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# CLINICAL CHARACTERISTICS OF ACTIVE INDIVIDUALS WITH CHRONIC ANKLE INSTABILITY

by

MARY BETH WINNINGHAM

(Under the Direction of Jessica Mutchler)

## ABSTRACT

Ankle sprains, specifically to the lateral ligament complex, are one of the most common injuries seen during athletic participation and may lead to chronic ankle instability (CAI).<sup>1</sup> Residual symptoms of CAI can include feelings of giving way and instability as well as, persistent weakness, pain during activity, and self-reported disability, which may affect postural control and functional performance.<sup>2</sup> The purpose of this study was to determine if there was a relationship between perceived kinesiophobia and dorsiflexion range of motion (DROM), measures of dynamic postural control, and measures of functional performance, within active individuals with CAI. Thirty-seven physically active individuals with self-reported CAI, filled out the Foot and Ankle Ability Measure (FAAM), Cumberland Ankle Instability Tool (CAIT), Tampa Scale of Kinesiophobia 11 (TSK-11), and the NASA Physical Activity Scale (NASA-PAS). Of those, five qualified as having CAI based on the 5<sup>th</sup> International Ankle Consortium guidelines for CAI classification<sup>1</sup> and completed one test session lasting approximately 45 minutes that included basic demographic data, leg length measurements, DROM, three directions of the Star Excursion Balance Test (SEBT), triple crossover hop test, and figure 8 hop test. Means and standard deviations were calculated and reported for all measures. Due to small sample size, only observational analysis could be performed between perceived kinesiophobia and dorsiflexion range of motion (DROM), measures of dynamic postural control, and measures of functional performance. Although only five participants classified as CAI, 36 of 37 participants reported some degree of kinesiophobia. Therefore we chose to examine the inclusionary questionnaires, and how they relate to our measure of kinesiophobia (TSK-11) and the number of reported ankle sprains. Pearson product-moment correlations were used to determine these relationships. Based on observational analysis there may be trends between kinesiophobia and DROM, and figure-8 hop test time. A strong positive relationship between the FAAM activities of daily living (FAAM-ADL) and FAAM-Sport subscales ( $r = 0.815$ ,  $p < 0.001$ ), a moderate negative relationship between the FAAM-ADL subscale and TSK-11 scores

( $r = -0.509$ ,  $p=0.001$ ), and a moderate negative relationship between the FAAM-Sport subscale and TSK-11 scores ( $r= -0.599$ ,  $p < 0.001$ ) were shown. There was also a moderate negative relationship between number of sprains and both the FAAM-ADL ( $r= -0.436$ ,  $p= 0.007$ ) and FAAM-Sport ( $r= -0.464$ ,  $p=0.004$ ) subscales. The current study showed potential trends between kinesiophobia and DROM, as well as functional performance specific to agility. Measures of functional performance and DROM in the current study when wearing ankle braces did not appear similar to previously published data. The TSK-11 was only moderately correlated to the FAAM. Therefore, perceived kinesiophobia may be independent of self-reported disability, and should be accounted for within the CAI population. Future research should further investigate the relationship between kinesiophobia and measures of dynamic postural control and functional performance.

**INDEX WORDS:** Chronic ankle instability, Ankle, Ankle sprain, Kinesiophobia

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## CHAPTER I

### INTRODUCTION

The ankle is one of the most commonly injured joints in the body during athletic participation. Therefore, ankle sprains are one of the most common injuries treated by orthopedic surgeons and athletic trainers.<sup>2</sup> Ankle sprains can affect the ligamentous structures on the lateral or medial side of the joint, with lateral ankle sprains accounting for 80% of injuries to the ankle.<sup>3</sup> Gribble et al defines a lateral ankle sprain as an “acute traumatic injury to the lateral ligament complex of the ankle joint as a result of excessive inversion of the rear foot or a combined plantarflexion and adduction of the foot.”<sup>1</sup> Recurrent ankle sprains are extremely common, with the most common predisposition to suffering a sprain being a history of previous ankle sprain. Approximately 32% to 74% of individuals with a history of at least one ankle sprain suffer from chronic symptoms, perceived instability, or have a recurrence of ankle sprain.<sup>1,4,5</sup> Repetitive lateral ankle sprains may increase the likelihood of chronic ankle instability (CAI).<sup>6,7</sup>

CAI is defined as an encompassing term used to classify a patient with both mechanical and functional instability of the ankle joint.<sup>8</sup> To be classified as having CAI, residual symptoms should be present for a minimum of 1 year post-initial sprain.<sup>8</sup> Residual symptoms can include feelings of giving way and instability as well as repeated ankle sprains, persistent weakness, pain during activity, and self-reported disability. The 5<sup>th</sup> International Ankle Consortium states that the feeling of ‘giving way’, a reported ‘feeling of disability or instability’, and ‘recurrent sprains’ are the strongest characteristics in defining CAI.<sup>1,8,9,10</sup> The endorsed definition of ‘feelings of instability’ is, “the situation whereby during activities of daily living (ADL) and sporting activities the subject feels that the ankle joint is unstable and is usually associated with the fear of sustaining an acute ligament sprain.”<sup>2,8</sup> Kinesiophobia is defined as the fear of movement or

fear of re-injury from movement.<sup>11</sup> Kinesiophobia may lead to alterations in movement patterns, or avoidance of movements. Lentz et al., determined that kinesiophobia, range of motion, and chronicity of symptoms could be used to predict self-reported disability in acute ankle sprain patients.<sup>12</sup> However, the relationship between kinesiophobia and perceived disability in CAI patients has yet to be established.

When assessing CAI, valid self-reported questionnaires should be used to address patient reported outcomes.<sup>1</sup> Multiple patient reported outcomes (PRO) have been developed to show self-reported disability. The Foot and Ankle Ability Measure (FAAM) is used to assess physical performance of patients with foot and ankle injuries. This patient reported outcome is region specific, but can be used to assess a broad range of musculoskeletal injuries. The Cumberland Ankle Instability Tool (CAIT) is a more specific scale used to determine the presence of CAI.<sup>13,14</sup> When used together, the FAAM and the CAIT have been shown to best detect CAI.<sup>13,14</sup> These measures provide clinicians and researchers with descriptive criteria to assess perceived ankle pain and disability, and may therefore be linked to kinesiophobia. Research has yet to define the relationship between self-report questionnaires for CAI and measures of kinesiophobia.

In addition to perceived ankle pain and disability, deficits in range of motion, postural control, and functional performance have been found in athletes with CAI. The anterior, posterolateral, and posteromedial directions of the Star Excursion Balance Test (SEBT) are used in CAI studies as a measure of dynamic postural control.<sup>15</sup> Functional performance tests typically used in CAI studies include single-leg hop tests for both time and distance.<sup>10,17</sup> Both lateral and forward hop tests can be used to assess functional performance.<sup>18</sup> Figure-8 and modified triple-crossover hop tests are specific functional performance measures used to assess power and

agility in athletes with CAI.<sup>10</sup> The figure-8 hop test for time has been used to evaluate speed and agility while placing extra lateral stress on the ankle joint.<sup>10,17</sup> The modified triple-crossover hop test for distance has been used to assess power while placing extra lateral stress on the ankle joint.<sup>10</sup>

The increased lateral stress that is required to perform these functional movement patterns may influence the presence of kinesiophobia,<sup>19</sup> and consequently affect performance due to avoidance or modification of movements that are painful. This avoidance of movement has been demonstrated in the literature.<sup>19</sup> Larmer et al., found that patients reported apprehension and avoidance of certain movements because of fear of reinjury.<sup>19</sup> The Tampa Scale for Kinesiophobia-11 is one of the most commonly used measures for assessing pain-related fear.<sup>20</sup> TSK-11 scores have a significant inverse association to pain-related acceptance, the willingness to experience pain without changing anything.<sup>21</sup> Without knowing the extent of pain-related acceptance in patients with CAI, the extent of avoidance of movement is unknown. Furthermore, the presence of kinesiophobia and its influence on postural control and functional performance in active individuals with CAI have not yet been established in the literature.

Although the influence of kinesiophobia has not been well established, feelings of instability have been widely accepted as a symptom of CAI. Due to feelings of instability it is often common practice to use prophylactic bracing in an athletic population to limit ankle range of motion<sup>22</sup>, and therefore help the individual feel more stable.<sup>23,24,25</sup> Research has shown ankle braces may reduce the risk of sustaining an ankle injury by half,<sup>26</sup> and may have the ability to prevent both initial and recurrent ankle sprains.<sup>27,28</sup> Thus, ankle bracing for patients with CAI during physical activity may be warranted. The National Athletic Trainer's Association Position Statement on the Conservative Management and Prevention of Ankle Sprains in Athletes

suggests that athletes with a previous history of ankle sprain wear a prophylactic for all practices and games.<sup>14</sup> Though this is the recommendation, the effects of ankle bracing on DROM, postural control and functional performance testing has yet to be examined in the literature.

We theorized that since patients with CAI report ‘feelings of instability’, they may experience kinesiophobia. This kinesiophobia could cause alterations in movement patterns resulting in decreased DROM, postural control, and functional performance. CAI research has yet to explore the relationship between clinical characteristics of active individuals with CAI and kinesiophobia. Therefore, the aim of this study was to identify relationships between kinesiophobia and measures of DROM, dynamic postural control, and functional performance in active individuals with CAI. The use of prophylactic ankle bracing while assessing these clinical characteristics was also lacking from current literature. Thus, the measures of DROM, dynamic postural control, and functional performance were compared to previously published data on individuals with CAI.

## CHAPTER II

### METHODOLOGY

#### Participants

A total of 37 male and female active individuals with a history of ankle sprains and self-reported CAI, volunteered to participate in the study. Five of the 37 participants were classified as CAI participants. All participants were from a large public university community and between the ages of 18-26 years old. Participants were eligible for the study if they reported a four or greater on the NASA Physical Activity Scale (NASA-PAS) and had a history of at least one ankle sprain, history of the ankle giving way, recurrent sprains, and/or feeling of instability.<sup>1</sup> In accordance with the 5<sup>th</sup> International Ankle Consortium, participants were identified as having CAI and qualified to complete the clinical measures if they scored less than 90% on the FAAM activities of daily living (ADL) subscale, less than 80% on the FAAM Sport subscale, and less than 24 on the CAIT.<sup>1</sup> If participants had the respective scores on both ankles, the ankle with the highest overall score was tested. Participants were excluded if they had a history of any lower extremity orthopedic surgery, history of lower extremity fracture, or lower extremity injury in the last three months that resulted in at least one day of interrupted physical activity.<sup>1</sup> This study was approved by the Institutional Review Board.

#### Procedures

Once the participants signed the informed consent form, they were enrolled in the study. All enrolled participants completed the NASA-PAS, FAAM-ADL, FAAM-Sport, CAIT, TSK-11, and descriptive measures including age, height, weight, and number of previous ankle sprains were recorded. Only participants who qualified as having CAI continued with the data



collection session and were fitted for an Ankle Stabilizing Orthosis (ASO) ankle brace (Ankle Stabilizing Orthosis, Medical Specialties Inc.) by the primary investigator. Once the ankle brace was fitted, a five minute elliptical warm-up and self-selected stretching took place. Testing began with dorsiflexion range of motion (DROM), followed by the assessment of dynamic postural control via the SEBT, and then the assessment of functional performance via the triple crossover hop for distance and figure-8 hop test for time. This testing sequence was chosen to protect participants from the influence of fatigue on the measurement of postural control. All measures were scored by the primary investigator.

#### Foot and Ankle Ability Measure (FAAM)

The FAAM is a 31 question PRO that includes an activities of daily living and sport specific section.<sup>8</sup> According to the 5<sup>th</sup> International Ankle Consortium, the FAAM is a general patient reported outcome that should be used in CAI research.<sup>2</sup> The FAAM-ADL subscale is specific to the activities that patients participate in during everyday life. The FAAM-Sport subscale is more specific to the sport specific skills required during athletic participation. The cutoff score for the FAAM-ADL is less than 90%, the FAAM-sport is less than 80%.<sup>2</sup> These scores indicate disability or ankle instability. The FAAM may be used to detect self-reported functional deficits related to CAI.<sup>29</sup> Reliability for the FAAM-ADL subscale has an Intra-Class Correlation (ICC) = .89 and the Sport subscale has an ICC = .87.<sup>8,30</sup> Construct validity for the FAAM has a relationship with the SF-36 for both the ADL and sport subscale ( $r=.84$ ,  $r=.78$  respectively.)<sup>8,30</sup> When examining score stability, the ICC for the ADL subscale was 0.89<sub>(2,1)</sub> with a SEM of 2.1 and the MDC  $\pm$  5.7 and the ICC for the sport subscale was 0.87<sub>(2,1)</sub> with a SEM of 4.5 and the MDC  $\pm$  12.3.<sup>31</sup>

### Cumberland Ankle Instability Tool (CAIT)

The CAIT is a nine question patient reported outcome that provides specific ankle injury questions.<sup>8</sup> The cutoff score for the CAIT is less than 24.<sup>2</sup> The CAIT is used to specifically determine the presence of CAI according to the 5<sup>th</sup> International Ankle Consortium. The CAIT has been shown to correlate with the Lower Extremity Functional Scale and the Visual Analog Scale. The CAIT demonstrated a strong correlation with the VAS with  $\rho = .76$  and a moderate correlation to the LEFS  $\rho = .50$ .<sup>13</sup> The CAIT has a test-retest reliability  $ICC_{(2,1)} = .96$ , a subject reliability index = .83, and an item reliability index = .99.<sup>13</sup> For the CAIT, sensitivity is 82.9% and specificity is 74.7%, with a positive likelihood ratio of 3.27 and a negative likelihood ratio of 0.23.<sup>13</sup>

### Tampa Scale of Kinesiophobia – 11 (TSK-11)

The TSK-11 was used to detect the fear of movement or re-injury, also known as kinesiophobia.<sup>25</sup> The TSK-11 has been used to detect kinesiophobia in chronic pain patients<sup>25</sup>, similar to a CAI population. The 11-item questionnaire has been shown to be reliable, valid, and sensitive to change, with a test-retest reliability ICC of 0.81<sub>(2,1)</sub>, standard error of the mean of 2.41, and minimal detectable change of 5.6.<sup>20,21,25</sup> The TSK-11 has shown to have a sensitivity of 66% and specificity of 67% for determining the presence of kinesiophobia.<sup>20</sup>

