Journal of Athletic Training 2019;54(6):662–670
doi: 10.4085/1062-6050-531-17

www.natajournals.org

The Prevalence of Pain in People With Chronic Ankle Instability: A Systematic Review

Saeed Al Adal, MSc; Fereshteh Pourkazemi, PhD; Martin Mackey, PhD; Claire E. Hiller, PhD

Faculty of Health Sciences, University of Sydney, Australia

Objective: To identify the prevalence of pain in people with chronic ankle instability (CAI) and how pain is related to the impairments of CAI.

Data Sources: We searched the databases of AMED, CINAHL, EMBASE, MEDLINE, PubMed, Scopus, SPORTDiscus, and Web of Science from inception to March 2017.

Study Selection: Eligible studies were peer-reviewed research in which investigators reported the presence of ankle pain or assessed the effects of pain on impairments in participants with CAI. Age and language were not restricted. Studies that included only surgical interventions were excluded.

Data Extraction: Studies identified by the search strategy were screened according to the eligibility criteria, and 2 independent reviewers extracted the data. Outcome measurements were (1) pain ratings using measures such as a visual analog scale and (2) other residual impairments, such as feelings of weakness, giving way, or deficits in functional performance.

Data Synthesis: Of the 5907 records identified through the database search, 14 studies were included in this review. All authors assessed ankle pain by self-report questionnaires or physical examination, or both. Pain was self-reported by 23% to 79% of participants and present on physical examination in 25% to 75% of participants, depending on the test applied. Among these studies, the highest reported pain level was 4.9 on the 11-point visual analog scale. Studies were heterogeneous for pain measures, participant groups, interventions, and follow-up periods. The relationship between pain and the structural and functional impairments associated with CAI was not investigated in the included studies.

Conclusions: Pain was present in a large proportion of people who had CAI, but pain levels were low. Information about the effects of pain was not reported, so researchers should examine the association between pain and function, balance, or other activities in people with CAI.

Key Words: ankle injuries, joint instability, sprains and strains, discomfort, chronic pain

Key Points

- In most studies, ankle pain was present in 50% to 79% of participants with chronic ankle instability.
- Self-reported pain was usually intermittent and mild and occurred during vigorous physical activity.
- No researchers investigated the effects of ankle pain on associated impairments or functional activities among participants with chronic ankle instability.

Ankle injuries are experienced by 20% of the population who sustain joint injuries.[1,2] Around 23 000 ankle injuries per day have been reported in the United States, and 5000 per day have been reported in the United Kingdom.[3] Lateral ankle sprain (LAS) is one of the most common specific injuries affecting the lower limb among the general[4] and sport populations,[5,6] and Fong et al[6] reported that it was the major regional body injury in 33 of 43 sports reviewed. Up to 74% of individuals with LASs have residual impairments for 7 years after the injury.[7,8] Ongoing impairments after an acute LAS include recurrent ankle sprain, perceived instability, giving way, and mechanical instability. These impairments have been termed *chronic ankle instability* (CAI).[1,9] Given such persistent impairments, people experience changes in their ability to perform activities of daily living,[10] with up to 72% being unable to maintain their previous physical activity levels[8,10] and 6% being unable to participate in any occupational activity.[11,12]

Pain is another common concern after acute LAS. The International Association of the Study of Pain defined *pain* as an unpleasant sensory and emotional experience associated with actual or potential tissue damage.[13] When pain is recurrent or continues for a length of time or outlasts the normal tissue-healing time, it is deemed *chronic pain*. Many clinicians have defined chronic pain according to the number of months after the initial injury: usually 3 to 6 months.[14] Chronic pain is considered not only a warning to prevent physical injury or disease but also a cause of changes in neural mechanisms.[15] Researchers[16,17] have shown that people with long-lasting pain conditions, such as low back pain and osteoarthritis, have structural alterations in the brain areas (cortical reorganization) that have altered the modulation of pain. Therefore, when pain becomes chronic, most investigators do not consider pain a symptom but the disease itself.[14] The negative effects of chronic pain extend beyond the main cause of pain.

Authors have documented common areas of chronic pain, such as the low back (28%), neck (15%), and knee (18%),[14,18] and a high prevalence of pain and functional limitations (75%) among participants with a history of anterior cruciate ligament (ACL) injury.[19] In contrast, few

researchers have assessed pain in participants with CAI, and none have used ankle pain as an inclusion criterion for participants with CAI.[1] Therefore, the primary purpose of our systematic review was to investigate the prevalence of pain among participants with CAI. Whereas several authors reported that ankle instability was associated with other impairments,[12,20,21] including proprioceptive deficits, altered neuromuscular control, muscle-strength deficits, and abnormal postural control,[22–24] the association between pain and these impairments is still unknown. Therefore, the secondary purpose of our study was to determine whether pain was associated with other residual impairments.

