± 9.30	-0.18 (-0.59 to 0.23)
PROMIS APSR*	57.81 ± 3.92	54.65 ± 5.14	-0.58 (-1.01 to -0.16)
PROMIS GMH	52.97 ± 7.25	54.97 ± 6.49	0.29 (-0.13 to 0.70)
FABQ PA*	1.42 ± 3.59	10.97 ± 4.28	2.40 (1.85–2.94)
FABQ Work*	0.66 ± 3.03	3.46 ± 5.71	0.61 (0.18–1.03)

IdFAI: Identification of Functional Ankle Instability, FAAM-ADL: Foot and Ankle Ability-Activities of Daily Living, FAAM-S: Foot and Ankle Ability Measure- Sport, PF: Physical Functioning, RLP: Role Limitations- Physical, GH: General Health, RLE: Role Limitations- Emotional, MH: Mental Health, SF: Social Functioning, APSR: Ability to Participate in Social Roles and activities, GMH: Global Mental Health, FABQ: Fear Avoidance Belief Questionnaire, PA: Physical Activity, \* Indicates a significant difference between the groups ( $p < 0.05$ ). † Indicates unequal variances between groups and the use of non-parametric statistics.

**Table 2**

Associations among generic and psychological patient reported outcomes (PROs) as well as regional PROs and injury characteristics of the CAI sample.

Regional PRO/ Injury History Characteristic	Generic PRO Psychological PRO	R value
Giving way episodes	SF-36 Physical Function	-0.506
Number of Ankle Sprains	–	–
IdFAI	SF-36 Physical Function	-0.400
	PROMIS Physical Function	-0.381
FAAM- ADL	SF-36 Physical Function	0.472
	SF-36 Pain	0.367
	PROMIS Physical Function	0.366
FAAM-S	SF-36 Physical Function	0.495
	SF-36 Pain	0.520
	PROMIS Physical Function	0.462

IdFAI: Identification of Functional Ankle Instability, FAAM-ADL: Foot and Ankle Ability-Activities of Daily Living, FAAM-S: Foot and Ankle Ability Measure- Sport.

physical function declined. Both regional PROs demonstrated weak to moderate positive associations with generic physical function scales (SF-36 and PROMIS) indicating higher self-reported function on a regional PRO corresponded with higher self-reported function on a generic PRO. The FAAM-ADL also had a weak positive association with pain while FAAM-S had a moderate positive association with pain indicating that less pain is associated with better self-reported function. All other associations were weak and insignificant. Select associations can be seen in the figure.

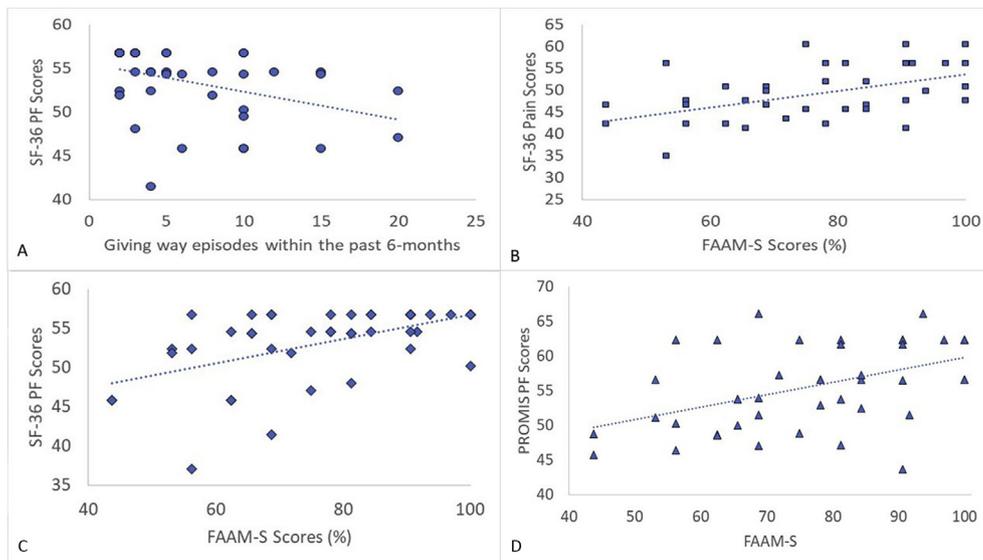
#### 4. Discussion

Our results are consistent with the existing literature and partially support our a priori hypothesis as generic and psychological scales that dealt with physical function, pain, and/or injury related fear differed between those with and without CAI while

