

< Clinical Research >

Prevalence of Chronic Ankle Instability in High School and Division I Athletes

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Abstract: Objective. *The purpose of this study was to determine the prevalence of chronic ankle instability among high school and collegiate athletes.* Design. *Descriptive epidemiological survey.* Methods. *Athletes from four high schools and a division I university were contacted to participate. For collegiate athletes, a questionnaire packet was distributed during preparticipation physicals. For high school athletes, parental consent was obtained and then questionnaires were distributed during preparticipation physicals, parent meetings, or individual team meetings. All athletes completed the Cumberland Ankle Instability Tool for both their left and right ankles. Subjects also provided general demographic data and completed the Ankle Instability Instrument regarding history of lateral ankle sprains and giving way. Athletes were identified as having chronic ankle instability if they scored less than 24 on the Cumberland Ankle Instability Tool.* Results. *Of the 512 athletes who completed and returned surveys, 23.4% were identified as having chronic ankle instability. High school athletes were more likely to have chronic ankle instability than*

their collegiate counterparts ($P < .001$). Chronic ankle instability was more prevalent among women than among men in both high school ($P = .01$) and collegiate settings ($P = .01$). Conclusions. *Findings of this study revealed differences in the distribution of chronic ankle instability that warrant further study.*

Levels of Evidence: *Prognostic, Level IV, case series*

Keywords: chronic ankle instability (CAI); ankle injury objective questionnaires; Cumberland Ankle Instability Tool (CAIT); epidemiology; athletes

Introduction

After one ankle sprain, an athlete increases his or her risk of sustaining a recurrent ankle injury.¹⁻⁴ An acute ankle sprain that was mobilized too quickly after insufficient rehabilitation can potentially lead to residual symptoms,⁵ recurrent instability, and possibly chronic ankle instability (CAI).⁶ CAI is most commonly defined as a history of recurrent sprains and a sensation of

"giving way."⁷ Patients with CAI do not necessarily have ligamentous laxity in the ankle joint,^{8,9} but might have proprioceptive and neuromuscular deficits.^{7,10} Individuals with CAI also show deficits in postural control in the injured ankle when compared with the contralateral uninjured ankle.^{6,7,11-13} Researchers believe there is a strong connection between an individual's history of recurrent ankle sprains and risk of developing CAI.¹⁻⁴

CAI [chronic ankle instability] is most commonly defined as a history of recurrent sprains and a sensation of 'giving way.'

There are multiple studies that identify the frequency and mechanism behind lateral ankle sprains (LASs)¹⁴⁻¹⁷ but there is limited literature on the prevalence of CAI. One difficulty in determining the prevalence of CAI is the lack of a gold standard in identifying the condition. Recently, Delahunt et al¹⁸ conducted a systematic review of the current literature on ankle instability. The results of their

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study confirmed that there is no "gold standard" to identify who has CAI. Most researchers use Freeman's definition as the minimally accepted criteria for CAI: a history of at least one ankle sprain and the sensation of "giving way" on the same ankle.⁷ To help create a more objective measure of CAI, a number of researchers have developed self-reporting questionnaires. Currently, there are 8 different self-assessment tools used by clinicians and researchers to help objectively assess patients with CAI. These include Ankle Instability Instrument (AII),¹⁹ Ankle Joint Functional Assessment Tool (AJFAT),²⁰ Chronic Ankle Instability Scale (CAIS),^{21,22} Cumberland Ankle Instability Tool (CAIT),²³ Foot and Ankle Ability Measure (FAAM),^{24,25} Foot Ankle Instability Questionnaire (FAIQ),²⁶ Foot and Ankle Outcome Source (FAOS),^{21,27} and Identification of Functional Ankle Instability (IdFAI).²⁸

There are several factors to consider when selecting a questionnaire. The questionnaire should be clear and concise, be able to be administered for each limb and provide a clear definition of "giving way" in the instructions.²⁸ The current study used the CAIT to identify the presence and severity of CAI in athletes. This instrument has been proven²³ to discriminate between subjects with and without CAI. The following studies demonstrate the reliability and validity of the CAIT. These studies report excellent test-retest reliability with an interclass correlation coefficient of 0.96.²³ The CAIT was tested for validity against the visual analog scale for subjects' perception of ankle instability. An acceptable correlation was found between these 2 instruments (0.76).²³ In a recent article evaluating self-reported measures of CAI, the CAIT resulted in the highest specificity of 0.86 and the second highest sensitivity of 0.56 when compared to all other questionnaires.²⁹ Another advantage of the CAIT is that it is completed for each limb, which allows us to identify athletes with unilateral or bilateral CAI. One item that is not specifically included as part of the CAIT is a clear history of giving way.

