Association of Ankle Sprain Frequency With Body Mass and Self-Reported Function: A Pooled Multisite Analysis

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Context: Ankle sprains result in pain and disability. While factors such as body mass and prior injury contribute to subsequent injury, the association of the number of ankle sprains on body anthropometrics and self-reported function are unclear in this population. Therefore, the purpose of this investigation was to assess differences in anthropometric measurements and self-reported function between the number of ankle sprains utilizing a large, pooled data set. Design: Cross-sectional. Methods: Data were pooled from 14 studies (total N = 412) collected by the Chronic Ankle Instability Outcomes Network. Participants were categorized by the number of self-reported sprains. Anthropometric data and self-reported function were compared between those who reported a single versus >1 ankle sprain as well as among groups of those who had 1, 2, 3, 4, and ≥5 ankle sprains, respectively. Results: Those who had >1 ankle sprain had higher mass (P = .001, d = 0.33) and body mass index (P = .002, d = 0.32) and lower Foot and Ankle Ability Measure-Activities of Daily Living (P < .001, r = .22) and Foot and Ankle Ability Measure-Sport (P < .001, r = .33), and Cumberland Ankle Instability Tool (P < .001, r = .34) scores compared to the single ankle sprain group. Those who had a single ankle sprain weighed less than those who reported ≥5 sprains (P = .008, d = 0.42) and had a lower body mass index than those who reported 2 sprains (P = .031, d = 0.45). Conclusions: Some individuals with a history of multiple ankle sprains had higher body mass and self-reported disability compared to those with a single sprain, factors that are likely interrelated. Due to the potential for long-term health concerns associated with ankle sprains, clinicians should incorporate patient education and interventions that promote physical activity, healthy dietary intake, and optimize function as part of comprehensive patient-centered care.

Keywords: patient-reported outcome measures, chronic ankle instability, body mass index

Lateral ankle sprains are the most common musculoskeletal injury, with health care costs being a significant burden for patients and the United States health care system. Individuals that sprain their ankle have difficulty restoring their preinjury levels of function with high occurrence of recurrent sprains and decreased levels of physical activity. As such, a history of ankle sprain is a significant risk factor in subsequent sprains. Similarly, 40% develop chronic ankle instability (CAI) within the first 12 months of an index ankle sprain, a condition characterized by a combination of mechanical impairments and neurophysiological deficits that result in persistent instability, pain, and disability. These deficits have been shown to persist and have lifelong influences on physical activity, body composition, and long-term health.

The environmental (social) and personal (psychological) factors that mediate rehabilitation compliance and outcomes are especially salient during rehabilitation and resumption of function. These factors are influenced by the ability to perform activities and continued social participation, which are limited or interrupted following an ankle sprain. In addition to the mediating effects, these factors are also influenced by diminished function and may contribute to a cycle of disablement following an ankle sprain. Utilizing self-reported function can provide insight into a patient’s specific deficits and guide rehabilitation for clinicians.

Without downplaying the role that these factors play in the recovery and experience of those who sprain their ankle, it remains a possibility that we are not capturing accurate snapshots of self-reported function of the ankle sprain population. As such, no clear link has yet been established between patient anthropometrics, self-reported function, and ankle sprain frequency, partially due to the need for larger sample sizes. While factors such as higher body mass and prior injury have been identified as risk factors to subsequent injury, the association of the number of ankle sprains on body morphology and self-reported function have yet to be determined. Therefore, the purpose of this exploratory investigation was to assess differences in anthropometric measurements and self-reported function between the number of ankle sprains utilizing a pooled data set.

Methods

Study Design

A cross-sectional study was performed. The independent variables were the number of self-reported ankle sprains sustained (1, 2, 3, 4, and ≥5 sprains). The dependent variables included were anthropometric data including height, body mass, and body mass index (BMI) as well as the Foot and Ankle Ability Measure-Activities of...
Daily Living (FAAM-ADL), FAAM-Sport, and Cumberland Ankle Instability Tool (CAIT).