scales focused on mental health did not. Scales dealing with social considerations demonstrated mixed results. Our results also supported our a priori hypothesis as some but not all generic and psychological PROs associated with injury history characteristics and regional PROs in those with CAI.

Consistent with a recent systematic review (Houston, Hoch et al. 2015a,b), we observed large between group differences in regional PROs. However, it must be noted that most CAI related investigations, including the current investigation, use discriminative (e.g. IdFAI) and/or evaluative regional PROs (e.g. FAAM) with specific thresholds for CAI and control groups as part of the inclusion criteria. Thus, the magnitude of between group differences should be interpreted with caution given the possible selection bias introduced when using PROs as part of the inclusion criteria. Despite this potential limitation, deficits in regional PROs associate with alterations in joint stability and sensorimotor function (Houston, Hoch et al. 2015a,b) and regional PROs improve following a variety of therapeutic interventions in those with CAI (Powden, Hoch, & Hoch, 2017). These results demonstrate the importance of incorporating regional PROs in clinical practice as ankle sprain rehabilitation is a multidimensional process governed by perception (McKeon & Donovan, 2019).

Consistent with the existing literature (Arnold, Wright, & Ross, 2011; Houston, Van Lunen et al., 2014), both SF-36 and PROMIS generic physical function scales differed between the CAI and uninjured control group. The larger PROMIS effect size was likely due to the number of CAI participants that reported no functional limitations on the SF-36 scale (see Fig. 1). While not all investigations quantify pain in those with CAI, the current CAI sample also demonstrated greater bodily pain (SF-36) relative to the uninjured control group. When coupled with (i) data indicating that bodily pain has an impact on sensorimotor function (Thompson, Hiller, & Scabrun, 2019; Wikstrom & Anderson, 2013), and (ii) the



**Fig. 1.** Associations between SF-36 physical function (PF) and giving way episodes (a), SF-36 pain and Foot and Ankle Ability Measure-Sport (FAAM-S) (b), SF-36 PF and FAAM-S (c), and PROMIS PF and FAAM-S (d) scores.

current associations with health-related quality of life it is recommended that pain be explicitly quantified in future CAI research and captured during clinical interactions with CAI patients.

Within the psychological domain, mental health subscales (SF-36 Mental Health, PROMIS Mental Health) did not differ between the groups, consistent with previous research investigating young and middle aged adults with and without CAI (Houston, Hoch et al. 2015a,b; Simon & Docherty, 2018). While speculative, it is possible that the included questions (e.g. Have you felt downhearted and blue? Have you completed work less carefully?) on these mental health scales are not appropriate to capture mental health deficits in those with CAI, if such deficits exist. However, mixed results were noted for both social (SF-36 Social Functioning, PROMIS Ability to Participate in Social Roles and activities) and emotional (SF-36 Role Limitations- Emotional, FABQ) scales. We hypothesize that the lower abilities to participate in social roles and activities scores in those with CAI may be driven by the importance of physical activity to our sample. Anecdotally, our sample reported that sport and recreation were (i.e. in secondary school) and are (e.g. intramural and recreational sports/activities) meaningful elements of their social interactions. Decreased physical function as a result of their past ankle injury(ies) could then partially explain a decreased ability to participate in social roles and activities but further research is needed to test our hypothesis. Emotionally, the increased FABQ (i.e. injury related fear) scores in those with CAI are consistent with previous results (Houston et al., 2018; Houston, Van Lunen et al., 2014). Cumulatively, it appears that generic physical function, psychological PROs related to past injury (i.e. pain), and potential for future injury (i.e. FABQ) consistently differ between those with and without CAI while scales related to mental health do not.