Therefore, we also used the AII to capture specific information regarding history of LASS and history and frequency of giving way.

Because of the subjective and often self-reported nature of identifying those with CAI, research is inconsistent when reporting the prevalence of CAI. Most of the previous articles evaluating residual symptoms following an ankle sprain are longitudinal or retrospective studies that focus on a variety of symptoms, such as pain, disability, or perceived instability.^{16,30-32} These symptoms may or may not be present in people with CAI. Because of these factors, it is difficult to identify an "at risk" population, or agree on an overall prevalence of CAI.

To better understand CAI it is imperative that we determine the number of people who are affected by this condition, and specifically if one gender, sport or level of competition are at a greater risk of developing CAI. Athletic trainers, physicians, and strength coaches can use these data to establish preventative exercises for athletes in whom CAI is prevalent. Therefore, the purpose of this study is to determine the prevalence of CAI in high school and college athletes.

Methods

Subjects

We contacted athletes at 4 local high schools and a division I university to participate in the study. The participants came from 11 teams at one high school, 7 teams at a second high school, 6 teams at the third high school, and 5 teams at the fourth. We also recruited 17 teams from an athletic department at a division I university. Subjects were excluded if they had a history of an ankle fracture, ankle surgery, neurological disorder such as Parkinson's disease, amyotrophic lateral sclerosis, or multiple sclerosis, or failed to completely answer the questionnaires. These subjects were excluded because their preexisting conditions might be confused with some of the symptoms associated with CAI. In subjects with a previous fracture it would be particularly difficult to distinguish

between instability from the fracture or a potential sprain.

Procedures

The collegiate athletes received the questionnaire packet at preparticipation physical examinations. Data were collected from high school athletes in a number of ways. The methods of distribution included group physicals, attending parent meetings prior to the season, and meeting with the teams individually during the season. The high school athletes were given an informed consent document to first be signed by themselves and their guardian. Once the signed consent form was returned, the questionnaire packet was distributed. All procedures related to this study were approved by the university institutional review board for the protection of human subjects.

Instruments

Data for this study were collected using a general demographic questionnaire, the CAIT, and AII. Demographic information included limb dominance, age, grade in school, sex, sport/s, years participated in sports, and race. All subjects completed separate questionnaires for their left and right ankles. A member of the research team was present when all questionnaires were completed. This allowed us to answer any questions the subjects had while completing the questionnaires. The CAIT was used to identify the presence or absence of CAI. It includes questions that address activities that cause pain or instability, how often individuals experience an ankle sprain, and how quickly they recover from those episodes. Participants can receive a maximum score of 30; any score less than 24 identified the athlete as having CAI.³³ The AII was included to capture data related to severity and frequency of ankle instability, in addition to activities that may cause the sensation of giving way.³⁴ The AII was proven to demonstrate reliability when distributed on two separate occasions seven days apart to 101 subjects.¹⁹ Intraclass

correlation coefficients for different items on the questionnaire ranged from 0.70 to 0.98.¹⁹

Statistical Analysis

Questionnaires were scored and subjects were categorized based on the presence or absence of CAI. The subjects were classified as having CAI if they scored less than 24 on CAIT. Athletes who were identified as having CAI were categorized as having either unilateral or bilateral condition; these categories were mutually exclusive. We used SPSS 19.0 for data analysis. Frequencies were calculated to determine the overall prevalence and percentage of unilateral and bilateral CAI, and to determine the prevalence of giving way and LASSs. We also looked at the frequencies of LAS and CAI by sport participation. A nonparametric χ^2 test of independence was used for association between CAI and gender, level of participation, severity of initial ankle sprain, and limb dominance. Alpha of .05 was used for all analyses.