Patients or Participants

Data were pooled from 14 different studies previously collected by the Chronic Ankle Instability Outcomes Network.19–32 The Chronic Ankle Instability Outcomes Network is an alliance of researchers with the goal of advancing the investigation of CAI knowledge through data collaborations. Each of the included data sets investigated participants with a history of lateral ankle sprain; however, they utilized a variety of inclusion criteria. Each individual study was previously approved by their respective institutional ethics review board prior to the initiation of the study. All data were de-identified prior to entering the pooled database with no identifiable information present. Participants without a history of ankle sprain were excluded. Many of the included studies’ inclusion criteria and operationalized definition of an ankle sprain slightly differed, with the majority20–22,25–26,31–33 adopting the International Ankle Consortium’s (IAC) recommendation33 of an ankle sprain that (1) occurred greater than 12 months prior to study enrollment; (2) demonstrated symptoms of inflammation such as pain or swelling; and (3) the sprain disrupted at least 1 day of physical activity; a few studies’ definition was “a history of a moderate to severe lateral ankle sprain including inflammatory symptoms (pain, swelling, and/or discoloration) with a disruption of desired physical activity” that occurred 12 months prior to study enrollment.19,30,32 One author group required participants to have an inversion mechanism with pain/swelling and activity modification for at least 24 hours.23,24,27,28 another study’s definition was “a history of mild to moderate ankle sprain at least 12 months before the study that required immobilization or nonweight bearing for at least 3 days,”29 while another was “an ankle sprain was defined as an incident in which the rearfoot was inverted or supinated and resulted in a combination of swelling, pain, and modification of activities of daily living for 1 day.”30 Having participants self-report ankle sprain is commonly used in research investigations, and patients have been found to be relatively accurate at self-reporting of the relative timing and injury (including ankle sprains).34

Procedures

Anthropometric data assessed included height, body mass, and calculated BMI. Height and body mass were measured directly in some of the studies,19,20,22,23,25,26,29,30,32 while some were self-reported21,23,24,27,28,31 by participants. Self-reported function was assessed using the FAAM-ADL, FAAM-Sport, and CAIT. The FAAM-ADL and FAAM-Sport are region-specific patient-reported outcomes and is commonly used during the entire lifespan for the FAAM-ADL and FAAM-Sport in those with a history of ankle sprain compared to those who reported multiple ankle sprains. Due to all studies not using one or both, the FAAM and the CAIT, sample sizes differed between these comparisons. Chi-square analyses were used to assess the association between the number of ankle sprains and the IAC recommended cutoff scores for the FAAM-ADL, FAAM-Sport, and the CAIT.

Secondary analyses were completed to assess the differences in the number of prior sprains (1, 2, 3, 4, or ≥5) on patientanthropometrics that were assessed using 1-way analyses of variance and post hoc Tukey Honest Significant Differences (P < .05). Cohen d effect sizes were calculated for all significant findings and were interpreted as 0.2 to 0.5 = small, 0.5 to 0.8 = moderate, and >0.8 = large, respectively.39 For the FAAM-ADL, FAAM-Sport, and the CAIT, nonparametric Kruskal–Wallis tests with pairwise comparisons were used to assess differences in the number of prior sprains (1, 2, 3, 4, or ≥5). For nonparametric statistical analyses, the effect size r was used and assessed as .1 to <.3 = small, .3 to <.5 = moderate, and >.5 = large, respectively.40

Results

A total of 412 individuals with a history of lateral ankle sprain were included in the analysis. Of the 412, 248 were females and 144 males, while 20 participants were missing gender information from the data set (Table 1). Four participants were missing mass, while one participant was missing height and mass. Of the 412 participants, 288 were evaluated with the FAAM-ADL and FAAM-Sport, while 246 were available for the CAIT.

Those who had multiple ankle sprains had higher mass (T405 = −3.079, P = .001, d = 0.33) and BMI (T405 = −2.98, P = .002, d = 0.32) compared to those with only one previous ankle sprain (Table 2). However, these effect sizes were considered small. There was no difference in height (T405 = −0.93, P = .18) between those with only one previous ankle sprain and those with multiple ankle sprains. In addition, those who had more than one sprain had lower FAAM-ADL (P < .001; Table 2), FAAM-Sport (P < .001), and CAIT (P < .001; Table 3) scores compared to those with only one prior sprain. While the FAAM-ADL effect size was considered small (r = .22), the FAAM-Sport (r = .33) and CAIT (r = .34) were considered moderate. For the FAAM-ADL, 96/288 (33.3%) fell below the 90% IAC recommended cutoff score, while 113/288 (64.6%) fell below the 80% FAAM-Sport cutoff, and 180/246 (73.2%) fell below the CAIT cutoff score.