METHODS

Data Sources

All studies were identified through a search of electronic databases, including AMED, CINAHL, EMBASE, MEDLINE, PubMed, Scopus, SPORTDiscus, and Web of Science from inception until March 2017. No language restriction was imposed. Key terms used in the search strategy were based on broad terms and related synonyms targeting 3 categories: ankle-sprain injury, joint instability, and ankle pain (Supplemental Table 1, available online at http://dx.doi.org/10.4085/1062-6050-531-17.S1).

Selection Criteria

This study protocol was developed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[25] and was registered on PROSPERO (registration number CRD42015024285). Studies of CAI were included if they met the following inclusion criteria: (1) the studies were peer reviewed (observational or randomized controlled trials); (2) participants were of any age; (3) participants had a history of LASs and ongoing impairments, such as pain, giving way, recurrent sprains, or feelings of instability; (4) patients were followed for more than 3 months after the initial LAS; and (5) patients had no associated fractures. Studies were excluded if they were incomplete (eg, abstracts), case studies, or reviews or included only surgical interventions. Studies of participants with medial ankle injuries or syndesmosis injury alone were also excluded.

Data Extraction

Articles identified by the search strategy were screened independently by 2 authors (S.A. and C.H. or F.P.) for the inclusion criteria using the title and abstract and then the full-text papers. Any discrepancies regarding inclusion were resolved by consensus. Data were extracted independently by 2 investigators (S.A. and C.H., M.M., or F.P.). A third author adjudicated when the first author (S.A.) and any of the other 3 investigators disagreed. Data extraction involved the following items: author and year, study type, sample size, participant demographics, target population, inclusion criteria, outcome measures, and study results. Outcomes were (1) pain ratings using measures such as a visual analog scale or physical examination and (2) other residual impairments, such as feelings of weakness, giving way, reduced balance, or deficits in functional performance.

The methodologic quality of the included studies was assessed independently by 2 reviewers (S.A. and C.H., M.M., or F.P.) using a modified version of the Downs and Black assessment tool.[26] The modified tool consisted of 25 items that covered the following quality characteristics: reporting, external validity, internal validity (ie, bias, confounding), and power. One of 4 answers could be selected when assessing each item: *yes* (score = 1), *no* (score = 0), *unable to determine* (score = 0), and *not applicable* (score = NA). Each study had a different total score, as NA answers were not included; therefore, the percentage of the total score was reported.

For the data synthesis, we calculated the total number of participants with CAI and then calculated the proportion of participants who still reported pain. Included studies were divided according to their pain-assessment method at the ankle (self-report or manual test) and ordered according to their quality-assessment results (Table). Data were presented as the percentage of pain in participants with CAI over different follow-up periods from the initial time of injury.

RESULTS

The initial search identified 5907 papers. After duplicates were removed, the titles and abstracts of 4140 papers were screened for potential eligibility. After the initial screening, we identified 154 articles as potentially eligible and sought full texts. After full-text screening, 14 full-text papers were included in the review (Figure 1).

Included studies comprised 9 prospective cohort studies,[2,8,28–30,32–35] 2 cross-sectional studies,[10,36] 1 self-administered study,[27] 1 observational study,[31] and 1 retrospective study.[11] Follow-up periods varied from 3 to 24 months after an LAS in some studies,[2,28,29,32–35] whereas they were more than 6 years in other studies[8,10,11] (Supplemental Table 2). The age of participants varied among studies, with most participants classified as *young*. The participants' mean age ranged from 20 to 35 years in 6 studies,[2,28,30,33,35,36] from 16 to 65 years in 7 studies,[8,10,11,27,31,32,34] and from 8 to 18 years in 1 study.[29] Participants were recruited from different settings, including hospitals or primary care practices or both,[8,11,27–29,31,34,35] military populations,[2,32,33] and metropolitan areas.[10,30,36]

Authors of 11 studies used a self-reported measure of pain outcome,[8,10,11,27–32,34,35] whereas researchers in 2 studies used either a pain-provoking physical examination procedure, such as a varus stress test and palpation,[2] or ankle end range of motion.[36] Gerber et al[33] used both a self-report measure and physical examination for pain assessment over 6 months. In investigations using a self-report measure, pain was measured by visual analog scale,[28,31,33,34] survey questions,[10,27] telephone call,[8,29,32,35] or pain questionnaires.[8,11]

In 9 studies using self-reported pain measures, the percentage of participants with CAI who had pain ranged from 18% to 79%, with an average of 58% (Figure 2).[8,10,11,27,29,31–33,35] None of these authors used pain as the primary outcome. No researchers investigated the relationship between the presence of pain in participants with CAI and other residual impairments of CAI.