Results

Subject Demographics

We collected a total of 672 questionnaires from high school and collegiate athletes. A total of 160 participants were excluded due to either incomplete questionnaires ($n = 58$) or a history of fractures ($n = 102$). A total of 512 (76%) subjects remained; 316 collegiate athletes (age 19.6 ± 1.2 years) and 196 high school athletes (age 15.9 ± 1.2 years). Table 1 illustrates a complete list of demographic data for all participating subjects. Athletes in a total of 17 sports were included in this study. Athletes who indicated cross-country/track, cross-country, or track and field were combined into one category of "Running." Gymnastics, cheerleading, and diving were grouped together for "Acrobatics." In addition, baseball and softball were combined for analyses. Rowing, golf, tennis, and field hockey were also included, although they had

Table 1.

Frequencies of Demographic Data for Subjects.

| | Participants (N = 512) | |
|-----------------------------|--------------------------|----------------------|
| | High School (n = 196); % | College (n = 316); % |
| Gender | | |
| Male | 57.7 | 59.0 |
| Female | 42.3 | 41.0 |
| Grade distribution | | |
| Freshman | 26.0 | 15.6 |
| Sophomore | 32.7 | 27.6 |
| Junior | 27.0 | 28.6 |
| Senior | 14.3 | 27.6 |
| Graduate | N/A | 0.6 |
| Race | | |
| White | 91.8 | 76.3 |
| African American | 2.6 | 17.7 |
| Hispanic/Latino | 2.6 | 1.6 |
| Asian | 1.5 | 2.2 |
| Prefer not to answer | N/A | 0.9 |
| Mixed race | 1.5 | 1.3 |
| Years participated in sport | | |
| 1-4 | 34.9 | 22.2 |
| 5-8 | 38.1 | 26.2 |
| 9-12 | 21.9 | 29.8 |
| 13-16 | 4.1 | 18.9 |
| 17+ | N/A | 3.0 |

very low participation numbers. Overall, we had data on 118 football athletes, 66 running athletes, 57 basketball athletes, 50 aquatic athletes, 41 soccer athletes, 38 baseball/softball athletes, 36 volleyball athletes, 35 acrobatic athletes, 23 wrestling athletes, 10 rowing athletes, 11 golf athletes, 14 tennis athletes, 11 field hockey athletes, and 2 athletes did not report sport.

Chronic Ankle Instability

Of all athletes surveyed, 23.4% had CAI, half of these participants had CAI bilaterally and the remainder had unilateral CAI. We found that high school athletes were more likely to have CAI than their collegiate counterparts, $\chi^2(1) = 10.5, P < .001$. When analyzed by level of participation, bilateral and unilateral CAI were both more prevalent among high

Table 2.

Percentage of High School and Collegiate Participants With Chronic Ankle Instability (CAI) and Lateral Ankle Sprains as Identified by the Questionnaire.

| | High School Athletes (n = 196); % | Collegiate Athletes (n = 316); % |
|----------------------|--------------------------------------|-------------------------------------|
| Prevalence of CAI | 31.1 | 18.7 |
| Unilateral CAI | 13.3 | 10.8 |
| Bilateral CAI | 17.9 | 7.9 |
| Lateral ankle sprain | 66.8 | 65.2 |

school athletes. Table 2 lists the prevalence of CAI and LAS for high school and collegiate athletes.

Gender

Chronic ankle instability was also more prevalent among women than men in both high school, $\chi^2(1) = 5.0, P = .01$, and collegiate athletes, $\chi^2(1) = 10.1, P = .01$. Overall, women were more likely to have CAI compared to men (32.1% vs 17.4%, respectively).

Lateral Ankle Sprain

A total of 337 (65.8%) athletes indicated a previous ankle sprain on the survey. Specifically, 66.8% of high school athletes and 65.2% of collegiate athletes reported a history of an LAS. Of those athletes with a history of LAS, 30.9% developed CAI. However, when evaluated by level of competition, a higher percentage of high school athletes developed CAI after an LAS compared to collegiate athletes (40.5% vs 24.8%, respectively).