### Dorsiflexion Range of Motion (DROM)

DROM was assessed using a weight-bearing lunge test. This test is frequently used within CAI literature.<sup>33,34</sup> DROM using a standing lunge was performed first without a brace and then with the brace. The participants faced a wall with the involved foot in front and toes lined up with the 10-cm mark on a cloth measuring tape. The second toe, center of the heel and knee

were kept in a plane perpendicular to the wall as seen in Figure 1.<sup>33</sup> The participants performed a lunge until the anterior knee made contact with the wall.<sup>34</sup> Participants were then moved backward in 1-cm increments until heel or knee contact were no longer maintained.<sup>34</sup> Each participant performed three trials with and without a brace. The average of the three trials was measured in centimeters. Inter-clinician and intra-clinician reliability have been found to be high (inter-clinician reliability ICC = 0.93 with SEM of 0.01; intra-clinician reliability ICC = 0.90 with SEM of 0.01.)<sup>35</sup>



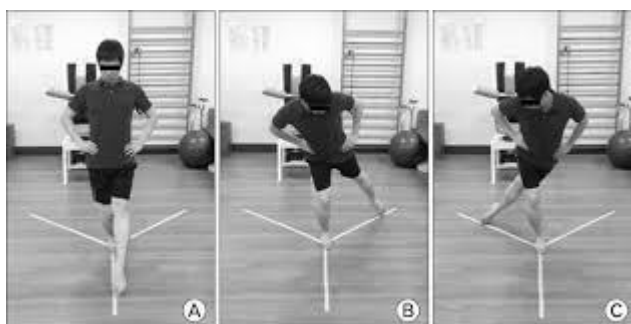
**Figure 1. Weight-Bearing Lunge Test**

#### Postural Control-Star Excursion Balance Test (SEBT)

Participants then performed three directions of the SEBT as a measure of postural control while in a brace. Participants stood on the involved leg while reaching and touching the opposite foot's big toe as far as possible along a measuring tape placed on the floor. The stance foot was centered in the middle of the testing grid.<sup>29</sup> Participants were then instructed to perform the anterior, posteromedial, and posterolateral directions<sup>36</sup> of the SEBT by reaching directly in front of their stance limb, diagonally posterior and medial to their stance limb, or diagonally behind their stance limb, as seen in Figure 2. The order of the directions were counterbalanced to

account for an order effect.<sup>37</sup> Participants were given five practice trials and three test trials in each direction. Following the practice trials, participants were allowed one minute of rest before performing the test trials. Additionally, participants were given one minute of rest between each direction. Participants were required to keep their hands on their hips for the duration of each reach,<sup>29</sup> and maintain balance throughout the reach. The greatest distance for each direction was normalized to leg length and used for data analysis.<sup>37,38</sup>

The SEBT is considered a highly representative dynamic postural control test that is both valid and reliable.<sup>37</sup> Inter-rater and intra-rater reliability of the SEBT has been examined in the literature with ICC values ranging from 0.83 to 0.93<sub>(3,1)</sub> and 0.88-0.96<sub>(3-1)</sub>, respectively. Test-retest reliability for ICCs ranged from 0.84-0.92<sub>(3-1)</sub>.<sup>39</sup>



**Figure 2. Star Excursion Balance Test (A) anterior reach direction, (B) posterolateral reach direction, (C) posteromedial reach direction.**

#### Functional Performance-Modified Triple-Crossover Hop Test

The modified triple-crossover hop test is a test to determine power as a measure of functional performance. This test has been used previously in CAI research.<sup>10,40,41</sup> Participants, while in the brace, were given instruction to hop on the involved limb across a line three

consecutive times, attempting to get the greatest overall distance.<sup>40,41</sup> All participants began on the involved leg and jumped laterally to the opposite side of the line as seen in Figure 3.<sup>40</sup> Participants performed three test trials, separated by one minute of rest. Participants were instructed they had to stick the landing without bending over or double hopping and maintain balance for two seconds. Participants were experiencing difficulty with this task during pilot testing, therefore a maximum of six test trials were possible and were discovered to be necessary. Distance was measured in centimeters from the starting point to the great toe.<sup>40,41</sup> The triple crossover hop test has been shown to be a reliable test with an ICC<sub>2,k</sub> of 0.96 and SEM of 15.95cm.<sup>36</sup> The modification, first describes by Hall et al., is used to place maximum stress on the ankle joint for patients with CAI and has a reliability ICC of 0.95.<sup>10</sup> The best performance, indicated by the longest distance, was recorded and used for data analysis.

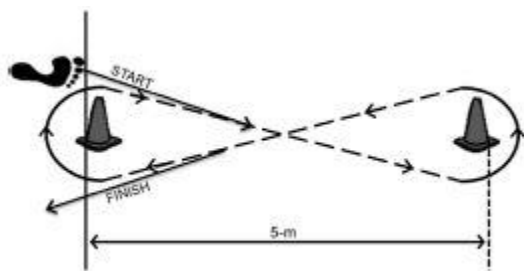


**Figure 3. Modified Triple-Crossover Hop**

#### Functional Performance-Figure-8 Hop Test

The figure-8 hop test was performed last in the brace. The figure-8 hop test is used to determine agility as a measure of functional performance. This test has been used previously in CAI research.<sup>10,16,40,42</sup> This is a timed test with one cone placed at the start and one at the end of a five meter course, as seen in Figure 4.<sup>40,43</sup> Participants were instructed to hop on the involved limb as quickly as possible twice through the course.<sup>40</sup> Timing gaits were used to determine the total time in seconds, and the shortest time of three trails was used for data analysis. One minute of rest was given between each trial.<sup>16</sup> In order to increase the amount of lateral stress required to

perform the test a participant starting on his/her left leg would begin on the right side of the first cone, so the first hop is lateral.<sup>10</sup> Hall et al., reported the reliability ICC to be 0.98.<sup>10</sup>



**Figure 4. Figure-8 Hop Course**

### Data Analysis

A cross sectional study design was used. The initial dependent variables included the score of the TSK-11, DROM in centimeters, SEBT reach distance normalized to leg length, modified triple-crossover hop test distance normalized to leg length and the figure-8 hop test time in seconds. Only five of the 37 participants were classified as having CAI, however 36 reported at least some level of kinesiophobia. This occurrence provided an opportunity to examine the questionnaires involved in the inclusion criteria (FAAM-ADL, FAAM-Sport and CAIT scores), and how they relate to kinesiophobia, via the scores on the TSK-11, and number of sprains. These measures were included in the data analysis due to at least minimal kinesiophobia reported by 36 of the 37 participants, even though only five qualified as having CAI.

The initial dependent variables were still recorded for the five participants that qualified to complete the entire data collection. For DROM, the average distance in centimeters for both the non-braced and braced conditions were used for analysis. SEBT average reach distance per direction divided by leg length and multiplied by 100 was used for analysis and reported as

%LL. The longest modified triple-crossover hop test trial was used for analysis and reported as %LL, and the fastest hop time for the figure-8 hop test was used for analysis and reported in seconds.

### Statistical Analysis

All statistical analysis was performed using SPSS version 21.0 (SPSS, Inc., Chicago, IL), with significance set *a priori* < 0.05. A Pearson's product-moment correlation was used to determine the relationships between the FAAM-ADL, FAAM-Sport, CAIT, number of sprains and TSK-11 scores. The correlation coefficients were interpreted as a low relationship if between 0 – 0.39, moderate relationship if between 0.4-0.69, and strong relationship if between 0.7-1.<sup>34</sup> Means and standard deviations for all measures were determined. The means and standard deviations of the DROM, SEBT, and triple crossover hop and figure-8 hop test were qualitatively compared to previously published means and standard deviations. Finally, an observational analysis was performed using graphs to determine trends between TSK-11 scores and DROM, dynamic postural control, and functional performance.

## CHAPTER III

### RESULTS

The final sample consisted of 37 male and female active individuals from one public university community. Of the 37 total participants, five were classified as having true CAI. If the CAIT had been the only PRO scale used, 26 of 37 participants would have classified as CAI. If the FAAM-Sport and CAIT had been used in combination, 14 of 37 participants would have classified as CAI participants. Of the 37 participants used in data analysis, 36 reported at least some level of kinesiophobia. Descriptive statistics are presented in Table 1. Means and standard deviations for all clinical measures can be found in Table 2.

Based on the results of the Pearson's  $r$  product-moment correlation there was a strong positive relationship between the FAAM-ADL and FAAM-Sport subscales ( $r = 0.815$ ,  $p < 0.001$ ), a moderate negative relationship between the FAAM-ADL subscale and TSK-11 scores ( $r = -0.509$ ,  $p=0.001$ ), and a moderate negative relationship between the FAAM-Sport subscale and TSK-11 scores ( $r= -0.599$ ,  $p < 0.001$ ). There was also a moderate negative relationship between number of sprains and both the FAAM-ADL ( $r= -0.436$ ,  $p= 0.007$ ) and FAAM-Sport ( $r= -0.464$ ,  $p=0.004$ ) subscales. There was a weak positive relationship between TSK-11 scores and the number of reported ankle sprains ( $r= 0.380$ ,  $p=0.20$ ). All correlation coefficients are presented in Table 3.

Based on preliminary observational analysis between TSK-11 scores and DROM, SEBT reach distances, triple crossover hop, and figure-8 hop test, there may be a trend between TSK-11 scores and DROM with and without a brace (Figure 5), as well as time on the figure-8 hop test (Figure 6). It appears that as TSK-11 scores increase, DROM may decrease. For the figure-8 hop time it appears that patients with lower TSK-11 scores completed the course in shorter time



than patients with higher TSK-11 scores. There does not appear to be trends between TSK-11 scores and SEBT reach distances (Figure 7) or triple crossover hop distance (Figure 8).

**Table 1. Descriptive statistics for all participants**

| Variable          | Mean $\pm$ SD (Min – Max)          |                                   |
|-------------------|------------------------------------|-----------------------------------|
|                   | Non-CAI (n=32)                     | CAI (n=5)                         |
| Age, y            | 21 $\pm$ 1.78 (18-26)              | 23 $\pm$ 2.83 (20-26)             |
| Ht, cm            | 172.56 $\pm$ 12.93 (142.24-200.66) | 165.77 $\pm$ 9.35 (155.75-180.34) |
| Wt, kg            | 76.06 $\pm$ 24.17 (45.36-136.08)   | 67.42 $\pm$ 18.95 (47.67-92.99)   |
| Leg Length, cm    | N/A                                | 91.85 $\pm$ 4.30 (87.00-98.83)    |
| NASA              | 8.03 $\pm$ 1.8 (4.0-10.0)          | 7.8 $\pm$ 1.79 (5.0-10.0)         |
| Number of Sprains | 3.16 $\pm$ 1.69 (1.0-7.0)          | 8 $\pm$ 7.31 (1.0-20.0)           |
| FAAM-ADL          | 97.13 $\pm$ 3.62 (85-100)          | 73.4 $\pm$ 15.42 (50.0-90.0)      |
| FAAM-Sport        | 92.16 $\pm$ 6.70 (78-100)          | 64.0 $\pm$ 4.18 (60.0-70.0)       |
| CAIT              | 24.00 $\pm$ 12.54 (5-85)           | 14.0 $\pm$ 3.32 (10.0-19.0)       |

**Table 2. Means and SD for all clinical measures**

| <b>Measure</b>            |                | <b>Mean <math>\pm</math> SD (Min – Max)</b> |
|---------------------------|----------------|---|
| TSK-11                    | Non-CAI        | 6.63 $\pm$ 4.70 (0-21)                      |
|                           | CAI            | 13.80 $\pm$ 5.81 (7.0-19.0)                 |
| DROM, cm                  | With Brace     | 6.73 $\pm$ 2.52 (4.0-9.0)                   |
|                           | Without Brace  | 7.80 $\pm$ 1.64 (6.0-9.0)                   |
| SEBT, %LL                 | Anterior       | 72.15 $\pm$ 1.84 (70.0-74.13)               |
|                           | Posteromedial  | 75.80 $\pm$ 3.35 (72.3-80.8)                |
|                           | Posterolateral | 86.92 $\pm$ 3.72 (82.6-91.0)                |
| Triple Crossover Hop, %LL |                | 374.34 $\pm$ 34.17 (335.28-411.48)          |
| Figure-8 Hop, s           |                | 12.18 $\pm$ 1.48 (10.26-13.79)              |

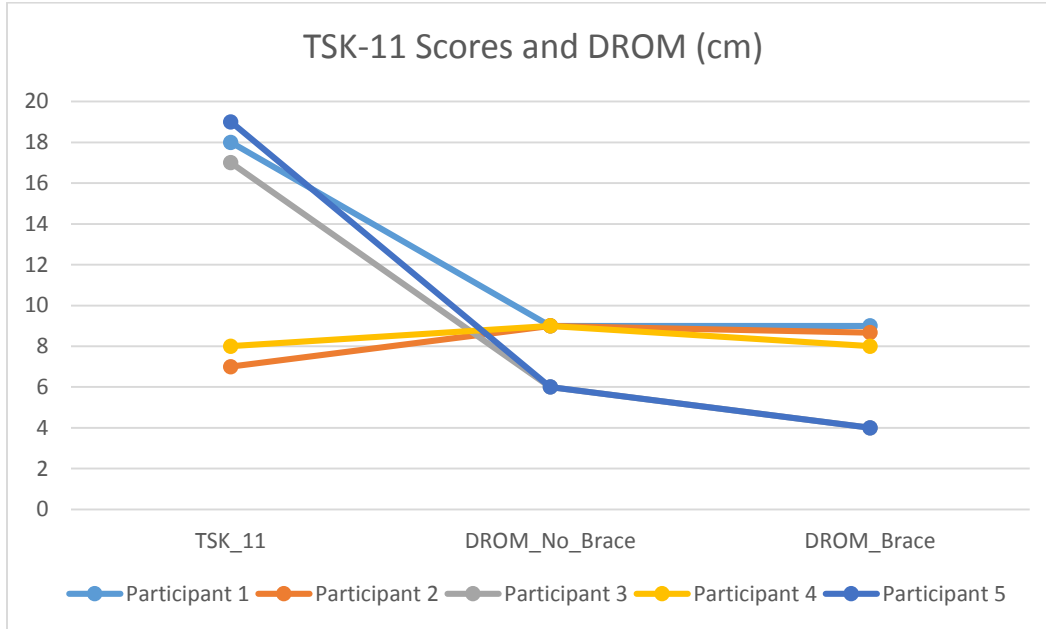
**Table 3. Results of Pearson's product-moment correlation**

|                | TSK-11 | FAAM-ADL           | FAAM-Sport         | CAIT  | No. of Sprains     |
|----------------|--------|--------------------|--------------------|-------|--------------------|
| TSK-11         | 1.00   | -.509 <sup>a</sup> | -.599 <sup>b</sup> | -.242 | .380 <sup>c</sup>  |
| FAAM-ADL       |        | 1.00               | .815 <sup>b</sup>  | .120  | -.436 <sup>a</sup> |
| FAAM-Sport     |        |                    | 1.00               | .235  | -.464 <sup>a</sup> |
| CAIT           |        |                    |                    | 1.00  | -.319              |
| No. of Sprains |        |                    |                    |       | 1.00               |