Most included studies were rated as *high quality* using the modified Downs and Black quality-assessment tool. The percentages of scores ranged from 54% to 100%, with a mean of 80.3%. Eleven of 14 studies scored from 71% to 100%, with a mean of 84.8% in total assessment

Table. Overview of Included Studies by Pain Assessment Continued on Next Page

Author	Sample Size, N	Pain Measure	Definition of CAI	Participants With Pain/CAI, n/N (%)	Pain Severity	Other Pain Information
Self-reported pain assessment						
Braun[27] (1999)	467	Self-administered survey	Pain, ankle swelling, ankle instability, and ankle weakness	347/528 (66)	Mild, moderate, or severe: 70.5% Moderate or severe only: 57.1%	NA
Konradsen et al[8] (2002)	648	Questionnaire or telephone call	Presence of pain, swelling, or recurrent sprains (≥3 severe sprains/y)	159/212 (75)	NA	Anterolateral corner: 21% Lateral malleolus: 50% Calcaneocuboid/talonavicular joint: 10% Fifth metatarsal: 10% Peroneal tendon: 12% Medial joint area: 4%
Hiller et al[10] (2012)	751	Categorical questions	Pain (lasting >3 mo), chronic ankle instability, and recurrent sprain	43/62 (69.3)	Always: 5 (8.1%) Often: 6 (9.7%) Occasionally: 32 (51.6%) Severe: 4 (6.5%) Moderate: 18 (29.0%) Mild: 21 (33.9%)	NA
Buchhorn et al[28] (2011)	81	Visual analog scale (range, 0–10)	At least 1 episode of giving way and subjective instability of the ankle	NA	Mean = 4.9/10	Intra-articular pain
Timm et al[29] (2005)	171	Telephone call	Persistent pain, swelling, or weakness; pain during or after exercise; or recurrent ankle injury	38/55 (69.1)	NA	Body mass index ≥85th percentile: 77.4% Body mass index <85th percentile: 58.3%
Cruz-Diaz et al[30] (2015)	70	Visual analog scale (range, 0–10)	Self-reported unilateral ankle sprain, subjective feeling of instability ≥6 mo before the study, CAIT score <27	NA	Mean = 2.54/10	NA
van Middelkoop et al[31] (2012)	102	Visual analog scale (range, 0–10)	Pain, resprain, and ankle instability	3 mo after initial injury: 15/66 (23) 12 mo after initial injury: 22/56 (39)	NA	Pain during rest: 10% Pain during walking: 8% Pain during running: 22%
Eiff et al[32] (1994)	77	Reporting pain by telephone	Pain, swelling, or limitation of activity	3 mo after initial injury: No. of participants not given (50) 6 mo after initial injury: No. of participants not given (22) 12 mo after initial injury: No pain	NA	NA
Gerber et al[33] (1998)	76	Visual analog scale (range, 0–10)	At least 1 recurrent sprain or reported episode of the ankle giving way since the original injury	15/34 (44)	NA	Grade 1 ankle sprain: 28% Grade 2 or 3 ankle sprain: 21%

Table. Continued From Previous Page

Author	Sample Size, N	Pain Measure	Definition of CAI	Participants With Pain/CAI, n/N (%)	Pain Severity	Other Pain Information
Verhagen et al[11] (1995)	577	Questionnaire	Pain, fear of giving way, actual instability, swelling that interferes with daily living or sport activities	9 mo after initial injury: 230/817 (28.2) 6.5 y after initial injury: 104/577 (18)	NA	Pain reported in the anterior aspect of the medial malleolar region 9 mo Grade 1: 137/491 (28%) Grade 2: 71/263 (27%) Grade 3: 22/63 (35%) 6.5 y Grade 1: 67/398 (17%) Grade 2: 28/128 (22%) Grade 3: 9/51 (18%)
van Rijn et al[34] (2011)	102	Visual analog scale (range, 0–10)	Pain and giving way during high ankle-load activities	NA	3 mo Walking (rough surface): 1.1 ± 1.7 Running (flat surface): 1.7 ± 2.4 Running (rough surface): 2.0 ± 2.7 12 mo Walking (rough surface): 1.0 ± 2.1 Running (flat surface): 1.3 ± 2.6 Running (rough surface): 1.6 ± 2.8	NA
Linde et al[35] (1986)	137	Telephone interviews and questionnaire	At least 1 of the following: pain, function-limiting sprain, new sprain, feeling of giving way	19/24 (79)	NA	Pain with walking: n = 1 (4%) Pain during sports: n = 6 (25%) Pain after sports: n = 6 (25%) Pain on certain motions: n = 6 (25%)
Pain on physical examination						
Kwon et al[2] (2014)	40	Varus stress	Intermittent or continuous pain since first injury and continuous since most recent injury	Neutral position: 10/40 (25) Plantar-flexed position: 30/40 (75)	5.2/10 5/10	NA
Gerber et al[33] (1998)	76	Pain with palpation	At least 1 recurrent sprain or reported episode of the ankle giving way since the original injury	15/34 (44)	NA	Grade 1 ankle sprain: 28% Grade 2 or 3 ankle sprain: 21%