Severity of ankle sprain was measured as mild (grade I) moderate (grade II), or severe (grade III). Severity of ankle injury was also highly associated with the occurrence of CAI, $\chi^2(3) = 38.0, P < .001$. Athletes could also indicate that they have a history of an LAS but did not seek care from a doctor or health care provider. Interpretation of the χ^2 test identified a significant association between developing CAI after an

undiagnosed LAS, $\chi^2(1) = 18.1, P < .001$, moderate ankle sprains, $\chi^2(1) = 21.3, P < .001$, and severe ankle sprains, $\chi^2(1) = 12.5, P < .001$. There was no significant association between CAI and a mild ankle sprain, $\chi^2(1) = 1.8, P = .172$. Only 11.7% of athletes with mild ankle sprains developed CAI compared with 30.8% of athletes with a moderate ankle sprain, 12.5% of athletes with a severe ankle sprain, and 45% of athletes who did not seek medical care.

Limb Dominance

Limb dominance was not associated with the development of unilateral ankle instability on the same limb, $\chi^2(1) = 0.5, P = .50$ in this study population. These results should be interpreted cautiously since only 10% of athletes were left limb dominant.

Sport

While CAI was prevalent among many surveyed sports, no single sport proved to be more associated with CAI than another. Specifically, basketball, field hockey, aquatics, and rowing all had high percentages of athletes with CAI. All surveyed sports identified at least one athlete with CAI except for tennis. Table 3 lists the number and percentage of athletes with CAI and LAS within each selected sport.

We also had some athletes who were multisport athletes, 22.9% of athletes identified a second sport in which they

participate. This percentage was much higher among the high school athletes; nearly 50% of high school athletes indicated that they participated in more than one sport. However, there was no association between the number sports an athlete participated in and prevalence of CAI, $\chi^2(2) = 1.9, P = .38$.

Discussion

The purpose of our study was to determine the prevalence of chronic ankle instability in high school and collegiate athletes. Our aim was to identify at-risk populations to help better educate athletic trainers, physicians, and other health care providers on preventing chronic ankle instability. We found that approximately 23% of the athletes surveyed had CAI. We also identified that high school athletes and female athletes were more likely to have CAI.

Previous research has reported the prevalence of perceived ankle instability between 20% and 47%.^{5,7,30,35-37} In some cases, perceived instability was defined as giving way⁵ or CAI,^{7,35} but other authors did not provide any operational definition for the condition they were measuring.^{30,36} Additionally, these data were captured using internal questionnaires. In this previous research, the questionnaires were created and distributed specifically for the purpose of that study and were not examined for validity or reliability. Depending on the study, the surveys asked questions specifically about recurrent sprains,^{30,35} instability,^{5,30,36} and presence of giving way,^{7,35} not necessarily CAI.^{5,30,36} It is also likely that the population included in these previous studies influenced the wide range in prevalence values. For example, CAI has been reported to occur in 40% of soldiers,⁷ 28% of athletes following a grade I LAS and 24% of athletes following grade II LAS.³⁵ Perceived instability has been reported in 20% of athletes³⁶ and 47% of patients from a hospital or general medical clinic.^{5,30} The most important aspect in reviewing the data in the current study

Table 3.

The Number and Percentage of Subjects With Chronic Ankle Instability (CAI) and Lateral Ankle Sprain (LAS) Within Each Selected Sport.

| Primary Sport | CAI % Within Sport (n) | LAS % Within Sport (n) |
|-------------------|------------------------|------------------------|
| Football | 23.7 (28/118) | 79.7 (94/118) |
| Running | 21.2 (14/66) | 43.9 (29/66) |
| Basketball | 29.8 (17/57) | 77.2 (44/57) |
| Aquatics | 32.0 (16/50) | 56.0 (28/50) |
| Soccer | 12.2 (5/41) | 61.0 (25/41) |
| Baseball/softball | 20.9 (9/38) | 79.1 (34/38) |
| Volleyball | 25.0 (9/36) | 63.9 (23/36) |
| Acrobatics | 25.0 (9/35) | 61.1 (22/35) |
| Wrestling | 26.1 (6/23) | 69.6 (16/23) |
| Tennis | 0.0 (0/14) | 42.9 (6/14) |
| Field hockey | 27.3 (3/11) | 63.6 (7/11) |
| Golf | 18.2 (2/11) | 45.5 (5/11) |
| Rowing/crew | 30.0 (3/10) | 80.0 (8/10) |

as well as this previously published literature is the clear evidence that a significant number of residual symptoms occur following an LAS. Subsequently, practitioners and clinicians should reevaluate if the care following a LAS is sufficient. It appears that a high number of the people with CAI sought no medical care following their LAS. This leads us to believe that one of the main contributing factors to CAI might be insufficient care following the LAS.