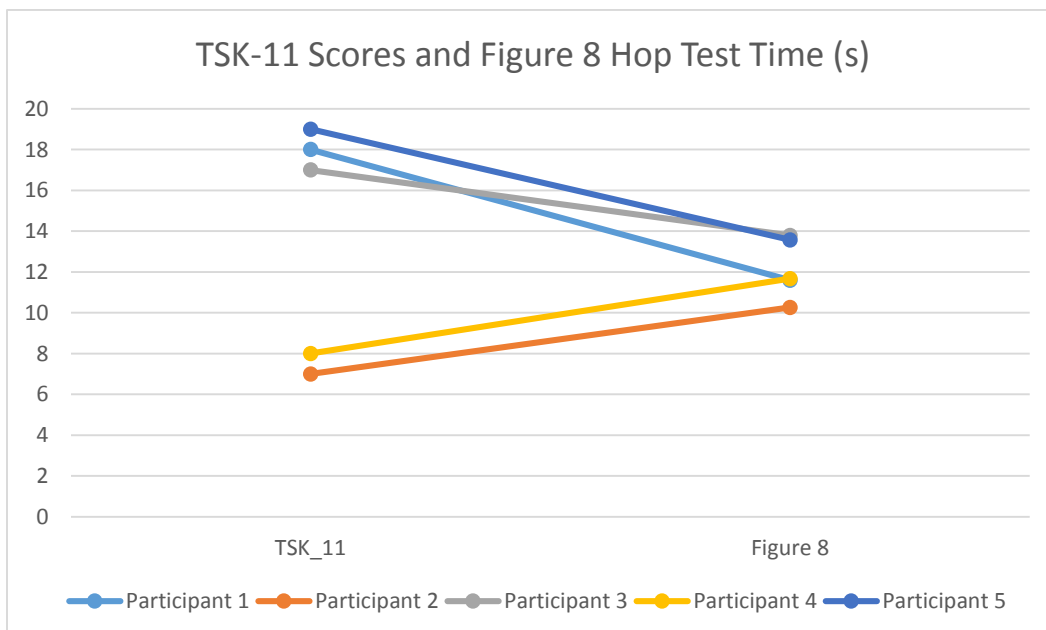
<sup>a</sup> indicates significance at  $p < 0.01$

<sup>b</sup> indicates significance at  $p < 0.001$

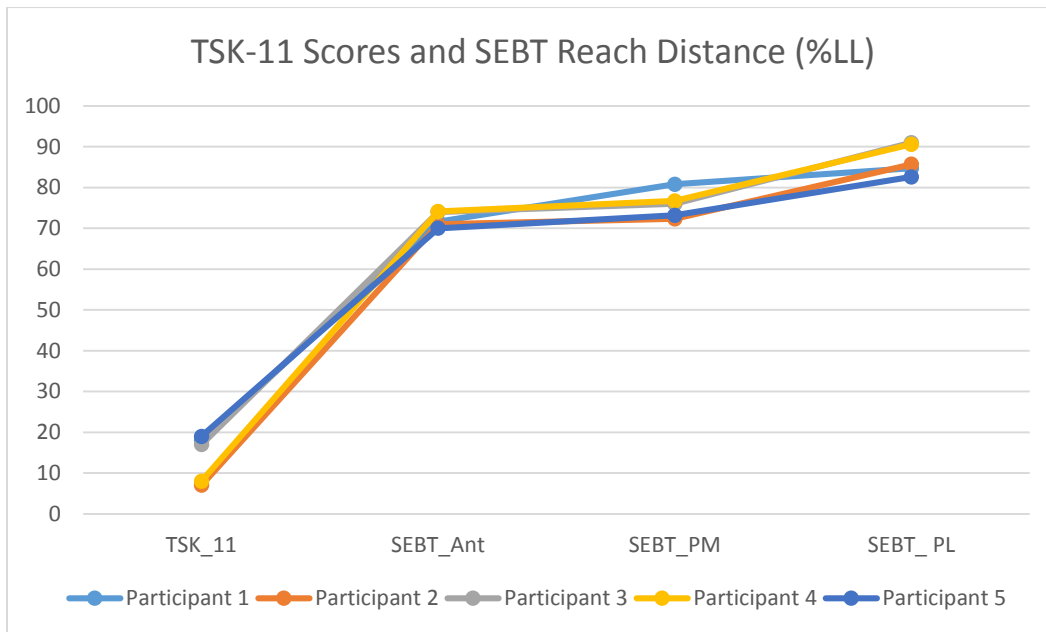
<sup>c</sup> indicates significance at  $p < 0.05$



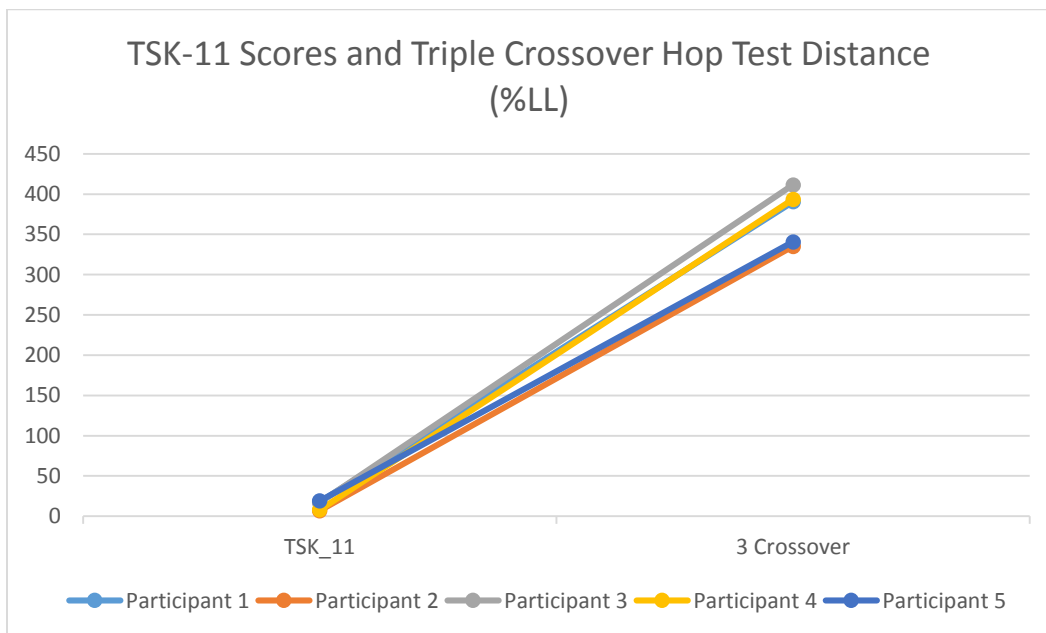
**Figure 5. TSK-11 scores and DROM measures**



**Figure 6. TSK-11 scores and figure-8 hop test time**



**Figure 7. TSK-11 scores and SEBT reach distance**



**Figure 8. TSK-11 scores and triple crossover hop distance**

## CHAPTER IV

### DISCUSSION

The aim of this study was to identify if there were relationships between multiple measures of clinical characteristics related to active individuals with CAI. We hypothesized that there would be a significant relationship between kinesiophobia, DROM, dynamic postural control and functional performance within athletic individuals with CAI. These relationships were not statistically analyzed due to the lack of participants that qualified to complete all of the clinical measures. However a preliminary observational analysis was conducted to determine if trends existed. Measures of DROM, dynamic postural control, and functional performance from the current study were also compared to previously published data on CAI participants that were not wearing ankle braces to perform the tasks. We addressed this aim by using the data from the five participants that qualified as having CAI.

An observational analysis was performed to address the original aim of the study. This was performed by assessing trends between TSK-11 scores and DROM, three SEBT reach distances, triple crossover hop test distance, and figure-8 hop test time. There appeared to be a potential trend between TSK-11 scores and DROM with and without a brace. The participants who reported higher amounts of kinesiophobia also appeared to have the least amount of DROM with and without a brace. In support, it has been addressed in the literature that patients with CAI do demonstrate decreased DROM.<sup>17,44</sup> However, the role that kinesiophobia plays in the lack of DROM has not been examined. For the figure-8 hop time it appeared that patients with lower TSK-11 scores completed the course in shorter time than patients with higher TSK-11 scores. One explanation could be the addition of the ankle brace. Since patients with CAI already demonstrate decreased DROM<sup>17,44</sup>, the addition of a brace may further limit DROM. Another

explanation could be the kinesiophobia aspect and potential associated movement strategy alterations while performing a functional performance test, specifically an agility test. The nature of this test does place additional lateral stress on the ankle<sup>10</sup> which could influence the movement patterns of an individual reporting instability. There does not appear to be trends between TSK-11 scores and SEBT reach distances or with triple crossover hop distance. The amount of reported kinesiophobia may be independent from the performance on tests measuring postural control and functional performance tests relying on power. However, these relationships or lack of relationships could not be confirmed through statistical analysis due to sample size. Therefore, these should be further examined in the literature.

All studies used to compare DROM, SEBT, triple crossover hop test, and figure-8 hop test values to that of previously published literature investigated similar CAI populations. When examining DROM, our results showed potential differences from previously reported literature. We found a mean of  $6.73 \pm 2.52$  cm within the CAI group and  $7.80 \pm 1.64$  cm in the non-CAI group. Konor et al., demonstrated a mean of  $9.5 \pm 3.1$  cm<sup>45</sup> and Hoch et al., showed a mean of  $9.03 \pm 2.33$  cm.<sup>40</sup> When examining SEBT reach distances, our means and standard deviations were potentially comparable to previously published literature. With anterior reach distance, we found a mean of  $72.15 \pm 1.84$  %LL. This was similar to results found by Gribble et al. ( $71.2 \pm 7.4$  %LL)<sup>38</sup> and Coughlan et al. ( $69.92 \pm 7.29$  %LL).<sup>46</sup> The average posteromedial and posterolateral reach distance for the current study ( $75.80 \pm 3.35$  %LL and  $86.92 \pm 3.72$  %LL, respectively) were both similar to that reported for females within a study by Gribble et al. ( $89.1 \pm 11.5$  %LL and  $85.5 \pm 13.5$  %LL, respectively).<sup>38</sup> The mean modified triple-crossover hop distance in the current study was  $374.34 \pm 34.17$  %LL. Our values for hop distance were less than that found by other authors. Munn et al., found a distance in centimeters of  $493 \pm 110$ <sup>41</sup> and

Hall et al., demonstrated a hop distance of  $455.5 \pm 96.4$ .<sup>10</sup> This would suggest the participants in the current study did not jump as far as those in previous studies. For figure-8 hop time, our results showed a mean of  $12.18 \pm 1.48$  seconds, which does not appear to be similar to the results found in previous literature. Sharma et al., demonstrated a time in seconds of  $7.87 \pm 0.13$  for a functional ankle instability group.<sup>47</sup> Caffrey et al., showed a time in seconds of  $11.3 \pm 0.6$ ,<sup>37</sup> and Docherty showed a time of  $7.18 \pm 1.26$  seconds.<sup>16</sup> When comparing the means, the mean speed of the current study was higher than that of previous studies, indicating a longer time needed to complete the course. This could be due to the addition of the ankle brace which has been shown in the literature to decrease DROM.<sup>48</sup> Future research should be done to determine the effect of ankle bracing during dynamic postural control and functional performance in CAI populations.

For the current study, descriptive statistics as well as means and standard deviations for all clinical measures were reported. The descriptive statistics were grouped by CAI or non-CAI classification. When comparing groups, the CAI group demonstrated scores on the FAAM-ADL, FAAM-Sport, and CAIT that indicated more disability, which led to their placement in the CAI group. Most other measures were similar, including their reports of giving way, recurrent ankle sprains, the presence of instability, and even kinesiophobia. According to the National Athletic Trainer's Association Position Statement on the Conservative Management and Prevention of Ankle Sprains in Athletes these symptoms, regardless of CAI severity, would warrant rehabilitation and prophylactic intervention. This may lend support for clinicians to also assess kinesiophobia to determine if rehabilitation is necessary since kinesiophobia may be present regardless of severity of perceived disability.

A new aim of the study was developed during data analysis, due to 36 of the 37 participants reporting at least some degree of kinesiophobia, but only five of them qualifying as



having CAI. The relationships between the inclusion criteria questionnaires, number of previous sprains and TSK-11 scores were examined and only moderate relationships were found between the FAAM-ADL and TSK-11 ( $r = -0.509$ ) and between FAAM-Sport and TSK-11 ( $r = -0.599$ ). These results suggest that as FAAM scores increase, TSK-11 scores may decrease, which would suggest that as perceived disability decreases, the individual may report less kinesiophobia.

Previous literature has not thoroughly examined the use of a kinesiophobia scale for highly active participants with CAI with a purpose of relating these scores to clinical measurements. Considering the FAAM subscales only moderately correlated to the scores on the TSK-11, and neither the CAIT or number of sprains were even moderately correlated with TSK-11 scores, kinesiophobia may be perceived independently from disability and frequency of injury. There was a strong positive relationship between the FAAM-ADL and FAAM-Sport subscales ( $r = 0.815$ ,  $p < 0.001$ ). Given that they are subscales of the same PRO that has been found to be both valid and reliable<sup>29</sup>, this relationship is not surprising. There was also a moderate negative relationship between number of sprains and both the FAAM-ADL ( $r = -0.436$ ,  $p = 0.007$ ) and FAAM-Sport ( $r = -0.464$ ,  $p = 0.004$ ) subscales. This could suggest that as number of ankle sprains increases, perceived disability increases as well. This could be explained because the FAAM is a region specific PRO that has been shown to detect instability following an ankle sprain.<sup>29</sup> Another explanation could be that since previous ankle sprain is the most common cause of CAI,<sup>49</sup> FAAM subscale scores may decrease with higher number of sprains due to increased instability. Finally, there was a weak positive relationship between TSK-11 scores and the number of reported ankle sprains ( $r = 0.380$ ,  $p = 0.20$ ). Meaning, as the number of ankle sprains increase, TSK-11 scores increase, suggesting that as the number of ankle sprains increases, kinesiophobia increases. Due to the relationship being weak, strong conclusions about

the relationship cannot be made. As previously demonstrated in the literature, patients with CAI report fear<sup>2</sup> and kinesiophobia and chronicity of symptoms can be used to predict self-reported disability in acute ankle sprain patients.<sup>12</sup> Since the severity of symptoms may predict self-reported disability<sup>12</sup>, and recurrent sprains are common in a CAI population<sup>2</sup>, it may be that with more ankle sprains the feelings of instability may increase. This may lead to an increase in fear of re-injury and avoidance of movement. Future research should determine the cumulative effects of ankle injuries on kinesiophobia.