Table. Continued From Previous Page

Author	Sample Size, N	Pain Measure	Definition of CAI	Participants With Pain/CAI, n/N (%)	Pain Severity	Other Pain Information
Wright et al[36] (2013)	69	Pain with palpation and end ROM (*yes/no*)	At least 1 sprain and recurrent instability and at least 2 episodes of giving way/mo	Palpation: 11/23 (48) End ROM: 12/23 (52)	NA	Location and end ROM Anterior talofibular ligament: 17.4% Calcaneofibular ligament: 13.0% Posterior talofibular ligament: 17.4% Plantar-flexion end ROM: 13% Inversion end ROM: 26% Eversion end ROM: 9%

Abbreviations: CAI, chronic ankle instability; CAIT, Cumberland Ankle Instability Test; NA, not available; ROM, range of motion.

points,[2,8,10,27–33,36] whereas 3 studies scored from 54% to 69%, with a mean of 64% (Supplemental Table 3).[11,34,35] In most studies, some criteria were not applicable, and they were not included in the total score. Low-quality characteristics identified in some studies included a lack of blinding of the study participants to the intervention, no randomized intervention, not reporting the number of participants lost to follow-up, and insufficient study power.[26]

DISCUSSION

In this systematic review, all included studies revealed pain as one of the residual impairments that was present for a prolonged time in participants with CAI. Generally, 55.4% of participants with CAI reported pain. Studies in which researchers used self-report measures of pain demonstrated a higher percentage of participants reporting pain (average = 58%) than those in which researchers used a physical provocation examination to investigate the presence of pain (average = 49%). No investigators examined the association between pain and other residual impairments among participants with CAI.

Pain was assessed by self-report and physical provocation examination. Among participants with CAI who had pain assessed by self-report at a single time, the 4 (out of 7) highest-quality studies showed that more than 66% of participants with CAI reported pain for a prolonged time (6 months to 7 years) after the initial injury.[8,10,27,29] This prevalence of pain was consistent across time. In contrast, Gerber et al[33] demonstrated that approximately 44% of participants with CAI had pain at 6 months after the initial injury. They focused on a young military population that may have been reluctant to admit having pain 6 months after the injury.[33] They stated that one of the reasons that soldiers returned to activity before completing their rehabilitation programs was concern about losing their positions after a prolonged absence. Much less pain prevalence was also shown in the 2 prospective studies.[11,32] In 1 study, the percentage of pain in participants with CAI declined from 50% at 3 months to 0% at 12 months.[28] The decline was probably due to the high dropout rate: from 21 to 2 participants. Verhagen et al[11] found a low prevalence of pain (28%) at 9 months after injury, which decreased by 6.5 years (18%; $\chi^2 = 4.896$, $P = .03$). The lower pain level may have been due to the standardized rehabilitation program participants followed in the first 6 weeks after the injury, which included a walking cast, partial immobilization with tape, and physiotherapy.

Studies that assessed pain by physical provocation examination[2,33,36] included palpation,[33] varus stress test,[2] and palpation or end–range-of-motion tests.[36] In the varus stress test, approximately 75% of participants with CAI experienced lateral ankle pain while in a plantar-flexed position, whereas 25% had pain in the neutral position.[2] Kwon et al[2] suggested that pain during the varus stress test may be correlated with a complete tear of the anterior talofibular ligament. However, they stated that ascertaining ligament status using magnetic resonance imaging could be biased. Whereas the test in the plantar-flexed position yielded a high percentage of participants reporting pain, the stresses applied in this test position