Bilateral and Unilateral Chronic Ankle Instability

Following an LAS, central changes may occur that can affect motor control patterns and create impairments in the uninjured ankle.³⁸ If one side is injured the uninjured limb may become compromised as well.³⁹ According to this theory, we would expect higher prevalence of bilateral CAI. Our results demonstrate various patterns among bilateral and unilateral

CAI depending on level of participation. Bilateral CAI was more prevalent among high school athletes, but collegiate athletes in our study had a higher prevalence of unilateral CAI. Among high school athletes with CAI, 57.4% had bilateral CAI and 42.6% had unilateral CAI. Of collegiate athletes with CAI, 42.4% had bilateral CAI and 57.6% had unilateral CAI. When all participants of our study were analyzed together, there were equal occurrences of bilateral and unilateral CAI. The limited previous literature has demonstrated a similar pattern. When developing the AII, the authors¹⁹ identified that of all participants who were classified as CAI, 52% of the subjects had bilateral instability and 48% had unilateral instability. Participants in the study were students from a large university and were not identified as athletes, although many participated in regular physical activity through recreational or competitive sports.¹⁹

Gender

It has been established in the literature that ACL tears are much more prevalent among female than male athletes.⁴⁰⁻⁴³ A similar association between gender and ankle injury has yet to be strongly established in the literature.⁴⁴ When comparing all athletic injuries between males and female participants, researchers have found mixed results; some authors found an increased risk of athletic injuries in females.^{45,46} Others have found no association between gender and athletic injury.^{44,47} Literature specific to ankle sprains have found the same incidence of injury between men and women.^{32,48,49} One study⁴² found that females had a greater risk of sustaining grade I ankle sprains, but there was no difference between sexes with grades II and III LAS. Our study found that females were more likely to develop CAI than males. Several explanations have been proposed for the increased risk of ankle injuries among female athletes. These include increased calcaneal eversion, tibial varum,⁴⁹ increased ankle laxity, and decreased postural control in females which may contribute to these injuries.⁴¹

Level of Participation

While both collegiate athletes and high school athletes had the same percentage of LASs, our results found a higher percentage of CAI at the high school level. Both groups have numerous factors that might make them more or less susceptible to injury. First, it is possible that the more common presence of athletic trainers at the collegiate level helps to prevent the development of CAI through ankle taping and bracing and comprehensive rehabilitation programs. Another option, is that elite athletes are more highly skilled than high school or recreational athletes, which may lead to a reduction of ankle injuries.³⁶ Or high school athletes may not be as well equipped or aware of the importance of stretching and warming up to prevent injuries.^{32,36} Collegiate athletes will typically have a strength and conditioning coach lead the team in a

warm-up and stretching protocol before every practice. High school teams may have a captain from the team lead stretching. One study found that athletes who did not stretch thoroughly before activity were 2.6 times more likely to injure their ankle than athletes who stretched.³² Conversely, collegiate and/or elite athletes may practice more frequently and train at higher levels of intensity and stress, placing more demand on their ankles than imposed on high school athletes.

A previous study³⁶ evaluated the occurrence of LAS at three different levels of participation; they included elite athletes, competitive athletes who participate on school or club teams, and recreational athletes. The authors found that the more elite athletes had a lower incidence of LAS compared with competitive or recreational athletes.³⁶ Additional research is required to fully understand the affect level of participation has on prevalence of injury, specifically CAI.