Interestingly, only five out of 37 participants were considered to have CAI. When the FAAM-Sport and CAIT were used in combination 14 out of 37 would have been considered to have CAI, and if the CAIT was the only inclusionary PRO 26 out of 37 would have classified as CAI. The use of the FAAM and CAIT have been looked at separately to determine the presence of CAI<sup>12,29,30,31</sup> but have not to our knowledge been used in combination for inclusionary purposes. The FAAM has been shown to correlate with several outcome measures that determine overall health related quality of life.<sup>30,31,50,51</sup> The CAIT has been shown to correlate with the Lower Extremity Functional Scale and the Visual Analog Scale.<sup>12</sup> Since the publication of the 5<sup>th</sup> International Ankle Consortium position statement for selection criteria for patients with CAI in 2013, only one known study has used the guidelines to determine CAI.<sup>27</sup> However, this study did not use the FAAM guidelines as exclusionary criteria. The reported mean and SD for their participants' FAAM scores (FAAM-ADL  $90.6 \pm 5.4\%$  and FAAM-Sport  $79.0 \pm 12.5\%$ ) indicate that some participants scored higher than the cutoff necessary to qualify as CAI.<sup>27</sup> This study included 15 participants and data was collected over 6 months. Their participants were physically active as defined by the NASA-PAS and had to report at least moderate levels of physical activity ( $6.1 \pm 1.8$ ).<sup>27</sup> For our study, participants also had to report at least moderate levels of

physical activity, but most were considered to be at a high level of exercise (NASA-PAS  $\geq 6.5$ ) with the average NASA-PAS score being 8.00. To our knowledge, no study has examined highly active participants with CAI and their scores on the CAIT and FAAM.

The current study differed from previous studies in that we chose to include the use of ankle braces for all functional testing. Ankle bracing is common practice in athletics. Braces may prevent ankle injuries by reducing ankle range of motion.<sup>22,48</sup> A review of studies on the effect of bracing and reduction in ankle sprains revealed that athletes with a history of ankle sprains who use a brace or tape experienced a lower incidence of both initial and recurrent ankle sprains.<sup>27,28,52</sup> In fact, it has been suggested that ankle braces may reduce the risk of sustaining an ankle injury by half.<sup>13</sup> Thus, ankle bracing for patients with CAI may be warranted. The National Athletic Trainer's Association Position Statement on the Conservative Management and Prevention of Ankle Sprains in Athletes suggests that athletes with a previous history of ankle sprain wear a prophylactic for all practices and games to aid in ankle stability.<sup>13,22-24,32</sup> Therefore, we used ankle braces as an attempt to make the participants feel more stable as well as providing them with what they may use in normal athletic participation. However, the effects of the addition of ankle braces have not been examined when performing DROM, SEBT, triple crossover hop, and figure-8 hop testing in patients with CAI. Future research should compare these tasks when being performed with and without ankle braces to determine the effects of ankle bracing.

As with any study, there were multiple limitations associated with this study. We were limited to active individuals at one university in southeastern Georgia, therefore the results from this study cannot be generalized to the entire population. Participants may have been familiar with the dynamic postural control assessment and/or functional performance tests utilized in this

study due to their relative similarity with athletic and rehabilitation tasks. This limitation could not be avoided, however the number of practice attempts allowed per task were the same for all participants and a maximum attempt limit was set. SEBT reach distance has been shown to be positively correlated to leg length and results in significant differences in excursion between gender when not normalized.<sup>38</sup> The literature suggests normalizing to leg length or matching paired participants for leg length when using the SEBT as an assessment.<sup>38</sup> SEBT reach distance values were normalized to leg length for all participants in the current study. It was a limitation that participants may or may not typically wear prophylactic ankle braces while performing in their physical activity, which could affect their movement familiarity. This was addressed by providing practice trials for all tasks. Recall bias of ankle sprain history was another limitation. All participants were asked to report number of previous ankle sprains, however we are assuming participants are honest and able to recall an exact number. Finally, we were limited to five participants that classified as CAI resulting in the inability to perform statistical analyses between clinical measures.

This study represents a starting point in incorporating kinesiophobia into research related to the clinical characteristics of active individuals with potential CAI, as well as the incorporation of an ankle brace during dynamic postural control and functional performance testing. Though it has already been suggested as part of CAI research, kinesiophobia has not been a necessary component when discussing dynamic postural control and functional performance and clinical measures. Future research should be conducted to attempt to further correlate kinesiophobia with postural control and functional performance within this population as well as others. Kinesiophobia should also be further compared to measures often used to determine the presence of CAI. The effects of using prophylactic measures when performing

dynamic postural control and functional performance tests in a CAI population should also be further examined. Research should be continued in larger populations to attempt to generalize results to the CAI population. Lastly, research should be conducted to determine the efficacy of the FAAM and the CAIT to adequately detect CAI in a highly competitive population.

## CHAPTER V

### CONCLUSIONS

The current study showed potential trends between kinesiophobia and DROM with and without an ankle brace, as well as functional performance specific to agility. Dynamic postural control measures in the current study when wearing ankle braces did appear to be similar to that of previously published data. Measures of functional performance and DROM in the current study when wearing ankle braces did not appear similar when compared to previously published data. The TSK-11 scores were not related to the CAIT scores and only moderately related to the FAAM-ADL and FAAM-Sport scores. Therefore, perceived kinesiophobia may be independent of self-reported disability, and should be accounted for within the CAI population. Future research should further investigate the relationship between kinesiophobia and measures of dynamic postural control and functional performance.

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APPENDIX A  
EXTENDED INTRODUCTION

**Research Question**

1. Is there a significant relationship between perceived fear and avoidance of movement, dorsiflexion range of motion, dynamic postural control and functional performance within active individuals with CAI?
  - a. Is there a significant relationship between TSK-11 scores and DROM?
  - b. Is there a significant relationship between TSK-11 scores and SEBT reach distances?
  - c. Is there a significant relationship between TSK-11 scores and figure-8 speed?
  - d. Is there a significant relationship between TSK-11 scores and triple cross-over hop distance?

**Research Hypothesis**

1. There will be a significant relationship between perceived fear and avoidance of movement, dorsiflexion range of motion, dynamic postural control and functional performance within active individuals with CAI.
  - a. There will be a significant negative relationship between TSK-11 scores and DROM?
    - i. As TSK-11 scores decrease, DROM will increase.
  - b. There will be a significant negative relationship between TSK-11 scores and SEBT reach distances?

- i. As TSK-11 scores decrease, SEBT reach distances will increase.
- c. There will be a significant positive relationship between TSK-11 scores and figure-8 time.
  - i. As TSK-11 scores increase, figure-8 time in seconds will increase.
- d. There will be a significant negative relationship between TSK-11 scores and triple cross-over hop distance?
  - i. As TSK-11 scores decrease, cross over-hop distance will increase.

### **Limitations**

1. The results from this study cannot be generalized to the entire population since it is specific to collegiate athletes at one university in southeastern Georgia.
2. This study only represents recreationally active athletes.
3. Participants may or may not be familiar with the dynamic postural control assessment and functional performance tests utilized in this study. If they are familiar, there may be a practice effect.
4. Participants may or may not typically wear prophylactic ankle braces while performing in their sport. If unfamiliar with a brace, the participant may not be as comfortable.

### **Assumptions**

1. We assumed all participants answered outcomes measures truthfully and to the best of their knowledge.

2. We assumed all participants were honest and did not have a current acute lower extremity injury at the time of the testing.
3. We assumed all participants were honest in not currently receiving treatment and/or participating in rehabilitation for an acute injury at the time of testing.
4. We assumed all participants were correctly identified as having CAI.
5. We assumed all participants performed the testing with maximum effort.

### **Delimitations**

1. This study was only performed on recreationally active individuals at one university in Georgia.
2. This study is only representative of collegiate age recreationally active individuals.
3. The consensus statement on the classification of individuals with chronic ankle instability was used to determine eligibility into the CAI group.
4. The time frame for this study is from August to February of 2015.

### **Operational Definitions**

1. *Ankle*. The ankle is the joint that connects the lower leg to the foot which contains the talus and the calcaneus.<sup>1</sup>
2. *Ankle Sprain*. “An acute traumatic injury to the lateral ligament complex of the ankle joint as a result of excessive inversion of the rear foot or a combined plantar flexion and adduction of the foot.”<sup>2,3</sup>

3. *Chronic Ankle Instability*. “An encompassing term used to classify a subject with both mechanical and functional instability of the ankle joint. To be classified as having chronic ankle instability, residual symptoms (“giving way” and feelings of ankle joint instability) should be present for a minimum of 1 year post-initial sprain.”<sup>2,3</sup>
4. *Giving Way*. “The regular occurrence of uncontrolled and unpredictable episodes of excessive inversion of the rear foot (usually experienced during initial contact during walking or running), which do not result in an acute lateral ankle sprain.”<sup>2,3</sup>
5. *Recurrent Sprain*. Multiple ankle sprains, at least three sprains to the same ankle, specifically to the lateral ligament complex.<sup>3</sup>
6. *Feeling of Ankle Joint Instability*. “The situation whereby during activities of daily living (ADL) and sporting activities the subject feels that the ankle joint is unstable and is usually associated with the fear of sustaining an acute ligament sprain.”<sup>2,3</sup>

## APPENDIX B

### LITERATURE REVIEW

The complexity of the ankle joint increases the susceptibility to suffer ligament sprains. Ankle sprains are frequent injuries seen in athletic populations. Repetitive ankle sprains can lead to chronic ankle instability. Chronic ankle instability (CAI) creates deficits for athletes in both sport specific activities and activities of daily living. These deficits can lead to long-term consequences and decrease quality of life. The following literature review will explore a brief review of ankle anatomical features, epidemiology of ankle sprains, epidemiology of CAI, characteristics of CAI, deficits associated with CAI, diagnostic criteria for CAI, intervention strategies commonly used with CAI patients, and ankle bracing. To conclude, ankle anatomy, an overview of CAI, and ankle bracing will be discussed.

#### **Anatomical Features of the Ankle**

The ankle is a hinge joint in the lower extremity that consists of four bones: the tibia, fibula, talus, and calcaneus.<sup>4</sup> These four bones are attached via five major ligaments: the anterior inferior tibiofibular ligament, the anterior talofibular ligament, the posterior talofibular ligament, the deltoid ligament complex, and the calcaneofibular ligament.<sup>4</sup> The ankle consists of two joints, the talocrual and subtalar joint.<sup>5</sup> The joints allow for plantarflexion, dorsiflexion, inversion, and eversion.<sup>4</sup>

Muscles encase the ankle joint, and along with the ligaments, provide strength and stability.<sup>1</sup> The major muscles acting on the ankle joint are the tibialis anterior, tibialis posterior, gastrocnemius, soleus, peroneus longus, and peroneus brevis.<sup>5</sup> Tibialis anterior performs



dorsiflexion, tibialis posterior performs inversion, the gastrocnemius and soleus perform plantarflexion, peroneus longus and peroneus brevis perform eversion.<sup>5</sup>

### **Ankle Sprains/Epidemiology**

There are more than three million emergency room visits annually for ankle and foot injuries in the United States (US),<sup>2,6</sup> and the largest percentage of self-reported musculoskeletal injuries (> 10%) are to the ankle.<sup>2,6</sup> This totals more than 628,000 ankle injuries, including ankle sprains and fractures, per year treated in US emergency rooms, accounting for 20% of all injuries treated in emergency facilities.<sup>2,7</sup> In the US, 28,000 ankle injuries occur daily.<sup>8</sup> These numbers only represent emergency room reports, and overall calculations may be much higher.

Ankle sprains are one of the most common injuries treated by orthopedic surgeons and athletic trainers, accounting for almost half of all injuries seen in an athletic population.<sup>8,9</sup> Ankle sprains can occur to the lateral, medial, or syndesmosis aspect of the ankle. Gribble et al., defines a lateral or inversion ankle sprain as an “acute traumatic injury to the lateral ligament complex of the ankle joint as a result of excessive inversion of the rear foot or a combined plantar flexion and adduction of the foot.”<sup>2</sup> This is describing a lateral ankle sprain, which accounts for 80% of injuries to the ankle.<sup>10</sup> Although ankle sprains are treated often, over half of patients with ankle sprains do not report for treatment from a healthcare professional.<sup>11,12</sup>

Physical requirements for particular sports may place participants at greater risk for ankle injury. Barker et al, found that lateral ankle sprains are predominate in cutting and jumping sports such as volleyball, football, soccer, and basketball.<sup>13</sup> The Center for Disease Control (CDC) performed an epidemiological study from 1998-1999 to the 2003-2004 collegiate athletic seasons. This study looked at fifteen sports throughout this time period to determine injury rates per athletic exposure. An athletic exposure would consist of any time that an athlete could injure

him or herself in an athletic environment. The results from the CDC's study indicated that 11,000 athletes sustain ankle sprains annually at a 0.86 annual rate of ankle sprain per 1,000 athlete exposures.<sup>14</sup> Results of a systematic review on high quality studies reporting incident rates of ankle sprains may suggest the incident rate is higher, with a pooled cumulative incident rate of 11.55 sprains per 1,00 exposures.<sup>15</sup>

Patients that sustain one ankle sprain are more susceptible to recurrent ankle sprain injuries. 32-74% of individuals with a history of at least one ankle sprain report chronic symptoms, perceived instability, or recurrence of ankle sprain.<sup>2,16,17</sup> Freeman et al., in 1965, was the first to state that repetitive lateral ankle sprains can lead to chronic ankle instability (CAI).<sup>18,19</sup>

### **Chronic Ankle Instability**

Multiple definitions have been used to classify patients that experience chronic symptoms following ankle sprains. Chronic ankle instability, functional ankle instability (FAI), mechanical ankle instability (MAI) and recurrent ankle instability have been used to describe the chronic symptoms.<sup>2,20-22</sup> Inconsistency of categorizing symptoms of ankle instability can lead to confusion among professionals. The 5<sup>th</sup> International Ankle Consortium (Consortium), in 2013, determined that a consistent definition for CAI was essential.<sup>2</sup> The Consortium endorses the definition used by Delahunt, in 2010.<sup>2</sup> Delahunt et al., defines chronic ankle instability as an encompassing term used to classify a patient with both mechanical and functional instability of the ankle joint.<sup>3</sup> Comprehending the components of the definition of CAI allows clinicians to make more accurate diagnoses. Mechanical instability is excessive inversion laxity of the rear foot or excessive anterior laxity of the talocrural joint.<sup>3</sup> Functional instability of the ankle is reported 'giving way' and feelings of instability.<sup>3</sup> When taking into account the description of

chronic ankle instability, clinicians should understand the likelihood for the dysfunction in an athletic population and non-athletic population.