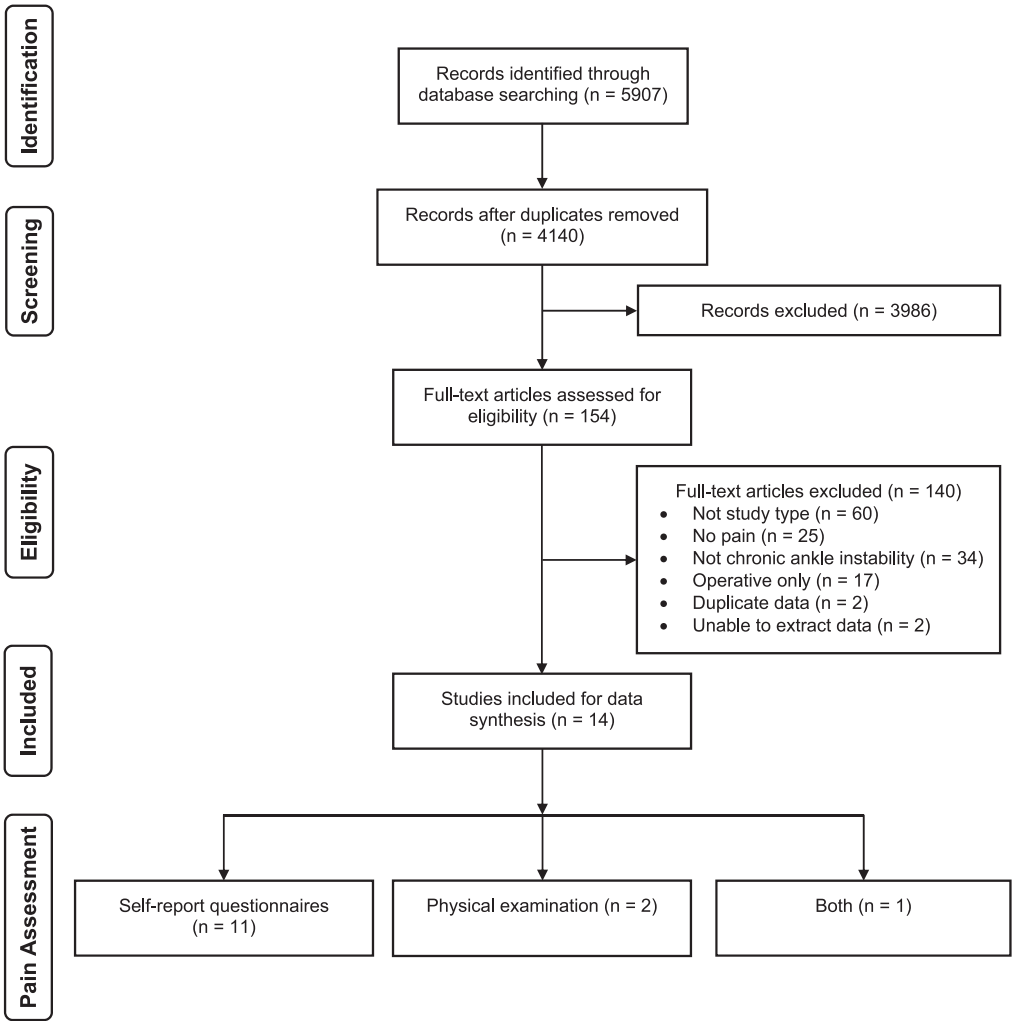

Figure 1. Flow chart of the review process.

would not be expected to occur during activities of daily living.

The effect of age on self-reported pain was unclear, as most studies included heterogeneous groups of participants with different age ranges.[8,10,11,27,28,30–32,34,35] The prevalence of pain in these studies ranged from 28.2%[11] to 79%[35] (Table). Only Gerber et al[33] focused on younger adults (age range, 17–24 years) and provided the percentage of CAI participants with pain (44%). Timm et al[29] evaluated children and adolescents (age range, 8–18 years) and found a pain prevalence in the upper range (69.1%) of the other studies.[8,10,27,28,32,35] No studies looked at older adults only. Whereas researchers[37] have suggested that older adults are more likely to be susceptible to the negative effects of pain, we could not find any work addressing the effect of age on reported pain among participants with CAI. Given that the effects of physiological, psychological, and social factors vary in younger and older adults and all these factors affect pain,[38–40] investigators should determine the effect of age on pain prevalence and severity among participants with CAI.

The frequency and severity of and activities that caused pain in participants with CAI were provided in some studies.[8,10,31,34,35] Comparing chronic ankle disorders, Hiller et al[10] showed that 51.6% of participants with CAI reported occasional ankle pain; the severity of pain was mild in 33.9% and moderate in 29.0%. Whereas this was the only study in which researchers reported the frequency and severity of pain, definitions of these terms were not supplied. Activities that caused pain were walking (8%),[31] running (22%),[31] and movements after sports (25%).[24] Overall, most subjective nonstandardized questionnaires described CAI pain as being intermittent, mild, and only incited by vigorous activity.

We found no studies in which researchers investigated the effects of pain on the residual impairments of CAI. Given that pain is known to affect functional activity,[11,41] we could hypothesize that participants with CAI who have pain may show differences in various functional performance measures compared with participants who do not have pain. Hass et al[42] demonstrated that chronic peripheral joint injury (ie, CAI) negatively altered the supraspinal aspects of motor control. These changes strongly suggested that centrally mediated changes to motor control may be important contributors to the underlying neurophysiological mechanism of CAI.