Lateral Ankle Sprain

The ankle is one of the most commonly injured joints among athletes, and sprains in particular are the most common of all ankle injuries.^{16,50} Although not the focus of this investigation, information regarding prevalence of LAS among high school and collegiate athletes was collected. We identified over 65% of athletes have experienced a LAS, but previous articles have identified the overall prevalence of ankle sprain in athletes as high as 83.4%.^{16,31}

The results of our study found a significant association between severity of LAS and development of CAI. Of the athletes who saw a physician, those with grade II LASs had the highest frequency of CAI (30.8%). A high percentage of CAI following a grade II LAS has been previously noted in the literature.^{55,51} Gerber et al⁵⁵ identified CAI in 24% of patients following a grade II LAS and in 28% of patients after a grade I LAS. In a separate study that included a nine year follow-up, 48% of patients reported fear

of instability after a grade II LAS compared with 36% and 35% of patients after grades I and III, respectively.⁵¹ However, it is important to note that all subjects identified an increased fear of instability regardless of initial severity.⁵¹ Therefore, all LASs should be treated and rehabilitated completely to prevent an increase in symptoms.⁵¹

Athletes who did not seek medical care following an ankle sprain had much higher frequencies of CAI compared with athletes diagnosed by a physician. Nearly half of our athletes did not see a physician or health care provider after their LAS. Previous literature has reiterated this finding.³² Similar to our athletes, 73% of participants in their study reported a history of an ankle sprain. Among athletes with recurrent sprains, only half were diagnosed by a physician and even fewer completed a rehabilitation program.³² This could be a major contributing factor in the prevalence of CAI. Professional health care providers can administer the best course of care following an acute injury to decrease the risk of reinjury.² Medical professionals can also provide a protective brace or ankle tape to prevent recurrent injury.¹⁻³ Failure to report an acute ankle sprain to a physician or health care provider can delay proper treatment or rehabilitation can potentially develop into CAI.⁶

Sports

We expected to find a higher percentage of CAI among the lower extremity dominant sports but we found that not one particular sport could be significantly connected to CAI. Specifically, football (n = 28 out of 118; 23.7%), basketball (n = 17 out of 57; 29.8%), running (n = 14 out of 66; 21.2%), and aquatics (n = 16 out of 50; 32.0%) had a high number of athletes with CAI. It is curious that swimming, an upper extremity dominant sport, has a high percentage of CAI. We suspect that since swimmers are primarily non-weight bearing during sport, they may experience decreased proprioceptive awareness while on land. Additionally,

flutter kick that is emphasized in freestyle and backstroke may develop hyperflexible joints in the ankles further increasing the risk of CAI. Another possibility is that athletes with CAI chose to become swimmers because they were hindered by their instability in other sports.

Other sports, such as volleyball, acrobatics, wrestling, field hockey, and rowing also had a high percentage of CAI athletes in this study. For these sports, 25% to 30% of the athletes were identified as having CAI, but overall the number of athletes participating in these sports was relatively low, ranging from only 10-36 athletes each. Subsequently, it is difficult to determine if athletes in these sports are at a greater risk of having CAI.

Limitations

The sample is somewhat heterogeneous because of the inclusion of high school and collegiate athletes. However, the study population is more homogeneous than if participants had been recruited from a more general population. While we recognize that the sample size is limited, these data provide a first look into the distribution of this problem in a highly relevant population. Given the statistical significance identified in the study, even with the limited sample size, we feel that these data can certainly be useful in determining the need for further studies.

Future Research

Delahunt et al¹⁸ conducted a systematic review of all the literature published to try and find a commonality between the research and develop a single definition for ankle instability. Several studies in this review used questionnaires or surveys for feedback on instability, but majority relied heavily on patient reported symptoms. At the conclusion of the article the authors provided operational definitions for functional instability of the ankle joint, giving way, and ankle joint instability.

Based on our findings, future studies should utilize the definitions established by Delahunt et al¹⁸ and use questionnaires that were specifically created to identify individuals with CAI. Additionally, specific information related to the history of LASs and presence and frequency of giving way should be used to determine the prevalence and severity of CAI.

Conclusion

The purpose of this study was to identify the prevalence of CAI among athletes using a questionnaire specifically designed to identify the pathology. From the data obtained for this study we can determine that LASs commonly occur in athletes and approximately 30% of these athletes will develop CAI following that injury. The presence of CAI will create long-term concern for both the athlete and health care provider. Athletic trainers and physicians should pay special attention to female and high school athletes as they are at a higher risk for developing CAI after an initial ankle injury. Targeting these populations for injury prevention or rehabilitation interventions could have a great impact on reducing the incidences of LAS and CAI. **FAA**

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