From the secondary analysis, there were no significant differences in height (F4,402 = 1.15, P = .335) based on the number of ankle sprains. Significant differences in body mass (F4,402 = 3.26, P = .012) and BMI (F4,402 = 2.79, P = .030) were found based on
the number of ankle sprains reported. Specifically, participants who sprained their ankle once had lower mass than those who reported ≥5 sprains (P = .008), while participants who had 1 sprain had a lower BMI than those who reported 2 sprains (P = .031). Each of these effect sizes were considered small (d = 0.42 and 0.45). No other pairwise comparisons were significant.

For the secondary analyses regarding self-reported function, significant differences in the FAAM-ADL (P < .001), FAAM-Sport (P < .001), and CAIT (P < .001) were found between ankle sprain frequency. Higher FAAM-ADL scores were present in the 1-ankle sprain compared to the 2-ankle sprain group (P = .008, r = .25), 3-ankle sprain group (P < .001, r = .41), 4-ankle sprain group (P < .001, r = .46), and 5-ankle sprain group (P < .001, r = .26). These effect sizes were considered small to moderate. The 2-ankle sprain group also demonstrated higher FAAM-ADL scores compared to the 3-ankle sprain group (P = .026, r = .11). However, this effect size was considered small. There were higher FAAM-Sport scores in the 1-ankle sprain group compared to the 2-ankle sprain group (P = .005, r = .20), 3-ankle sprain group (P < .001, r = .36), 4-ankle sprain group (P < .001, r = .25), and 5-ankle sprain group (P < .001, r = .26). These effect sizes were considered small to moderate. The 2-ankle sprain group also demonstrated higher FAAM-Sport scores compared to the 3-ankle sprain group (P = .018, r = .14). Similarly, for the CAIT, higher scores were found in the 1-ankle sprain group compared to the 2-ankle sprain group (P = .003, r = .30), 3-ankle sprain group (P < .001, r = .41), 4-ankle sprain group (P < .001, r = .47), and 5-ankle sprain group (P < .001, r = .40). These effect sizes were considered small to moderate. The 2-ankle sprain group also demonstrated higher CAIT scores compared to the 3-ankle sprain group (P = .035, r = .08) and the 4-ankle sprain group (P = .040, r = .20). These effect sizes were considered small.

**Discussion**

Individuals with a history of multiple ankle sprains demonstrated higher BMI and self-reported disability compared to those who have a history of one sprain. The effect sizes indicated that differences in anthropometric data were small; however, differences in self-reported function were moderate to large. This may have significant implications for patients with ankle injuries and may change how clinicians need to conceptualize their treatment and rehabilitation of ankle injuries. Clinicians may need to consider a holistic approach to account for higher levels of body mass in those with a higher frequency of ankle sprain.

Consistent evidence demonstrates that both a history of ankle sprain as well as CAI are associated with greater mass or BMI. Additionally, based on our data, 61.2% were considered of normal

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Table 1  Mean and SD of the Demographic Outcomes Based on the Number of Ankle Sprains