Chronic pain was associated with sensitization of the neural network that promotes pain and changed circuits in the nociceptive pathways.[17] In an animal model, these changes were evident in the representation areas of pain in

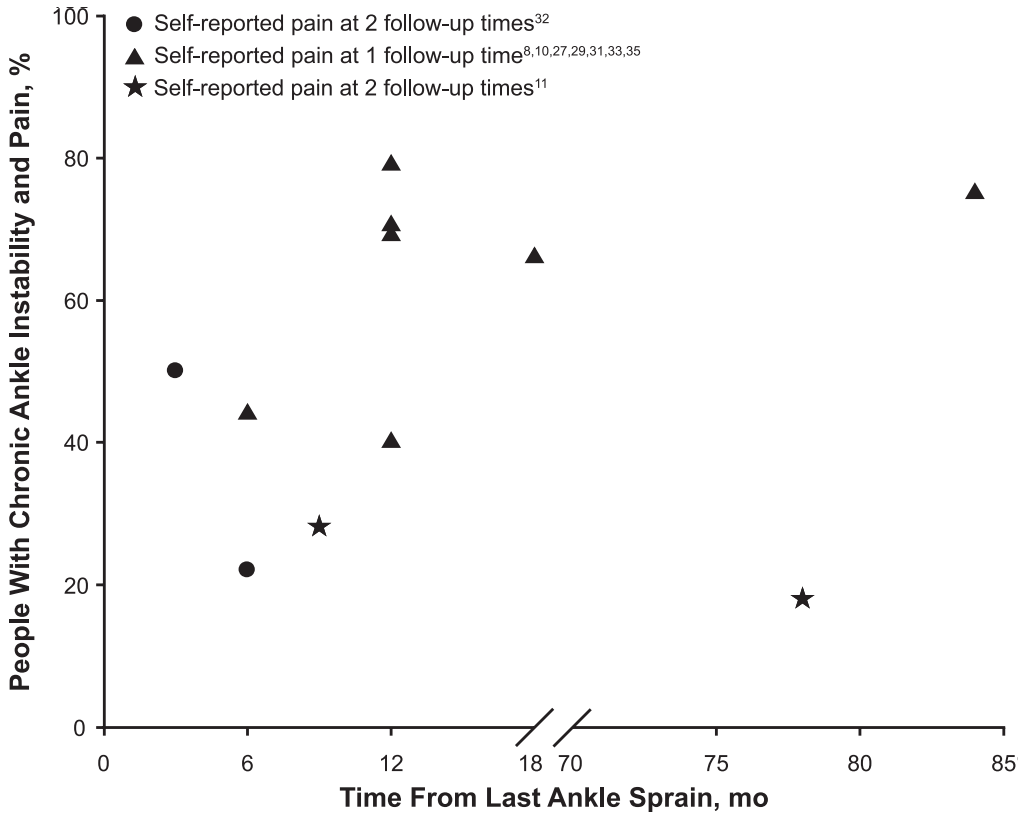

Figure 2. Percentage of participants with chronic ankle instability who had pain over time. The graph demonstrates the percentage of pain in participants with chronic ankle instability in 10 different studies over time. The time was calculated from the beginning of ankle sprain in months. Studies were divided according to the method of pain assessment.

the thalamus and cortex.[43] Patients with chronic pain were hyperactive to noxious stimuli, and hyperactivity increased with pain chronicity.[44] Researchers noted that the pain threshold and pain tolerance were lower among patients with chronic back pain[44,45] or knee osteoarthritis.[46] These results demonstrate that the changes in the central nervous system play a major role in chronic pain. Given that participants with CAI may have central alternations, investigating these changes associated with pain in participants with CAI could be an important topic for researchers to address.

LIMITATIONS

A limitation of this systematic review was that the authors of the included studies used mostly subjective methods of measuring and describing pain rather than validated questionnaires. Many investigators assessed populations whose characteristics were slightly broader than the International Ankle Consortium selection criteria for individuals with CAI.[1] Our inclusion criterion of 3 months since the initial injury was less than the 6 months recommended by the International Ankle Consortium; however, the results did not change when a 6-month criterion was applied.

FUTURE STUDIES

Researchers should be aware of the criteria associated with CAI to create clear descriptions of CAI and avoid heterogeneous groups. Future investigators should incorporate both subjective and objective pain measures, such as pain-threshold tests. The role of pain in the model and definition of CAI and the influence on long-term outcomes should also be explored in future studies.

CLINICAL IMPLICATIONS

We highlighted the importance of investigating the effects of pain in participants with CAI. Validated measures of pain severity, such as the Numeric Rating Scale, and provoking activities should continue to be monitored by clinicians, as pain appears to persist for a greater time than previously appreciated.

CONCLUSIONS

Ankle pain in participants with CAI is a common impairment that can potentially affect functional activity. The proportion of participants with CAI who still reported pain varied widely but was 50% to 79% in most studies. However, a large knowledge gap exists in describing ankle pain among participants with CAI and associated impairments, functional measures, and activities, which needs to be addressed.

REFERENCES

1. Gribble PA, Delahunt E, Bleakley C, et al. Selection criteria for patients with chronic ankle instability in controlled research: a position statement of the International Ankle Consortium. *J Orthop Sports Phys Ther*. 2013;43(8):585–591.

