Treatment and prevention of acute and recurrent ankle sprain: an overview of systematic reviews with meta-analysis

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ABSTRACT

Background Ankle sprains are highly prevalent with high risk of recurrence. Consequently, there are a significant number of research reports examining strategies for treating and preventing acute and recurrent sprains (otherwise known as chronic ankle instability (CAI)), with a coinciding proliferation of review articles summarising these reports.

Objective To provide a systematic overview of the systematic reviews evaluating treatment strategies for acute ankle sprain and CAI.

Design Overview of intervention systematic reviews.

Participants Individuals with acute ankle sprain/CAI.

Main outcome measurements The primary outcomes were injury/reinjury incidence and function.

Results 46 papers were included in this systematic review. The reviews had a mean score of 6.5/11 on the AMSTAR quality assessment tool. There was strong evidence for bracing and moderate evidence for neuromuscular training in preventing recurrence of an ankle sprain. For the combined outcomes of pain, swelling and function after an acute sprain, there was strong evidence for non-steroidal anti-inflammatory drugs and early mobilisation, with moderate evidence supporting exercise and manual therapy techniques. There was conflicting evidence regarding the efficacy of surgery and acupuncture for the treatment of acute ankle sprains. There was insufficient evidence to support the use of ultrasound in the treatment of acute ankle sprains.

Conclusions For the treatment of acute ankle sprain, there is strong evidence for non-steroidal anti-inflammatory drugs and early mobilisation, with moderate evidence supporting exercise and manual therapy techniques, for pain, swelling and function. Exercise therapy and bracing are supported in the prevention of CAI.

INTRODUCTION

The incidence of ankle sprain is high, posing a significant risk for participants of a wide range of activity types and sports.[1] Ankle sprain is associated with significant socioeconomic cost in addition to the acute debilitating symptoms (which include pain, swelling and impaired function); each year, over two million ankle sprains are treated in emergency departments in the US and UK.[2–5] The long-term prognosis of acute ankle sprain is poor, with a high proportion of patients (up to 70%) reporting persistent residual symptoms and injury recurrence.[6 7] 'Chronic ankle instability' (CAI) is the encompassing term used to describe the chronic symptoms that may develop following an acute ankle sprain, with injury recurrence at the epicentre of the chronic paradigm.[8]

There is an abundance of literature evaluating treatment strategies for acute ankle sprains and/or CAI. In accordance with this, a large number of systematic reviews have emerged to combine these studies' findings to synthesise and extract the best evidence for treatment guidelines. However, there are now such a large number of systematic reviews that identification, appraisal and consideration of each individual paper is not feasible for practitioners. This issue is further compounded by the probability that these reviews vary in quality and scope (with several reviews for one prevention/treatment type) and their inclusion of papers with a high degree of overlap in the injury target (acute ankle sprain/CAI). Thus, there is a need to collate this evidence in a non-biased, systematic manner to ascertain evidence-based recommendations for the treatment of acute ankle sprain and CAI.

The aim of this paper was to provide a systematic overview of the systematic reviews evaluating treatment strategies for acute ankle sprain and CAI. A secondary aim was to identify the current gaps in the literature for researchers, and identify any conflicting evidence between reviews.

METHODOLOGY

Protocol

The study protocol was developed using the framework described by Smith *et al*,[9] which relates to the methodology of conducting a systematic review of systematic reviews of healthcare interventions. The protocol for the review was not pre-registered prior to its completion.

In January 2016, we undertook a computerised literature search of the following databases from inception: PubMed, PEDro, Scopus, Web of science, EBSCO and the Cochrane library.[10] The database search was further supplemented with a manual search of the reference lists in each review. These processes retrieved a set of systematic reviews closely related to the treatment of ankle sprain injuries and CAI.

The empirical search strategy was developed in accordance with the recommendations outlined by Montori *et al*.[11] The search strategy was constructed for MEDLINE and completed in a stepwise manner using the Boolean operators (table 1).

The search strategy was adapted for each database on the basis of previously published recommendations.[12] No restrictions (including language) were applied in any of the databases when the search was completed. One investigator reviewed

Table 1 Search strategy

Steps	Text string
(1)	ankle[Text Word]
(2)	sprain OR strain OR rupture OR instability OR unstable OR repeated OR recurrent OR multiple OR functional OR functionally OR chronic OR chronically
(3)	intervent*[Title/Abstract] OR rehab*[Title/Abstract] OR prevent*[Title/Abstract] OR therap*[Title/Abstract]
(4)	(#1 AND #2 AND #3)
(5)	meta-analysis[Publication Type] OR meta-analysis[Title/Abstract] OR meta-analysis[MeSH Terms] OR review[Publication Type] OR search*[Title/Abstract]
(6)	#4 AND #5

all the titles produced by the database searches, and retrieved suitable abstracts. After screening by abstract, full text articles were obtained for review (figure 2).