### **Epidemiology**

CAI is a common ailment for both athletic and non-athletic populations. Thirty percent of patients who suffer a first time lateral ankle sprain develop chronic ankle instability (CAI).<sup>12,16,23,24</sup> Conversely, this percentage has been reported to be as high as 75%.<sup>12,16</sup> Following ankle sprain, most athletes return to full activity within six weeks or less.<sup>25</sup> Seventy-four percent of athletes report at least one residual symptom up to four years after ankle injury; including loss of function, repeated injury, and disability.<sup>8,16,26</sup> Tanen et al., in 2014 administered the CAIT to 316 collegiate athletes and 196 high school athletes to determine the presence of CAI. Of the athletes surveyed, 23.4% had CAI and half of these had CAI bilaterally.<sup>27</sup> A total of 337 athletes reported a history of previous ankle sprain.<sup>27</sup> Recurrent ankle sprains increases the risk of long-term consequences for patients.

History of previous ankle sprain is the most common risk factor for CAI, but may not be the only cause of ankle instability.<sup>28</sup> The majority of high school and collegiate athletes with CAI, reported a history of lateral ankle sprain.<sup>27</sup> Tanen et al., found that 30% of athletes with a history of lateral ankle sprain developed CAI, consistent with previous reports that CAI occurs in 28% of athletes following a grade I ankle sprain and 24% of athletes following grade II ankle sprain.<sup>27,31</sup> CAI may also be a result of positional faults, or bony malalignment.<sup>25,32</sup>

Osseous characteristics such as bony alignment may be the origin of CAI. Radiographic evidence has shown that the position of the talus in relation to the tibia, as well as the curvature of the talus can be an intrinsic risk factor for CAI.<sup>32,33</sup> CAI patients have a greater rear-foot inversion angle than healthy individuals.<sup>34,35,36</sup> An increased inversion angle changes the

mechanics of the foot both in walking and running activities. Therefore, patients with CAI are placed in a position making them more susceptible for injury.

### **Characteristics of CAI**

In the following paragraphs, different characteristics of CAI will be discussed. To further understand the characteristics associated with CAI, a general knowledge of CAI assessments and assessment tools are necessary.

When assessing for CAI, athletic trainers should take a detailed past medical history. CAI is characterized by residual symptoms that include feelings of giving way and instability, as well as repeated ankle sprains, persistent weakness, pain during activity, and self-reported disability, which can be verified by patient-reported outcomes (PROs).<sup>2</sup>

Freeman et al., was the first to characterize the symptoms of chronic ankle instability as: feelings of instability, episodes of giving way, weakness, pain during activity, repeated sprains, and self-reported disability.<sup>18</sup> Though every patient presents differently, there are three distinct symptoms reported when patients suffer from chronic ankle instability. The feeling of ‘giving way’, a reported ‘feeling of disability’, and ‘recurrent sprains’ are the strongest characteristics in defining CAI.<sup>2,37</sup> Athletic trainers should also know different ways patients may describe these characteristics. Gribble et al defines ‘giving way’ as uncontrolled episodes of inversion that do not produce an acute ankle sprain.<sup>2</sup> This may happen both on and off the court for athletes. Most athletes with CAI will report multiple sensations of the ankle ‘giving way’ or feeling unstable. Patients with CAI report fear of ankle injury during athletic activities as well as activities of daily living, or feeling of ankle instability.<sup>2</sup> CAI can present with multiple ankle sprains on the same ankle. The 5<sup>th</sup> International Ankle Consortium endorses the definition of recurrent ankle sprain as having at least two sprains to the same ankle.<sup>2</sup>

The reported symptoms may be verified by using PRO instruments. Physically active individuals with chronic ankle instability exhibit deficits on a variety of these instruments.<sup>38</sup> CAI has been associated with decreased health related quality of life (HRQOL) based on global and regional outcomes.<sup>38-40</sup> HRQOL assessments demonstrate discrepancies for both the general population and an athletic population. Arnold et al, indicated that individuals with CAI have reported decreased function on the Short Form-36 (SF-36). Also, there is a positive correlation between SF-36 Physical Function domain scores and the Foot and Ankle Ability Measure (FAAM).<sup>38,40</sup> Therefore, CAI may reduce quality of life.<sup>38</sup> Although clinicians in the past have chosen PROs based on their experience, recent literature has identified further guidelines and suggests for the selection, implementation and use of PROs.

According to the 5<sup>th</sup> International Ankle Consortium, when assessing CAI, valid self-reported questionnaires should be used.<sup>2</sup> Multiple PRO assessments have been developed to describe self-reported disability. Both specific ankle instability and general foot and ankle questionnaires are recommended.<sup>2</sup> Specific ankle instability questionnaires contain specific cut-off numbers that allow researchers and clinicians to confirm CAI diagnosis. General questionnaires define the amount of disability and lack of function in the ankle.

The CAIT is a specific ankle instability self-reported assessment, whereas the FAAM is a general ankle questionnaire.<sup>2</sup> These questionnaires reveal not only the cardinal signs of chronic ankle instability but also functional performance deficits and daily activity deficits. The Foot and Ankle Disability Index (FADI), the Foot and Ankle Ability Measure (FAAM), and the Cumberland Ankle Instability Tool (CAIT) best detect the presence of CAI.<sup>8</sup> These measures provide clinicians and researchers with specific criteria to assess ankle pain and instability. The FAAM is a 31 question PRO that includes an activities of daily living and sport specific

sections.<sup>8</sup> The CAIT is a 9 question patient reported outcome that provides general ankle injury questions.<sup>8</sup> According to the 5<sup>th</sup> International Ankle Consortium, the cutoff score for the FAAM-ADL is less than 90%, the FAAM-sport is less than 80%.<sup>2</sup> These scores indicate disability or ankle instability. The FAAM may be used to detect self-reported functional deficits related to CAI.<sup>39</sup> The FAAM has been shown to correlate with several outcomes measures that determine overall health related quality of life.<sup>40-43</sup> Reliability for the FAAM-ADL subscale has an Intra-Class Correlation (ICC) = .89 and the Sport subscale has an ICC = .87.<sup>8,42</sup> Construct validity for the FAAM has a relationship with the SF-36 for both the ADL and sport subscale (r=.84, r=.78 respectively).<sup>8,42</sup> However, Carcia et al. also stated that when the healthy group of individuals was removed from the data, correlations between the SF-36 and the FAAM were weaker.<sup>39</sup> Carcia et al. found that FAAM scores were lower for CAI participants (88±7.7 for the ADL subscale and 76±12.7 for the sport subscale) greater for healthy participants (100 ± 0.0 for the ADL subscale and 99± 3.5 for the sport subscale).<sup>39</sup> Martin et al., examined the validity of the FAAM by looking at physical therapy patients that were in rehabilitation for at least four weeks.<sup>41</sup> When examining score stability, the ICC for the ADL subscale was 0.89 with a SEM of 2.1 and the MDC ± 5.7 and the ICC for the sport subscale was 0.87 with a SEM of 4.5 and the MDC ± 12.3.<sup>41</sup> The cutoff score for the CAIT is less than 24.<sup>2</sup> The CAIT has been shown to correlate with the Lower Extremity Functional Scale and the Visual Analog Scale. The CAIT demonstrated a strong correlation with the VAS with  $\rho = .76$  and a moderate correlation to the LEFS  $\rho = .50$ .<sup>44</sup> The CAIT has a test-retest reliability ICC = .96, a subject reliability index = .83, and an item reliability index = .99.<sup>44</sup> For the CAIT, sensitivity is 82.9% and specificity is 74.7%, with a positive likelihood ratio of 3.27 and a negative likelihood ratio of 0.23.<sup>44</sup> When

performing research and working with a clinical population that has CAI, these outcomes measures can be used both for pre-participation and post-intervention.

The effects of CAI on health related quality of life contribute to long-term limitations and restrictions in recreational and occupational activities.<sup>43-45</sup> CAI symptoms influence athletic performance and activities of daily living. The clinical symptoms present in CAI lead to long-term deficits. These deficits include but are not limited to increased laxity<sup>46,47</sup>, impaired DROM<sup>46,48</sup>, deficient leg and hip strength<sup>46,47,49</sup>, diminished postural control<sup>46,50,51</sup>, and impaired movement strategies.<sup>46, 49,51</sup> Other authors have documented similar deficits and have expanded on previously recognized additional insufficiencies associated with chronic ankle instability. Patients with CAI often exhibit deficits in functional performance,<sup>11,39,40,42,52</sup> proprioception,<sup>36,53-56</sup> and strength<sup>18,40,53,54</sup>, deficits with postural control<sup>50,57,58</sup>, changes in neuromuscular recruitment<sup>59,60</sup>, and impaired joint position sense.<sup>60-64</sup>

Joint position sense is acknowledging where the joint is in space. Inability to actively and passively locate the foot in space is associated with decreases in postural control and altered mechanics before and during stance phase of gait.<sup>65,66</sup> Yokoyama et al., found that individuals with ankle instability incorrectly estimated the combined motions of plantar flexion and inversion during passive joint position sense; those with ankle instability were more plantar flexed and inverted than they estimated.<sup>64,67</sup> The alteration of joint position sense may affect gait kinematics.<sup>17,67,68</sup> This altered joint position sense may place patients with CAI in a position to reinjure the lateral ligament complex. Patients with chronic ankle instability also demonstrate decreased dorsiflexion range of motion. While jogging, patients with CAI were less dorsiflexed at the peak point of dorsiflexion in the gait cycle. This may be due to restricted arthrokinematics at the talocrural joint.<sup>34,67,69</sup> Altered kinematics of the rearfoot before initial contact and during

stance phase predisposes CAI patients to multiple lateral ankle sprains.<sup>66,70,71</sup> Houston et al., in 2014, performed an assessment of FAAM scores between a control group and CAI group.<sup>38</sup> The differences between groups indicated that chronic ankle instability patients not only displayed significant differences compared with the healthy group but also had room for clinically meaningful improvement.<sup>38</sup>

Patients with CAI may have increased likelihood to develop osteoarthritis. Functional deficits may contribute to long-term consequences such as degenerative joint disease and decreased physical activity.<sup>25,38,72</sup> Wikstrom et al., consistent with previous literature, found a link between CAI and post-traumatic ankle osteoarthritis (OA), with 68–78 % of CAI patients developing ankle OA.<sup>12,73-75</sup> There is evidence to support that recurrent ankle joint trauma may lead to the development of post-traumatic ankle joint osteoarthritis.<sup>2,76,77</sup> Saltzman et al, has reported that four in five cases of ankle joint OA are the result of previous ankle musculoskeletal trauma.<sup>2,78</sup>

Functional performance is impaired in subjects with CAI.<sup>25,48,79</sup> CAI decreases functional performance on single-limb hop tests.<sup>79</sup> Specifically, figure-8 hop tests and side hop tests reveal functional deficits in patients with CAI.<sup>48</sup> These assessments consist of lateral movements that place the ankle in a more compromised position. When using frontal plane functional performance tests, patients with CAI do not reveal discrepancies compared to a control group.<sup>48</sup> Specific deficits should be addressed by clinicians to decrease signs and symptoms of CAI.

CAI increases the dorsiflexion/plantarflexion muscles torque ratio and decreases the eversion/inversion ratio.<sup>80</sup> Muscular torque ratio insufficiencies can be one explanation why patients with CAI suffer multiple ankle sprains. Several authors<sup>2,36,80</sup> have reported decrements in isokinetic strength for CAI patients during concentric ankle eversion. Andersen et al.,



discovered when comparing strength of ankle dorsal and plantar flexor muscles manually and through isokinetic dynamometry that manual testing leads to significant underestimation of frequency and severity of muscle weakness.<sup>80,81</sup> Therefore, clinical examinations should ideally be performed using isokinetic dynamometry, to decrease inaccuracy.<sup>80,81</sup>

When an athlete is forced into ankle inversion, evertors must act eccentrically to attempt to correct the joint before injury. Impairments in evertor strength may reduce the muscles' ability to dynamically control inversion and thus predispose the ankle to an inversion sprain.<sup>82</sup>

Leanderson et al., measured the ankle evertor muscle peak torque value using isokinetic dynamometry and found deficit after ankle sprains.<sup>80,83</sup> Studies performed by David et al., and Willems et al., evidenced a 22% impairment in eccentric evertor strength.<sup>56,84</sup> Following ankle injury, clinicians should increase strength both concentrically and eccentrically.

Eccentric muscle contraction could be considered a critical component of ankle control following injury.<sup>80,85</sup> Eccentric muscle actions represent dynamic ankle stabilization mechanisms.<sup>80,86</sup> If eccentric muscle contractions do not occur, the athlete may sprain their ankle. Webster et al, performed an assessment of gluteus maximus activation during a rotational squat to determine differences between patients with CAI and a control group. The CAI group had significantly less maximum activation than the healthy group during the rotational squat at the point of maximum excursion, and it may be important for clinicians to implement the rotational squat during rehabilitation for those with CAI.<sup>87</sup> These strength deficits influence a patient's postural control during athletic activities.

Poor balance is linked to ankle sprains.<sup>88,89</sup> Multiple balance assessments have been employed to identify poor balance associated with postural control insufficiencies.<sup>89</sup> These assessments include: the Balance Error Scoring System (BESS), time-in-balance test, foot-lift

test, force-plate measures, 4 and functional measures like the Star Excursion Balance Test (SEBT).<sup>48,89</sup> Postural control insufficiencies may also be seen while performing static stance on a force plate. Force plates will pick up more minimal differences in postural control than assessments like the BESS and SEBT. Single-leg force plate measurements in CAI patients demonstrate postural control deficits.<sup>50,90-93</sup> Balance deficits may place an athlete in an unstable and uncomfortable position during athletic activities and static standing.