2. Kwon DG, Sung KH, Chung CY, et al. Associations between MRI findings and symptoms in patients with chronic ankle sprain. *J Foot Ankle Surg*. 2014;53(4):411–414.
3. Kannus P, Renstrom P. Treatment for acute tears of the lateral ligaments of the ankle: operation, cast, or early controlled mobilization. *J Bone Joint Surg Am*. 1991;73(2):305–312.
4. Waterman BR, Owens BD, Davey S, Zacchilli MA, Belmont PJ. The epidemiology of ankle sprains in the United States. *J Bone Joint Surg Am*. 2010;92(13):2279–2284.
5. Hiller CE, Kilbreath SL, Refshauge KM. Chronic ankle instability: evolution of the model. *J Athl Train*. 2011;46(2):133–141.
6. Fong DT, Hong Y, Chan LK, Yung PS, Chan KM. A systematic review on ankle injury and ankle sprain in sports. *Sports Med*. 2012;37(1):73–94.
7. Anandacoomarasamy A, Barnsley L. Long term outcomes of inversion ankle injuries. *Br J Sports Med*. 2005;39(3):e14.
8. Konradsen L, Bech L, Ehrenbjerg M, Nickelsen T. Seven years follow-up after ankle inversion trauma. *Scand J Med Sci Sports*. 2002;12(3):129–135.
9. Delahunt E, Coughlan GF, Caulfield B, Nightingale EJ, Lin CW, Hiller CE. Inclusion criteria when investigating insufficiencies in chronic ankle instability. *Med Sci Sports Exerc*. 2010;42(11):2106–2121.
10. Hiller CE, Nightingale EJ, Raymond J, et al. Prevalence and impact of chronic musculoskeletal ankle disorders in the community. *Arch Phys Med Rehabil*. 2012;93(10):1801–1807.
11. Verhagen RA, de Keizer G, van Dijk CN. Long-term follow-up of inversion trauma of the ankle. *Arch Orthop Trauma Surg*. 1995;114(2):92–96.
12. van Rijn RM, van Os AG, Bernsen RM, Luijsterburg PA, Koes BW, Bierma-Zeinstra SM. What is the clinical course of acute ankle sprains? A systematic literature review. *Am J Med*. 2008;121(4):324.e6–331.e6.
13. Merskey H, Bogduk N, eds. *Classification of Chronic Pain: Descriptions of Chronic Pain Syndromes and Definitions of Pain Terms*. 2nd ed. Seattle, WA: IASP Press; 1994:210.
14. Sluka KA. Definitions, concepts, and models of pain. In: Sluka KA, ed. *Mechanisms and Management of Pain for the Physical Therapist*. Seattle, WA: IASP Press; 2009:3–18.
15. Melzack R. Pain and the neuromatrix in the brain. *J Dent Educ*. 2001;65(12):1378–1382.
16. McMahon SB, Koltzenburg M, Tracey I, Turk D. *Wall and Melzack's Textbook of Pain*. 6th ed. Philadelphia, PA: Elsevier/Saunders; 2013:262–263.
17. Moseley GL, Flor H. Targeting cortical representations in the treatment of chronic pain: a review. *Neurorehabil Neural Repair*. 2012;26(6):646–652.
18. Papageorgiou AC, Croft PR, Ferry S, Jayson MI, Silman AJ. Estimating the prevalence of low back pain in the general population: evidence from the South Manchester Back Pain Survey. *Spine (Phila PA 1976)*. 1995;20(17):1889–1894.
19. Lohmander LS, Östenberg A, Englund M, Roos H. High prevalence of knee osteoarthritis, pain, and functional limitations in female soccer players twelve years after anterior cruciate ligament injury. *Arthritis Rheum*. 2004;50(10):3145–3152.
20. dos Santos MJ, Gorges AL, Rios JL. Individuals with chronic ankle instability exhibit decreased postural sway while kicking in a single-leg stance. *Gait Posture*. 2014;40(1):231–236.
21. Pourkazemi F, Hiller CE, Raymond J, Nightingale EJ, Refshauge KM. Predictors of chronic ankle instability after an index lateral ankle sprain: a systematic review. *J Sci Med Sport*. 2014;17(6):568–573.
22. Hertel J. Functional anatomy, pathomechanics, and pathophysiology of lateral ankle instability. *J Athl Train*. 2002;37(4):364–375.
23. Freeman MA, Dean MR, Hanham IW. The etiology and prevention of functional instability of the foot. *J Bone Joint Surg Br*. 1965;47(4):678–685.
24. Tropp H, Odenrick P. Postural control in single-limb stance. *J Orthop Res*. 1988;6(6):833–839.
25. Moher D, Liberati A, Tetzlaff J, Altman DG; The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the PRISMA statement. *PLoS Med*. 2009;6(7):e1000097.
26. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health*. 1998;52(6):377–384.
27. Braun BL. Effects of ankle sprain in a general clinic population 6 to 18 months after medical evaluation. *Arch Fam Med*. 1999;8(2):143–148.
28. Buchhorn T, Sabeti-Aschraf M, Dlaska CE, Wenzel F, Graf A, Ziai P. Combined medial and lateral anatomic ligament reconstruction for chronic rotational instability of the ankle. *Foot Ankle Int*. 2011;32(12):1122–1126.
29. Timm NL, Grupp-Phelan J, Ho ML. Chronic ankle morbidity in obese children following an acute ankle injury. *Arch Pediatr Adolesc Med*. 2005;159(1):33–36.
30. Cruz-Diaz D, Lomas-Vega R, Osuna-Perez MC, Contreras FH, Martinez-Amat A. Effects of 6 weeks of balance training on chronic ankle instability in athletes: a randomized controlled trial. *Int J Sports Med*. 2015;36(9):754–760.
31. van Middelkoop M, van Rijn RM, Verhaar JA, Koes BW, Bierma-Zeinstra SM. Re-sprains during the first 3 months after initial ankle sprain are related to incomplete recovery: an observational study. *J Physiother*. 2012;58(3):181–188.
32. Eiff MP, Smith AT, Smith GE. Early mobilization versus immobilization in the treatment of lateral ankle sprains. *Am J Sports Med*. 1994;22(1):83–88.
33. Gerber JP, Williams GN, Scoville CR, Arciero RA, Taylor DC. Persistent disability associated with ankle sprains: a prospective examination of an athletic population. *Foot Ankle Int*. 1998;19(10):653–660.
34. van Rijn RM, Willemsen SP, Verhagen AP, Koes BW, Bierma-Zeinstra SM. Explanatory variables for adult patients' self-reported recovery after acute lateral ankle sprain. *Phys Ther*. 2011;91(1):77–84.
35. Linde F, Hvass I, Jurgensen U, Madsen F. Early mobilizing treatment in lateral ankle sprains: course and risk factors for chronic painful or function-limiting ankle. *Scand J Rehabil Med*. 1986;18(1):17–21.
36. Wright CJ, Arnold BL, Ross SE, Ketchum J, Ericksen J, Pidcoe P. Clinical examination results in individuals with functional ankle instability and ankle-sprain copers. *J Athl Train*. 2013;48(5):581–589.
37. Gibson SJ, Farrell M. A review of age differences in the neurophysiology of nociception and the perceptual experience of pain. *Clin J Pain*. 2004;20(4):227–239.
38. Adams N, Field L. Pain management 1: psychological and social aspects of pain. *Br J Nurs*. 2001;10(14):903–911.
39. Christensen JO, Knardahl S. Work and neck pain: a prospective study of psychological, social, and mechanical risk factors. *Pain*. 2010;151(1):162–173.
40. Myhre K, Roe C, Marchand GH, et al. Fear-avoidance beliefs associated with perceived psychological and social factors at work among patients with neck and back pain: a cross-sectional multicentre study. *BMC Musculoskelet Disord*. 2013;14:329.
41. Genthon N, Bouvat E, Banihachemi JJ, Bergeau J, Abdellaoui A, Rougier PR. Lateral ankle sprain alters postural control in bipedal stance: part 1. Restoration over the 30 days following the injury. *Scand J Med Sci Sports*. 2010;20(2):247–254.
42. Hass CJ, Bishop MD, Doidge D, Wikstrom EA. Chronic ankle instability alters central organization of movement. *Am J Sports Med*. 2010;38(4):829–834.