Limited data is available regarding associations among regional, generic, and psychological PROs as well as injury characteristics in those with CAI (Arnold et al., 2011; Houston, Van Lunen et al., 2014). As stated above, not all variables were associated but we noted several significant associations between generic and psychological PROs with regional PROs and injury history characteristics. For example, SF-36 physical function scores associated with giving way episodes, IdFAI, FAAM, and FAAM-S scores. As noted above, many CAI participants reported perfect physical function on this SF-36

scale, thus, the observed associations are being driven by a smaller subset of our CAI sample that reported deficits in SF-36 physical function (see Fig. 1). Multiple subsets within a CAI sample is consistent with the heterogeneous nature of CAI (i.e. CAI presents differently among individuals) (Hertel & Corbett, 2019; Hiller, Kilbreath, & Refshauge, 2011). The FAAM-ADL and FAAM-S associations with PROMIS physical function and pain appear to be representative of the entire sample (Fig. 1). Interestingly, associations between pain and FAAM-S ( $r = 0.520$ ) were stronger than the association between pain and FAAM-ADL ( $r = 0.367$ ). This suggests that within this sample of CAI participants (i.e. young non-health care seeking individuals) activities of daily living do not provoke pain to the same extent as sporting activities. Further research is needed to determine how the observed associations in ADLs would change in populations further removed from sporting activities. Overall, only a small subset of associations were significant and those associations were observed to be weak to moderate in strength. This could be due to the heterogeneous nature of CAI but could also be because the generic and psychological PROs capture unique aspects of health-related quality of life relative to regional PROs and injury history characteristics. The potential to capture unique aspects of health-related quality of life and the limited data on non-physical function PRO domains, suggests that future CAI related research should capture a range of PROs to better our understanding of how PROs interact, how they could be best deployed in clinical practice, and how treatment paradigms could address the breadth of deficits associated with CAI.

This investigation is not without limitations. First, only a small subset (i.e. young non-health care seeking) of the CAI population was used and thus it cannot be determined how these results would translate to other subsets of the CAI population. Further, like many CAI studies, we included a PRO (IdFAI) and a specific cut-point for both groups as part of our inclusion criteria. Thus, the current results may only be representative of individuals with greater CAI severity. Within our sample, weight appears to differ between the groups which may have influenced our initial results. However, our results did not change during a secondary analysis that used weight as a co-variate. Future research should further explore the potential influence of weight on PROs by matching participants. Additionally, only a small sampling of regional,

generic, and psychological PROs were used in this investigation. As a result, there may be other PROs that are more sensitive to CAI associated impairments. Finally, based on the cross-sectional study design, we are unable to determine if generic and psychological PROs are sensitive to change following therapeutic interventions in those with CAI.

Clinically, our results suggest that a broader range of health-related quality of life scales need to be assessed in this population as perception governs the multidimensional process of ankle sprain rehabilitation (McKeon & Donovan, 2019). While rehabilitation improves outcomes, including regional PRO scores in those with CAI (Cruz, Oliveira, & Silva, 2019; Powden et al., 2017), limited information is available about how rehabilitation impacts generic and psychological PROs. More specifically, a recent 4-week multimodal intervention that combined both supervised and at home sessions significantly improved: range of motion, balance, strength, and regional, generic physical function, and psychological PROs (i.e. fear of reinjury) in those with CAI (Powden, Hoch, Jamali, & Hoch, 2019). Future research is needed to confirm these initial results in order to continue to improve treatment paradigms for CAI.

## 5. Conclusions

Those with CAI have deficits in self-reported physical function on several regional and generic physical function PROs. Generic subscales related to mental health are not different between those with and without CAI however pain and injury related fear, quantified via the FABQ, were greater in those with CAI. Several moderate associations were noted between generic and psychological PROs, giving way episodes and regional PROs among individuals with CAI.

## Ethical approval

The work has been approved by the appropriate ethical committee at the institution at which it was performed and all participants gave written informed consent prior to participation.

## Conflicts of interest

None.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ptsp.2019.09.004>.

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