### **CAI Intervention**

The current standard of care for acute lateral ankle sprain management involves rest, ice, compression, elevation (RICE) and functional rehabilitation.<sup>94</sup> Depending on severity, lateral ankle sprains may be treated with crutches and even immobilized for a period of time.<sup>31,94</sup> Intervention strategies should address specific deficits in patients with CAI. Manual therapy techniques used to restore normal arthrokinematic motion may be beneficial to help restore dorsiflexion ROM.<sup>8,95,96</sup>

Clinicians should emphasize the importance of returning dorsiflexion ROM to normal following ankle injury. Inadequate restoration of dorsiflexion increases the risk of ankle sprain,<sup>49</sup> limits functional activities, and increases long-term pain and disability.<sup>50</sup> Diminished dorsiflexion prevents the ankle from attaining a closed-pack position. Static stretching can have a strong effect on ankle dorsiflexion improvement after acute ankle sprains. Clinicians should employ stretching of the anterior and posterior ankle musculature to improve normal gait and function following ankle sprain. Tightness in the gastrocnemius-soleus complex may not be caused by acute lateral ankle sprain but may develop as an adaptation to immobilization and result from an abnormal gait pattern.<sup>97</sup>

Other studies have explored performing joint mobilizations to correct positional faults.<sup>21,97,98</sup> While joint mobilizations have reduced self-reported symptoms,<sup>21,97,98</sup> they do not improve functional symptoms. Mobilization with movement has also helped improve outcomes from CAI. A single application of weight bearing-mobilization with movement (WB-MWM) or high velocity and low amplitude manual technique improves ankle dorsiflexion in people with CAI, and the effects persist for at least two days; both techniques have similar effectiveness for improving ankle dorsiflexion although WB-MWM demonstrated greater effect sizes.<sup>98</sup> WB-MVM may correct positional faults and allow the joint to glide within a full ROM.<sup>98</sup> Other mobilization techniques have been evaluated for patients with CAI. Mulligan taping techniques may also decrease patient-reported outcomes in patients with chronic ankle instability. Someeh et.al, found that Mulligan Ankle Taping (MAT) improves functional performance tests in athletes with CAI. As a result, MAT may be an effective method for enhancing athletes' performance in sports that require lateral movements.<sup>25</sup>

Strategies that focus on balance, strength, and dynamic movements with changes in direction may be effective in reducing the risk of recurrent ankle sprains in patients with functional deficits.<sup>8,51,99</sup> Strength training improves self-reported disability and strength deficits in patients with CAI.<sup>54</sup> There is no consensus on the effect of strength training on functional performance, balance, or proprioception.<sup>54,55,100</sup> Incorporating resistance band and tubing strength training protocols three times a week for six weeks may increase signs and symptoms of CAI.<sup>54,46,100</sup> Docherty et al., used this principle and reported improvements in eversion and dorsiflexion strength after 6 weeks of progressive elastic-band training.<sup>100,101</sup> Smith et al., found increases in inversion and eversion strength in the training group when post tested when compared with the control group.<sup>101</sup> Hall et al., found improvements with isometric strength for

dorsiflexion, inversion, eversion and visual analog measures with both resistance band training and proprioceptive neuromuscular facilitation.<sup>54</sup> No improvements were reported with balance, or functional performance. Functional performance is typically tested using hop tests. Hall et al., These hop tests are performed both pre- and post-intervention to assess improvement following intervention.<sup>54</sup>

### **Ankle Bracing**

Ankle braces are commonly used in sport. The support provided by the ankle brace prevents ankle injuries by constraining frontal-plane ankle motion.<sup>102</sup> Ankle braces reduce the risk of sustaining an ankle injury by half, compared to those who received ankle taping.<sup>12</sup> A review of studies on the effect of bracing and reduction in ankle sprains revealed that athletes with a history of ankle sprains who use a brace or tape experienced a lower incidence of ankle sprains.<sup>103</sup> The ankle brace is easily retightened during use, unlike athletic tape, which must be removed and replaced to restore its effectiveness.<sup>1</sup> Since the brace can be retightened and reused, many players prefer a brace as they are more suitable to use and are more cost effective.<sup>75</sup> A brace can be retightened, quickly and easily, at any point during an athletic contest if loosen.<sup>105</sup> A study found that patients treated with a brace returned to play significantly faster.<sup>106</sup> Patients with moderate ankle sprains managed with braces had a shorter recovery time by up to 40 percent.<sup>107</sup>

Ankle bracing may have the ability to prevent both initial and recurrent ankle sprains.<sup>108,109</sup> Ankle braces have been shown to reduce the risk of ankle sprain incidence in high school basketball players at a rate of 0.47 when compared to a control group where the incidence was 1.41 per 1000 athlete exposures.<sup>108</sup> Similarly, in high school football players, acute ankle injury rates while braced were shown to be 0.48, while a control group had an incidence of 1.12 per 1000 athlete exposures.<sup>109</sup> Janssen et al., performed a study examining the effects of

neuromuscular training for 8 weeks, wearing a brace in all athletic activities for 12 months, and a combination of the two interventions for 8 weeks. Results showed that following 12 months, participants in the brace group had significantly less incidents of ankle sprain than the neuromuscular training group and the combination group per 1000 hours of sport. (1.34, 2.51, 1.78 respectively) It is important to note that the intervention for the neuromuscular training group and combination group only lasted 8 weeks, while the brace group lasted 12 months. However, the authors did find that wearing an ankle brace added a 47% reduction in the risk of reinjury occurring.<sup>110</sup> Ankle braces have been shown to restrict ankle ROM and increase the Hoffman reflex in the peroneus longus while in a neutral foot position.<sup>111</sup> However, one study found that using ankle braces can decrease lower extremity muscle activation.<sup>111</sup> Feger et al., found that patients with CAI had significantly less gastrocnemius muscle activity when performing a forward lunge in the pre-initial contact phase and significantly less peroneus longus activity in the post-initial contact phase.<sup>111</sup> Furthermore, the study found that wearing lace-up ankle braces decreased lower extremity muscle activation of the peroneus longus, lateral gastrocnemius, rectus femoris, gluteus medius, the thigh and total muscle activity when performing the SEBT.<sup>111</sup> Therefore, clinicians should be cautioned not to use prophylactics when performing functional exercises for rehabilitation. The National Athletic Trainer's Association Position Statement on the Conservative Management and Prevention of Ankle Sprains in Athletes suggests that athletes with a previous history of ankle sprain wear a prophylactic, like a brace, for all practices and games.<sup>8</sup>

The addition of prophylactic agents may help athletes feel more stable.<sup>112-114</sup> When an athlete experiences fear, they may avoid movement. Since patients with CAI report fear<sup>2</sup>, they also avoid movements that are painful. This avoidance of movement has been demonstrated in

the literature. Larmer et al., performed a study that investigated patient's perception of function and physical performance following ankle sprain.<sup>115</sup> The study used questionnaires, physical performance tasks, and a semi-structured interview. The study found that patients reported apprehension and avoidance of certain movements because of fear of reinjury.<sup>115</sup> The questionnaires and physiotherapy could not illustrate the fear and caution participants felt. Participants were quoted saying, "*Probably the fear of doing it again. That affects me when I go for a run, I'm scared that I will do it again*", "*..it was funny because I thought there were some of these things that I would not be able to do, but when you got me to do them I was surprised that I couldn't feel my ankle hardly at all, it was really good you know*", and "*I've sort of been avoiding doing that. I was pretty sure that it would hurt too much. It might have hurt a bit a while ago so I haven't tried again. I just think that I would have kept on not doing those things. I mean I've really tried not to make myself do those twisting movements and even when like kicking the ball thing I've been using my left foot way more than I used to.*"<sup>115</sup>

To increase stability during athletic participation, athletes may use prophylactics to help them feel more stable.<sup>112-114</sup> Gear et al., showed that while performing a dynamic balance task, the mean overall stability index for the ankle brace condition was  $2.23 \pm 0.85$  compared to  $2.18 \pm 0.93$  for the ankle tape condition. The study also found that the perception of stability for the ankle brace condition was  $2.90 \pm 0.77$  compared to the barefoot condition,  $2.57 \pm 0.60$ .<sup>112</sup>

Kinesiophobia is defined as the fear of movement or fear of re-injury from movement.<sup>116</sup> The Tampa Scale for Kinesiophobia-11 is one of the most commonly used measure for assessing pain-related fear.<sup>117</sup> TSK-11 scores have a significant inverse association to pain-related acceptance, the willingness to experience pain without changing anything.<sup>118</sup> The somatic focus section of the TSK-11 could predict perceived disability and the activity avoidance section could

predict physical performance when controlling for pain severity.<sup>118</sup> Lentz et al., determined that kinesiophobia, ROM, and chronicity of symptoms could be used to predict self-reported disability in ankle sprain patients.<sup>119</sup> Therefore, it can be hypothesized that athletes with CAI that demonstrate high TSK-11 scores have pain-related fear, avoid movement, and consider themselves to be disabled.

### **Conclusion**

CAI is a common ailment for athletic and non-athletic populations. History of repeated ankle sprains is the most common cause of CAI.<sup>11</sup> Patients with CAI have decreased HRQOL and also experience sport-specific functional deficits.<sup>13,30,35,44,48,74</sup> While strengthening and other rehabilitation programs have shown improvement of ROM and strength, the focus on strength training lacks desirable outcomes for functional performance improvement.<sup>54</sup> Prophylactic ankle supports are used in sport to provide mechanical stability to the ankle joint. Fear and avoidance of movement has been reported in chronic pain patients<sup>116</sup> and in patient's suffering from ankle sprains.<sup>115</sup> It can be hypothesized that athletes with CAI that demonstrate pain-related fear, avoid movement, and consider themselves to be disabled. Since self-reported disability is one of the characteristics associated with CAI,<sup>2,3,18,37,54</sup> assessing kinesiophobia in CAI patients may be necessary for clinicians. Research has yet to explore the relationships between wearing a prophylactic ankle brace and kinesiophobia while performing dorsiflexion range of motion, dynamic postural control, and functional performance tests in active individuals with CAI.

**Table 4. Previously published means and SD on SEBT reach distances**

| Author   | Population              | Findings  | Special Characteristics   |
|--|-------------------------|---|---|
| Bastien, M.,<br>Moffett, H.,<br>Bouyer, L.,<br>et al   | 10 men                  | <u>Healthy Participants: (Distance in cm)</u><br>Maximal reach distance (%LL)<br>Anteromedial: 91.5 +/- 5.78<br>Posteromedial: 99.17 +/-7.38<br>Medial: 94.42 +/- 6.32<br>Maximal reach distance (%Ht)<br>Anteromedial: 47.75 +/- 3.02<br>Posteromedial: 51.93 +/- 3.48<br>Medial: 49.27 +/- 3.30<br><u>Lateral Ankle Sprain Participants: (cm)</u><br>Maximal reach distance (%LL)<br>Anteromedial: 84.32 +/- 5.89<br>Posteromedial: 93.90 +/- 6.23<br>Medial: 89.60 +/- 6.58<br>Maximal reach distance (%Ht)<br>Anteromedial: 43.63 +/- 3.20<br>Posteromedial: 48.56 +/- 3.02<br>Medial: 46.33 +/- 3.16 | All participants were military participants with lateral ankle sprains. |
| Coughlan,<br>G., Fullam,<br>K., Delahunt,<br>E., et al | 20 male<br>participants | <u>% Maximized Reach Distance:</u><br>Left leg<br>Anterior: 69.92 +/- 7.29<br>Posteromedial: 111.51 +/- 5.76<br>Posterolateral: 104.00 +/- 6.42<br>Right leg<br>Anterior: 69.49 +/- 7.14<br>Posteromedial: 110/82 +/- 7.23<br>Posterolateral: 104.03 +/- 6.89   | Compared to Y-Balance Test. Used healthy active population.             |



|  |                                    |   |  |
|--|------------------------------------|---|--|
| Fullam, K.,<br>Caulfield,<br>B.,Coughlan,<br>G., et al | 15 healthy<br>male<br>participants | <u>% Maximized Reach Distance</u><br>Anterior: 67.05 +/- 4.97<br>Posterolateral: 99.71 +/- 8.67<br>Posteromedial: 106.15 +/-7.94  | Compared to Y-Balance Test.                    |
| Gabriner,<br>M., Houston,<br>M., Kirby, J.,<br>et al   | 40<br>participants                 | <u>% Maximized Reach Distance</u><br>Anterior: 81.19 +/- 5.52<br>Posteromedial: 90.38 +/- 8.1<br>Posterolateral: 80.68 +/- 11.23  | All participants were healthy adults with CAI. |
| Gribble, P.,<br>Hertel, J.                             | 30<br>participants                 | <u>Raw Scores (cm)</u><br>Male:<br>Anterior: 71.2 +/- 7.4<br>Posterolateral: 81.2 +/- 11.9<br>Posteromedial: 86.0 +/- 8.1<br>Female:<br>Anterior: 67.1 +/-5.4<br>Posterolateral: 74.6 +/- 11.5<br>Posteromedial: 77.7 +/- 10.1<br><u>Normalized (% LL)</u><br>Male:<br>Anterior: 79.2 +/- 7.0<br>Posterolateral: 90.4 +/- 13.5<br>Posteromedial: 95.6 +/- 8.3<br>Female:<br>Anterior: 76.9 +/- 7.0<br>Posterolateral: 85.5 +/- 13.2<br>Posteromedial: 89.1 +/- 11.5 | Distances should be normalized to LL.          |

**Table 5. Previously published means and SD for triple crossover hop**

| Author  | Population                    | Findings  | Special Characteristics  |
|---|-------------------------------|---|--|
| Grindem, H., Logerstedt, D., Eitzen, I, et al | 91 patients                   | Distance in<br>Fn below normal: 88.4 (82.9 - 90.3)<br>Fn within normal:<br>90.8 (82.5-98.2)   | Non-operative patients with ACL injury.  |
| Munn, J., Beard, D., Refshauge, K., et al     | 16 university age patients    | <u>Distance in meters:</u><br>Injured: 4.83 +/- 0.91<br>Uninjured: 4.93 +/- 1.10  | All participants had unilateral functional ankle instability   |
| Hall, E., Docherty, C., Simon, J., et al      | 39 participants; 13 per group | <u>Distance in cm:</u><br>RB-Pre: 455.5 +/- 96.4<br>RB-Post: 480.4 +/- 84.6<br>PNF-Pre: 451.1 +/- 108<br>PNF-Post: 479.2 +/-95.1<br>Cntrl-Pre: 519.7 +/-150<br>Cntrl-Post: 509.6 +/-120 | Performed intervention. Had control group, resistance band group, and proprioceptive neuromuscular facilitation group. |