<table>
<thead>
<tr>
<th>Number of sprains</th>
<th>1 (n = 122)</th>
<th>&gt;1 (n = 290)</th>
<th>2 (n = 83)</th>
<th>3 (n = 66)</th>
<th>4 (n = 45)</th>
<th>≥5 (n = 96)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, n</td>
<td>38</td>
<td>105</td>
<td>29</td>
<td>19</td>
<td>16</td>
<td>42</td>
</tr>
<tr>
<td>Female, n</td>
<td>82</td>
<td>166</td>
<td>51</td>
<td>43</td>
<td>22</td>
<td>50</td>
</tr>
<tr>
<td>Age, y</td>
<td>21.5 (4.1)</td>
<td>21.7 (4.0)</td>
<td>21.6 (3.9)</td>
<td>21.9 (4.4)</td>
<td>22.1 (3.9)</td>
<td>21.5 (3.8)</td>
</tr>
<tr>
<td>Height, cm</td>
<td>169.8 (8.9)</td>
<td>170.8 (9.9)</td>
<td>170.4 (10.4)</td>
<td>169.3 (858)</td>
<td>171.0 (8.9)</td>
<td>172.1 (10.6)</td>
</tr>
<tr>
<td>Mass, kg</td>
<td>68.6 (12.3)</td>
<td>73.3 (14.5)</td>
<td>73.6 (13.9)</td>
<td>70.9 (14.3)</td>
<td>72.4 (13.2)</td>
<td>75.0 (15.7)</td>
</tr>
<tr>
<td>Body mass index</td>
<td>23.7 (3.6)</td>
<td>25.0 (4.0)</td>
<td>25.4 (4.1)</td>
<td>24.6 (3.9)</td>
<td>24.7 (3.6)</td>
<td>25.2 (4.1)</td>
</tr>
</tbody>
</table>

Note: >1 = data pooled from columns 2 to ≥5.

Table 2  Medians, Interquartile Ranges, and 95% CIs of the FAAM-ADL and FAAM-Sport Based on the Number of Ankle Sprains

<table>
<thead>
<tr>
<th>Number of sprains</th>
<th>1 (n = 97)</th>
<th>&gt;1 (n = 191)</th>
<th>2 (n = 58)</th>
<th>3 (n = 38)</th>
<th>4 (n = 34)</th>
<th>≥5 (n = 61)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAAM-ADL</td>
<td>98.8 (6.5)</td>
<td>94.0 (13.7)</td>
<td>96.4 (10.8)</td>
<td>92.3 (12.8)</td>
<td>91.7 (11.9)</td>
<td>94.0 (8.4)</td>
</tr>
<tr>
<td>95% CI</td>
<td>94.4–98.1</td>
<td>89.4–93.5</td>
<td>87.4–96.5</td>
<td>85.3–94.6</td>
<td>81.7–94.9</td>
<td>90.7–95.5</td>
</tr>
<tr>
<td>FAAM-Sport</td>
<td>91.9 (15.0)</td>
<td>84.4 (23.4)</td>
<td>89.3 (30.4)</td>
<td>75.0 (18.3)</td>
<td>82.8 (27.0)</td>
<td>85.9 (18.0)</td>
</tr>
<tr>
<td>95% CI</td>
<td>88.2–95.5</td>
<td>78.7–85.5</td>
<td>75.1–91.1</td>
<td>70.4–85.1</td>
<td>69.9–88.2</td>
<td>80.1–89.0</td>
</tr>
</tbody>
</table>

Note: >1 = data pooled from columns 2 to ≥5.

Table 3  Medians, Interquartile Ranges, and 95% CIs of the CAIT Based on the Number of Ankle Sprains

<table>
<thead>
<tr>
<th>Number of sprains</th>
<th>1 (n = 54)</th>
<th>&gt;1 (n = 192)</th>
<th>2 (n = 54)</th>
<th>3 (n = 46)</th>
<th>4 (n = 23)</th>
<th>≥5 (n = 69)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAIT</td>
<td>26.0 (8.0)</td>
<td>20.0 (7.0)</td>
<td>22.0 (9.0)</td>
<td>17.5 (7.0)</td>
<td>18.0 (7.5)</td>
<td>20.0 (6.0)</td>
</tr>
<tr>
<td>95% CI</td>
<td>22.3–26.3</td>
<td>18.4–20.7</td>
<td>19.2–23.8</td>
<td>15.8–20.9</td>
<td>13.7–20.0</td>
<td>17.5–21.5</td>
</tr>
</tbody>
</table>

Note: >1 = data pooled from columns 2 to ≥5.
BMI, 26.5% overweight, and 10.4% obese. In a study assessing pediatric Emergency Room visits, overweight children were 2 to 3 times more likely to have an ankle sprain. Meanwhile, a recent study found that recovery from an ankle sprain may be inhibited in individuals categorized as obese. A causal relationship was demonstrated in that ankle injury reduced physical activity across the lifespan in a mouse model. Furthermore, this finding is supported by a study that demonstrated decreased levels of physical activity in college students post ankle sprain and those with CAI. Thus, with obesity potentially showing a relationship with ankle injury combined with the decreased physical activity observed in this with CAI this could create a difficult to manage, perpetuating cycle of disability and trauma. Sports medicine clinicians may therefore need to consult and refer patients to other health care providers such as registered dieticians or nutritionists to provide specific recommendations for patients to promote healthy lifestyles.