43. Benoist JM, Gautron M, Guilbaud G. Experimental model of trigeminal pain in the rat by constriction of one infraorbital nerve: changes in neuronal activities in the somatosensory cortices corresponding to the infraorbital nerve. *Exp Brain Res*. 1999;126(3):383–398.
44. Kleinböhl D, Hölzl R, Möltner A, Rommel C, Weber C, Osswald PM. Psychophysical measures of sensitization to tonic heat discriminate chronic pain patients. *Pain*. 1999;81(1–2):35–43.
45. Flor H. Cortical reorganisation and chronic pain: implications for rehabilitation. *J Rehabil Med*. 2003;35(suppl 41):66–72.
46. Arendt-Nielsen L, Nie H, Laursen MB, et al. Sensitization in patients with painful knee osteoarthritis. *Pain*. 2010;149(3):573–581.

SUPPLEMENTAL MATERIAL

Supplemental Tables. Key terms used in search strategy; included studies with more detailed information; results of modified Downs and Black's Quality Assessment Tool

Found at DOI: http://dx.doi.org/10.4085/1062-6050-531-17.S1

Address correspondence to Claire E. Hiller, PhD, Faculty of Health Sciences, University of Sydney, PO Box 170 Lidcombe, 1825 NSW, Sydney, Australia. Address e-mail to claire.hiller@sydney.edu.au.