**Table 6. Previously published means and SD for figure-8 hop test**

| Author   | Population                                      | Findings   | Special Characteristics  |
|--|---|--|--|
| Sharma, N., Sharma, A., Sandhu, J.               | 62 participants 31 FAI, 21 Non-FAI; ages 19-24; | <u>Time in Sec</u><br>FAI-GW: 7.87 +/- 0.13; FAI-NGW: 7.33 +/- 0.21; Non-FAI: 6.92 +/- 0.12  | Matched controls; giving way; non-giving way groups  |
| Caffrey, E., Docherty, C., Schrader, J., et al   | 60 college students; 30 FAI, 30 Non-FAI;        | <u>Time in Sec</u><br>FAI: 11.3 +/- 0.6<br>Non-FAI: 11/0 +/- 0.5   | Matched controls; giving way; non-giving way groups  |
| Hall, E., Docherty, C., Simon, J., et al         | 39 participants; 13 per group                   | <u>Time in Sec</u><br>RB: Pre: 10.7 +/- 1.7<br>Post: 10.1 +/- 1.2<br>PNF: Pre: 11.2 +/- 1.8<br>Post: 10.2 +/- 1.5<br>CON: Pre: 10.4 +/-1.9<br>Post: 10.3 +/- 1.9 | Performed intervention. Had control group, resistance band group, proprioceptive neuromuscular facilitation group. |
| Docherty, C., Arnold, B., Gansneder, B., et al   | 60 participants; 42 injured, 8 uninjured        | <u>Time in Sec</u><br>Injured: 2-3 symptoms: 7.18 +/- 1.26<br>4-6 symptoms: 7.86 +/- 0.91<br>Uninjured: 6.98 +/- 1.01  |  |
| Someeh, M., Norasteh, A., Daneshmandi, H., et al | 16 professional athletes with unilateral CAI    | <u>Time in Sec</u><br>Pre-tape: 5.36 +/- 0.79<br>Post-tape: 4.97 +/- 0.59  | Applied a mulligan tape application prior to re-testing.   |

## APPENDIX C

## INSTITUTIONAL REVIEW BOARD

|   |                         |                      |
|---|-------------------------|----------------------|
| Georgia Southern University<br>Office of Research Services & Sponsored Programs |                         |                      |
| <b>Institutional Review Board (IRB)</b>   |                         |                      |
| Phone: 912-478-0843   |                         | Veazey Hall 2021     |
|   |                         | P.O. Box 8005        |
| Fax: 912-478-0719   | IRB@GeorgiaSouthern.edu | Statesboro, GA 30460 |

**To:** Mary Beth Winningham  
Jessica Muteher  
Tamera Hunt  
Barry Munkasy  
Josh Krispin

**From:** Office of Research Services and Sponsored Programs  
Administrative Support Office for Research Oversight Committees  
(IACUC/IBC/IRB)

**Initial Approval Date:** 01/08/2016

**Expiration Date:** 12/31/2016

**Subject:** Status of Application for Approval to Utilize Human Subjects in Research –  
Full Medical Board Process

After a review of your proposed research project numbered H16180 and titled "Clinical Characteristics of NCAA Division I Athletes and Cheerleaders with Chronic Ankle Instability" it appears that (1) the research subjects are at minimal risk, (2) appropriate safeguards are planned, and (3) the research activities involve only procedures which are allowable. You are authorized to enroll up to a maximum of 80 subjects.

*Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that the Institutional Review Board has approved your proposed research. Description: This study will assess the relationship between fear and avoidance of movement, dorsiflexion range of motion, dynamic postural control, and functional performance measures with competitively active individuals with chronic ankle instability, while wearing prophylactic ankle braces.*

If at the end of this approval period there have been no changes to the research protocol, you may request an extension of the approval period. Total project approval on this application may not exceed 36 months. If additional time is required, a new application may be submitted for continuing work. In the interim, please provide the IRB with any information concerning any significant adverse event, **whether or not it is believed to be related to the study**, within five working days of the event. In addition, if a change or modification of the approved methodology becomes necessary, you must notify the IRB Coordinator **prior** to initiating any such changes or modifications. At that time, an amended application for IRB approval may be submitted. Upon completion of your data collection, you are required to complete a *Research Study Termination* form to notify the IRB Coordinator, so your file may be closed.

Sincerely,

  
Eleanor Haynes  
Compliance Officer

|  |                         |   |
|--|-------------------------|---|
| Georgia Southern University<br>Office of Research Services & Sponsored Programs<br><b>Institutional Review Board (IRB)</b> |                         |   |
| Phone: 912-478-0845  |                         | Veazey Hall 2021<br>P. O. Box 8005<br>Statesboro, GA 30460-8005 |
| Fax: 912-478-0719  | IRB@GeorgiaSouthern.edu |   |

**To:** Mary Beth Winningham  
Jessica Mutchler  
Tamera Hunt  
Bary Munkasy  
Josh Krispin

**From:** Office of Research Services and Sponsored Programs  
Administrative Support Office for Research Oversight Committees (ACUC/IBC/IRB)

**Date:** 02/15/2016

**Expiration Date:** 12/31/2016

**Subject:** Status of Research Study Modification Request

After a review of your Research Study Modification Request on research project numbered **H16150** and titled "**Clinical Characteristics of Active Individuals with Chronic Ankle Instability**" your request for modification appears that (1) the research subjects are at minimal risk, (2) appropriate safeguards are planned, and (3) the research activities involve only procedures which are allowable.

*Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that the Institutional Review Board has approved your modification request. This amendment changes the title of the study to "Clinical Characteristics of Active Individuals with Chronic Ankle Instability," as well as expand the study to include active individuals as defined by the NASA Physical Activity Survey.*

**The expiration date of your original application approval remains in effect.** If additional time beyond your expiration date is required to complete your data collection and analysis and there have been no further changes to the research protocol, you may request an extension of the approval period. If your project will require approval beyond 36 months from the initial approval date, a new submission and review will be required. In the interim, please provide the IRB with any information concerning any significant adverse event, **whether or not it is believed to be related to the study**, within five working days of the event. In addition, another change or modification of the approved methodology becomes necessary; you must notify the IRB Coordinator **prior** to initiating any such changes or modifications. At that time, an amended application for IRB approval may be submitted. Upon completion of your data collection, you are required to complete a *Research Study Termination* form to provide the final information to allow your file to be closed.

Sincerely,

  
Eleanor Haynes  
Compliance Officer

APPENDIX D  
INFORMED CONSENT



College of Health and Human Sciences

Department of Kinesiology

**INFORMED CONSENT TO ACT AS A SUBJECT IN AN EXPERIMENTAL STUDY**

1. Title of Project: Clinical Characteristics of Active Individuals With Chronic Ankle Instability

Investigator's Name: Mary Beth Winningham, ATC Phone: (931) 261 - 6645

Participant's Name \_\_\_\_\_ Date: \_\_\_\_\_

Data Collection Location: Biomechanics Laboratory, Georgia Southern University

2. The purpose of this study is to determine if there is a relationship between perceived fear and avoidance of movement, dorsiflexion range of motion, dynamic postural control and functional performance within active individuals with chronic ankle instability (CAI).
3. Participation in this study will include the completion of basic demographic data, leg length measurements, three questionnaires, ankle range of motion, a postural control test and two functional performance hop tests. To begin the testing session, basic information will be collected, such as height, weight, age, BMI, and leg length followed by your completion of the Foot and Ankle Measure (FAAM), Cumberland Ankle Instability Tool (CAIT), and Tampa Scale for Kinesiophobia (TSK-11). Participants whom do not meet the FAAM and CAIT score criteria, will not be eligible to continue. If you meet the FAAM and CAIT score criteria, you will continue with the next stage of testing. If you meet the inclusion criteria for both ankles, the ankle with the most recent and/or more severe disability will be identified as the involved limb and the limb of interest in the study.

You will be asked to perform a 5-minute warm-up and self-stretching followed by dorsiflexion range of motion, using a lunge test. This test will be performed in a standing position by having you lunge forward, touching your knee to the wall. The furthest position of your test foot from the wall when your knee can still touch will be recorded. Functional testing will consist of the Star Excursion Balance Test (SEBT), single-leg triple crossover hop test, and the figure-8 test. You will perform the SEBT first. You will be asked to stand on the involved leg while reaching and touching the opposite foot's big toe as far as possible along a measuring tape placed on the floor. This test will be performed with you reaching directly in front of you, followed by diagonally to one side and then diagonally behind your

stance limb. You will be given five practice trials and three test trials in each direction with rest between each trial and direction. The greatest distance for each direction will be recorded. Next you will be asked to perform a single-leg crossover hop test. You will be instructed to hop three consecutively times, crossing over the line with each hop and covering as much distance as possible. All participants will begin by standing on the involved limb only and jumping to the opposite side of the line. Three test trials will be performed, and the trial with the longest distance will be recorded. Finally, you will perform the figure-8 hop test for speed. Starting on your involved limb, you will be asked to hop as fast as you can through a course of three cones, placed at the start, end and middle of the 5-meter course. You will perform this test three times with one minute of rest between each trial.

4. There is minimal risk of injury that is no greater than the risks associated with your current sport activity. The test procedure includes the use of a prophylactic ankle brace while completing the study, which may lower your risk of injury and muscle soreness. Additionally, we will attempt to reduce the risk of muscle soreness by having you complete a warm-up prior to and following testing, and will provide sufficient rest time between trials and tests. By participating in this study and signing this informed consent you are confirming you have read and agree to the following statement. “I understand that medical care is available in the event of injury resulting from research but that neither financial compensation nor free medical treatment is provided. I also understand that I am not waiving any rights that I may have against the University for injury resulting from negligence of the University or investigators.”
5. There are no direct benefits to you as a participant. There may be benefits regarding the research, care and outcomes of athletes with CAI. These benefits may include providing further knowledge to clinicians about how to test for chronic ankle instability and the relationship that fear and avoidance of movement has with assessment tools currently used to determine return to play and outcomes for athletes with CAI.
6. The duration of the study will be one forty-five minute session.
7. You will not be identified by name in the data set or any reports using information obtained from this study, and your confidentiality as a participant in this study will remain secure. Subsequent uses of records and data will be subject to standard data use policies which protect the anonymity of individuals and institutions. All information obtained will be stored in a secure room within a locked file cabinet for a minimum of three years before being properly and securely destroyed.

8. Participants have the right to ask questions and have those questions answered. If you have questions about this study, please contact the researcher named above or the researcher's faculty advisor, whose contact information is located at the end of the informed consent. For questions concerning your rights as a research participant, contact Georgia Southern University Office of Research Services and Sponsored Programs at 912-478-0843.
9. You will not receive any form of compensation for participation in this study.
10. You do not have to participate in this study if you do not want to. Participation in this study is completely voluntary. Even if you begin the testing, you can choose to withdraw at any time.
11. There are no penalties for removing yourself from the study or denying participation in the study.
12. You must be 18 years of age or older to consent to participate in this research study. If you consent to participate in this research study and to the terms above, please sign your name and indicate the date on the following page.

You will be given a copy of this consent form to keep for your records. This project has been reviewed and approved by the GSU Institutional Review Board under tracking number H16180.



Title of Project: Clinical Characteristics of Active Individuals With Chronic Ankle Instability

Principal Investigator:

Mary Beth Winningham, ATC

Hanner Fieldhouse, 1208

931-261-6645

[Mw07212@georgiasouthern.edu](mailto:Mw07212@georgiasouthern.edu)

Additional Investigators:

Joshua Krispin, ATC

Hanner Fieldhouse, 1208

419-705-5151

[Jk05044@georgiasouthern.edu](mailto:Jk05044@georgiasouthern.edu)

Faculty Advisor:

Dr. Jessica Mutchler

Hollis Building, 1101D

912-478-7400

[jmutchler@georgiasouthern.edu](mailto:jmutchler@georgiasouthern.edu)

\_\_\_\_\_  
Participant Signature

\_\_\_\_\_  
Date

I, the undersigned, verify that the above informed consent procedure has been followed.

\_\_\_\_\_  
Investigator Signature

\_\_\_\_\_  
Date

APPENDIX E  
TESTING SHEET, FAAM, CAIT, TSK-11, NASA-PAS

Gender: \_\_\_\_\_ Age: \_\_\_\_\_ years  
 Height: \_\_\_\_\_ cm Weight: \_\_\_\_\_ lbs  
 Leg Length: Right \_\_\_\_\_ cm Left \_\_\_\_\_ cm Dominant Leg: **R or L**

Sport \_\_\_\_\_

No. of Sprains: Right \_\_\_\_\_ Left \_\_\_\_\_

CAIT Score: Right \_\_\_\_\_ Left \_\_\_\_\_  
 FAAM ADL Score: Right \_\_\_\_\_ Left \_\_\_\_\_  
 FAAM Sport Score: Right \_\_\_\_\_ Left \_\_\_\_\_

Involved Limb: **R or L**

**Outcome Measures**

**TSK-11:** \_\_\_\_\_

**Dorsiflexion Range of Motion**

\_\_\_\_\_ cm

**Dynamic Postural Control - Star Excursion Balance Test**

*Involved Leg-Reach Distance*

Anterior<sub>1</sub> \_\_\_\_\_ cm      Posteriomed<sub>1</sub> \_\_\_\_\_ cm      Posteriolat<sub>1</sub> \_\_\_\_\_ cm  
 Anterior<sub>2</sub> \_\_\_\_\_ cm      Posteriomed<sub>2</sub> \_\_\_\_\_ cm      Posteriolat<sub>2</sub> \_\_\_\_\_ cm  
 Anterior<sub>3</sub> \_\_\_\_\_ cm      Posteriomed<sub>3</sub> \_\_\_\_\_ cm      Posteriolat<sub>3</sub> \_\_\_\_\_ cm

---

Average<sub>A</sub> \_\_\_\_\_ cm      Average<sub>PM</sub> \_\_\_\_\_ cm      Average<sub>PL</sub> \_\_\_\_\_ cm

**Average<sub>A</sub>** \_\_\_\_\_ cm/LL      **Average<sub>PM</sub>** \_\_\_\_\_ cm/LL      **Average<sub>PL</sub>** \_\_\_\_\_ cm/LL

*Composite Score* \_\_\_\_\_ cm/LL

**Functional Figure-8**

Trial 1 \_\_\_\_\_ s      Trial 2 \_\_\_\_\_ s      Trial 3 \_\_\_\_\_ s

**Score** \_\_\_\_\_ s

**Triple Crossover Hop**

Trial 1 \_\_\_\_\_ cm      Trial 2 \_\_\_\_\_ cm      Trial 3 \_\_\_\_\_ cm

**Score** \_\_\_\_\_ cm



**Foot and Ankle Ability Measure (FAAM)**  
**Activities of Daily Living Subscale**  
**Page 2**

Because of your foot and ankle how much difficulty do you have with:

|   | No<br>Difficulty<br>at all | Slight<br>Difficulty     | Moderate<br>Difficulty   | Extreme<br>Difficulty    | Unable<br>to do          | N/A                      |
|---|----------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Home responsibilities                               | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Activities of daily living                          | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Personal care                                       | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Light to moderate work<br>(standing, walking)       | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Heavy work<br>(push/pulling,<br>climbing, carrying) | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Recreational activities                             | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

How would you rate your current level of function during you usual activities of daily living from 0 to 100 with 100 being your level of function prior to your foot or ankle problem and 0 being the inability to perform any of your usual daily activities.