Patient-reported outcome measures have shed light on the levels of both perceived function and disablement that is experienced by people with ankle sprains and CAI. Our findings are consistent with the literature that describes decreased self-reported function and worse symptoms in those with more frequent ankle sprains. In addition, based on the IAC recommended cutoff scores for the population observed, participants more often fell under the CAIT and the FAAM-Sport cutoff scores for CAI compared to the FAAM-ADL. This is most likely since many of the studies used the CAIT as inclusion/exclusion criteria for study enrollment. Similarly, based on our working model of this multifaceted pathology, capturing more than just perceived function is necessary to ensure a comprehensive evaluation. While it is helpful to measure the recovery of function following injury, this limited scope cannot capture the other factors such as overall physical health, mental health, and kinesiophobia that are believed to play a role in patient well-being. We recommend incorporating PROs such as the FAAM or CAIT as a patient-centered approach to capture information about an individual’s ankle health status.

In sports medicine settings, clinicians and researchers should also consider implementing questionnaires that assess the global well-being of the individual to capture multiple aspects of functional status. For example, the Patient-Reported Outcomes Measurement Information System is a valid series of questions that have been shown to capture multiple components of the International Classification of Functioning, Disability, and Health model of disablement in adults and pediatric patients. The Patient-Reported Outcomes Measurement Information System is freely available and valid when administered digitally. Using PROs that capture all aspects of patient wellness may significantly improve short- and long-term outcomes in patients with ankle sprains or CAI.

From a research perspective, pooling data from multiple distinct and geographically separated collection sites may help to improve external validity of findings. For example, individual participant data meta-analyses are often seen as the gold standard for answering research questions. The individual participant data meta-analysis builds on the aggregated effect size approach of a standard meta-analysis and allows researchers to investigate subgroups across multiple samples of the same population. Local environmental factors, such as cultural norms and expectations of behavior, and the psychological factors that are shaped in that environment, frequently vary across geographic regions. Since perceptions of injury and recovery are a strong mediator for return to function that may be influenced by cultural factors, pooling of similar data across multiple geographic regions may help to improve the generalizability of study findings. Future study of the influence of cross-cultural perceptions of injury and response to treatment following lateral ankle sprain and CAI using PROs is certainly warranted.

We must acknowledge several limitations with this study. First and foremost, this was a retrospective analysis on multiple data sets; while we were able to garner a relatively large sample size, we were still limited based on the data provided. As there was no systematic literature search involved, we are not able to classify this investigation as an individual participant data meta-analysis. Related to this, due to the inconsistency of reporting within the database as well as many of the studies occurring prior to the IAC’s recommendations regarding CAI inclusion criteria, CAI status was not assessed. While this may cause some variations on the where individual participants fell on the CAI continuum, this allowed us to further expand on the spectrum of patient function in individuals with a history of ankle sprain. Similarly, the inconsistency of reporting of contextual factors related to the participants, index sprain, and subsequent behaviors (eg, types of physical activity engaged in, date of initial sprain, time since injury, if the patient sought/received treatment for their injury, etc) across studies likely contributed to heterogeneity in the participant population; however, this provides opportunities for future studies within this research group. Future collaborations from the Chronic Ankle Instability Network will involve the collection of common data elements, alignment of inclusion/exclusion criteria, and consistency in reporting.

Conclusions

We found significant differences in mass, BMI, and self-reported function in patients with varying ankle sprain history. Our findings related to differences in sprain frequency and self-reported function are consistent with the heterogenous clinical presentation of these injuries and the need to treat the whole patient. However, in order to successfully accomplish a holistic approach to this patient population, appropriate framing and training may be necessary to maximize outcomes. We recommend clinicians take body composition, diet, and physical activity levels into consideration for the prevention, evaluation, and rehabilitation of ankle sprains.

Acknowledgments

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