\_\_\_ \_\_\_ . 0 %

**Foot and Ankle Ability Measure (FAAM)  
Sports Subscale**

Because of your foot and ankle how much difficulty do you have with:

|  | No<br>Difficulty<br>at all | Slight<br>Difficulty     | Moderate<br>Difficulty   | Extreme<br>Difficulty    | Unable<br>to do          | N/A                      |
|--|----------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Running  | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Jumping  | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Landing  | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Starting and<br>stopping quickly                                       | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Cutting/lateral<br>Movements   | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Ability to perform<br>Activity with your<br>Normal technique           | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Ability to participate<br>In your desired sport<br>As long as you like | <input type="checkbox"/>   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

How would you rate your current level of function during your sports related activities from 0 to 100 with 100 being your level of function prior to your foot or ankle problem and 0 being the inability to perform any of your usual daily activities?

\_\_\_ . 0%

Overall, how would you rate your current level of function?

Normal     Nearly Normal     Abnormal     Severely Abnormal

Martin, R.; Irrgang, J.; Burdett, R.; Conti, S.; VanSwearingen, J.: Evidence of Validity for the Foot and Ankle Ability Measure. *Foot and Ankle International*. Vol.26, No.11: 968-983, 2005.

## Cumberland Ankle Instability Tool (CAIT)

Please tick the ONE statement in EACH question that BEST describes your ankles.

|   | LEFT                     | RIGHT                    |
|---|--------------------------|--------------------------|
| 10. I have pain in my ankle   |                          |                          |
| Never   | <input type="checkbox"/> | <input type="checkbox"/> |
| During sport  | <input type="checkbox"/> | <input type="checkbox"/> |
| Running on uneven surfaces  | <input type="checkbox"/> | <input type="checkbox"/> |
| Running on level surfaces   | <input type="checkbox"/> | <input type="checkbox"/> |
| Walking on uneven surfaces  | <input type="checkbox"/> | <input type="checkbox"/> |
| Walking on level surfaces   | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. My ankle feels UNSTABLE   |                          |                          |
| Never   | <input type="checkbox"/> | <input type="checkbox"/> |
| Sometimes during sport (not every time)   | <input type="checkbox"/> | <input type="checkbox"/> |
| Frequently during sport (every time)  | <input type="checkbox"/> | <input type="checkbox"/> |
| Sometimes during daily activity   | <input type="checkbox"/> | <input type="checkbox"/> |
| Frequently during daily activity  | <input type="checkbox"/> | <input type="checkbox"/> |
| 12. When I make SHARP turns my ankle feels UNSTABLE                                     |                          |                          |
| Never   | <input type="checkbox"/> | <input type="checkbox"/> |
| Sometimes when running  | <input type="checkbox"/> | <input type="checkbox"/> |
| Often when running  | <input type="checkbox"/> | <input type="checkbox"/> |
| When walking  | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. When going down the stairs my ankle feels UNSTABLE                                  |                          |                          |
| Never   | <input type="checkbox"/> | <input type="checkbox"/> |
| If I go fast  | <input type="checkbox"/> | <input type="checkbox"/> |
| Occasionally  | <input type="checkbox"/> | <input type="checkbox"/> |
| Always  | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. My ankle feels UNSTABLE when standing on ONE leg                                    |                          |                          |
| Never   | <input type="checkbox"/> | <input type="checkbox"/> |
| On the ball of my foot  | <input type="checkbox"/> | <input type="checkbox"/> |
| With my foot flat   | <input type="checkbox"/> | <input type="checkbox"/> |
| 15. My ankle feels UNSTABLE when  |                          |                          |
| Never   | <input type="checkbox"/> | <input type="checkbox"/> |
| I hop from side to side   | <input type="checkbox"/> | <input type="checkbox"/> |
| I hop on the spot   | <input type="checkbox"/> | <input type="checkbox"/> |
| When I jump   | <input type="checkbox"/> | <input type="checkbox"/> |
| 16. My ankle feels UNSTABLE when  |                          |                          |
| Never   | <input type="checkbox"/> | <input type="checkbox"/> |
| I run on uneven surfaces  | <input type="checkbox"/> | <input type="checkbox"/> |
| I jog on uneven surfaces  | <input type="checkbox"/> | <input type="checkbox"/> |
| I walk on uneven surfaces   | <input type="checkbox"/> | <input type="checkbox"/> |
| I walk on a flat surface  | <input type="checkbox"/> | <input type="checkbox"/> |
| 17. TYPICALLY when I start to roll over (or 'twist') on my ankle I can stop it          |                          |                          |
| Immediately   | <input type="checkbox"/> | <input type="checkbox"/> |
| Often   | <input type="checkbox"/> | <input type="checkbox"/> |
| Sometimes   | <input type="checkbox"/> | <input type="checkbox"/> |
| Never   | <input type="checkbox"/> | <input type="checkbox"/> |
| I have never rolled over on my ankle  | <input type="checkbox"/> | <input type="checkbox"/> |
| 18. Following a TYPICAL incident of my ankle rolling over, my ankle returns to 'normal' |                          |                          |
| Almost immediately  | <input type="checkbox"/> | <input type="checkbox"/> |
| Less than one day   | <input type="checkbox"/> | <input type="checkbox"/> |
| 1-2 days  | <input type="checkbox"/> | <input type="checkbox"/> |
| More than 2 days  | <input type="checkbox"/> | <input type="checkbox"/> |
| I have never rolled over on my ankle  | <input type="checkbox"/> | <input type="checkbox"/> |

## Cumberland Ankle Instability Tool (CAIT)

Please tick the ONE statement in EACH question that BEST describes your ankles.

|  |   | LEFT                      | RIGHT                    | Score |
|--|---|---------------------------|--------------------------|-------|
|  |   | (Not on participant copy) |                          |       |
| 1. I have pain in my ankle   | Never                                   | <input type="checkbox"/>  | <input type="checkbox"/> | 5     |
|  | During sport                            | <input type="checkbox"/>  | <input type="checkbox"/> | 4     |
|  | Running on uneven surfaces              | <input type="checkbox"/>  | <input type="checkbox"/> | 3     |
|  | Running on level surfaces               | <input type="checkbox"/>  | <input type="checkbox"/> | 2     |
|  | Walking on uneven surfaces              | <input type="checkbox"/>  | <input type="checkbox"/> | 1     |
|  | Walking on level surfaces               | <input type="checkbox"/>  | <input type="checkbox"/> | 0     |
| 2. My ankle feels UNSTABLE   | Never                                   | <input type="checkbox"/>  | <input type="checkbox"/> | 4     |
|  | Sometimes during sport (not every time) | <input type="checkbox"/>  | <input type="checkbox"/> | 3     |
|  | Frequently during sport (every time)    | <input type="checkbox"/>  | <input type="checkbox"/> | 2     |
|  | Sometimes during daily activity         | <input type="checkbox"/>  | <input type="checkbox"/> | 1     |
|  | Frequently during daily activity        | <input type="checkbox"/>  | <input type="checkbox"/> | 0     |
| 3. When I make SHARP turns my ankle feels UNSTABLE                                     | Never                                   | <input type="checkbox"/>  | <input type="checkbox"/> | 3     |
|  | Sometimes when running                  | <input type="checkbox"/>  | <input type="checkbox"/> | 2     |
|  | Often when running                      | <input type="checkbox"/>  | <input type="checkbox"/> | 1     |
|  | When walking                            | <input type="checkbox"/>  | <input type="checkbox"/> | 0     |
| 4. When going down the stairs my ankle feels UNSTABLE                                  | Never                                   | <input type="checkbox"/>  | <input type="checkbox"/> | 3     |
|  | If I go fast                            | <input type="checkbox"/>  | <input type="checkbox"/> | 2     |
|  | Occasionally                            | <input type="checkbox"/>  | <input type="checkbox"/> | 1     |
|  | Always                                  | <input type="checkbox"/>  | <input type="checkbox"/> | 0     |
| 5. My ankle feels UNSTABLE when standing on ONE leg                                    | Never                                   | <input type="checkbox"/>  | <input type="checkbox"/> | 2     |
|  | On the ball of my foot                  | <input type="checkbox"/>  | <input type="checkbox"/> | 1     |
|  | With my foot flat                       | <input type="checkbox"/>  | <input type="checkbox"/> | 0     |
| 6. My ankle feels UNSTABLE when  | Never                                   | <input type="checkbox"/>  | <input type="checkbox"/> | 3     |
|  | I hop from side to side                 | <input type="checkbox"/>  | <input type="checkbox"/> | 2     |
|  | I hop on the spot                       | <input type="checkbox"/>  | <input type="checkbox"/> | 1     |
|  | When I jump                             | <input type="checkbox"/>  | <input type="checkbox"/> | 0     |
| 7. My ankle feels UNSTABLE when  | Never                                   | <input type="checkbox"/>  | <input type="checkbox"/> | 4     |
|  | I run on uneven surfaces                | <input type="checkbox"/>  | <input type="checkbox"/> | 3     |
|  | I jog on uneven surfaces                | <input type="checkbox"/>  | <input type="checkbox"/> | 2     |
|  | I walk on uneven surfaces               | <input type="checkbox"/>  | <input type="checkbox"/> | 1     |
|  | I walk on a flat surface                | <input type="checkbox"/>  | <input type="checkbox"/> | 0     |
| 8. TYPICALLY when I start to roll over (or 'twist') on my ankle I can stop it          | Immediately                             | <input type="checkbox"/>  | <input type="checkbox"/> | 3     |
|  | Often                                   | <input type="checkbox"/>  | <input type="checkbox"/> | 2     |
|  | Sometimes                               | <input type="checkbox"/>  | <input type="checkbox"/> | 1     |
|  | Never                                   | <input type="checkbox"/>  | <input type="checkbox"/> | 0     |
|  | I have never rolled over on my ankle    | <input type="checkbox"/>  | <input type="checkbox"/> | 3     |
| 9. Following a TYPICAL incident of my ankle rolling over, my ankle returns to 'normal' | Almost immediately                      | <input type="checkbox"/>  | <input type="checkbox"/> | 3     |
|  | Less than one day                       | <input type="checkbox"/>  | <input type="checkbox"/> | 2     |
|  | 1-2 days                                | <input type="checkbox"/>  | <input type="checkbox"/> | 1     |
|  | More than 2 days                        | <input type="checkbox"/>  | <input type="checkbox"/> | 0     |
|  | I have never rolled over on my ankle    | <input type="checkbox"/>  | <input type="checkbox"/> | 3.    |

**Tampa Scale-11 (TSK-11)**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

*This is a list of phrases which other patients have used to express how they view their condition. Please circle the number that best describes how you feel about each statement.*

|  | Strongly Disagree | Somewhat Disagree | Somewhat Agree | Strongly Agree |
|--|-------------------|-------------------|----------------|----------------|
| 1. I'm afraid I might injure myself if I exercise.   | 1                 | 2                 | 3              | 4              |
| 2. If I were to try to overcome it, my pain would increase.  | 1                 | 2                 | 3              | 4              |
| 3. My body is telling me I have something dangerously wrong.   | 1                 | 2                 | 3              | 4              |
| 4. People aren't taking my medical condition serious enough.   | 1                 | 2                 | 3              | 4              |
| 5. My accident/problem has put my body at risk for the rest of my life.  | 1                 | 2                 | 3              | 4              |
| 6. Pain always means I have injured my body.   | 1                 | 2                 | 3              | 4              |
| 7. Simply being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my pain from worsening. | 1                 | 2                 | 3              | 4              |
| 8. I wouldn't have this much pain if there wasn't something potentially dangerous going on in my body.                               | 1                 | 2                 | 3              | 4              |
| 9. Pain lets me know when to stop exercising so that I don't injure myself.  | 1                 | 2                 | 3              | 4              |
| 10. I can't do all the things normal people do because it's too easy for me to get injured.  | 1                 | 2                 | 3              | 4              |
| 11. No one should have to exercise when he/she is in pain.   | 1                 | 2                 | 3              | 4              |
|  |                   |                   |                |                |

Source: Woby et al. (2005), Psychometric properties of the TSK-11: A shortened version of the Tampa Scale for Kinesiophobia. Pain, 117, 137-144.



## NASA activity scale (NAS)

Using the NASA Physical Activity Status Scale (PASS), what is your exercise Activity Rating?

Please choose the scale number which best describes your physical activity level for the last month:

**0 - 1 = Sedentary to light exercise**

**2 - 3 = Recreational activity, e.g., golf, bowling, yard work**

**4 - 10 = Heavy aerobic exercise, e.g., running or brisk walking or comparable activity, e.g., basketball, tennis, racquetball, aerobic dance**

- 0. Avoid walking or exertion, e.g., always use elevator, drive whenever possible instead of walking.
- 1. Walk for pleasure, routinely use stairs, or occasionally exercise sufficiently to cause heavy breathing or perspiration.
- 2. 10 to 60 minutes per week.
- 3. Over one hour per week.
- 4. Run about 1 mile per week or walk about 1.3 miles per week or spend about 30 minutes per week in comparable physical activity.
- 5. Run 1 to 5 miles per week or walk 1.3 to 6 miles per week or spend 30 to 60 minutes per week in comparable physical activity.
- 6. Run 6 to 10 miles per week or walk 7 to 13 miles per week or spend in 1 to 3 hours per week in comparable physical activity.
- 7. Run 11 to 15 miles per week or walk 14 to 20 miles per week or spend 4 to 6 hours per week in comparable physical activity.
- 8. Run 16 to 20 miles per week or walk 21 to 26 miles per week or spend 6 to 8 hours per week in comparable physical activity.
- 9. Run 21 to 25 miles per week or walk 27 to 33 miles per week or spend 9 to 11 hours per week in comparable physical activity.
- 10. Run over 25 miles per week or walk over 34 miles per week or spend over 12 hours per week in comparable physical activity.

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