Inclusion/exclusion criteria

Our inclusion criteria were as follows: (1) the study must be a systematic review, which was defined as a research study that collects and evaluates multiple studies, and that limits inclusion bias of authors by using a clearly defined search strategy; (2) it must evaluate the efficacy of an intervention for the treatment and/or prevention of acute ankle sprain and/or CAI; (3) the efficacy of the intervention must be measured by means of an experimentally quantifiable outcome (detailed later). Patients with CAI were defined by having a history of at least one ankle sprain, a history of the previously injured ankle joint 'giving way' and/or recurrent sprain and/or 'feelings of instability'.[8] No restrictions were applied with regard to the intervention type or sample population of the studies included in the review papers.

Data extraction

A data extraction form was devised by all the authors. Data extraction was performed by one author. A random sample of studies were selected and doublechecked by a second author, to ensure quality. Data extraction included information related to both the review itself (including study details (author, year of publication and title), the injury type(s), outcome(s), intervention type(s) and main findings), and the individual studies included in the reviews (including study details (author, year of publication and title), design (randomised controlled trial (RCT)/non-RCT), sample population (% males vs females), experimental group N, control group N, injury type(s), intervention type(s), comparison type (s), protocol, outcome(s), findings (number of injuries in the control/experimental groups), conclusions). For studies in which an exercise therapy intervention was administered, the total 'dose' of the intervention (in minutes) was calculated and extracted.

Reviews were divided as to whether they concerned the treatment of acute ankle sprain or CAI (injury type). Owing to the potential overlap of treatment goals, any review that evaluated the efficacy of a prevention strategy for a new or recurrent ankle sprain with sufficient follow-ups (≥12 months) was also grouped into the 'CAI treatment' division, as recurrent ankle sprain is considered to be at the centre of the CAI paradigm.[8 13] No restrictions were placed on the severity or type of ankle sprain sustained (lateral/medial/syndesmotic).

Intervention types were divided into surgical and non-surgical. Non-surgical interventions were further subclassified into physiotherapeutic (including exercise and manual therapies), external support (including taping, bracing and orthotics), electrophysical (including cryotherapy and any type of electrotherapies), pharmacological (including medications) and complementary (acupuncture; aromatherapy and herbal medicines) agents. These interventions were chosen following a thorough review of the literature and on the basis of the classification system used by Bleakley *et al*.[14]

The outcomes of interest were delineated into primary and secondary types. The primary outcomes were (re-) injury incidence/prevalence and/or self-reported function/disability based on a validated questionnaire for ankle joint function.[13] The secondary outcomes included pain, strength, range of motion (ROM), proprioception and muscle activity in the region of ankle joint, in addition to performance measures (which included biomechanical analyses of static/dynamic postural control, gait or jumping/landing tasks). A schematic depicting the aforementioned classification system is depicted in figure 1.

Risk of bias assessment

The quality of the systematic reviews was independently assessed by two authors (CD and SH) using the AMSTAR tool.[15] Any disagreement between authors was resolved by group consensus. Where reviews provided an overall quality assessment of the included studies (items number 7/8 of the AMSTAR tool), those tools were extracted as potentially valuable research resources.

Analysis

The main conclusions from each systematic review concerning injury and intervention type were extracted. The reviews were categorised as 'high' or 'low' quality based on an arbitrary score of 7/11 on the AMSTAR quality rating. This 'high- quality' threshold was subsequently used to conduct a best evidence synthesis of the reviews. The outcomes, intervention type, main results and conclusions relating to our predefined primary and secondary outcomes (defined in data extraction) from the high-quality reviews (ie, rating ≥7) were compiled in tabular format, and stratified according to intervention type. This best evidence synthesis was conducted in order to provide a reference point for the interventions with the strongest evidence supporting or opposing their use.

Additionally, the individual papers included in each review were identified to determine; if they reported on any of the primary or secondary outcomes. The reference for each individual paper was extracted in such situations. In situations where there were contradictory conclusions from reviews then the individual quality rating of each review was presented (to contextualise a given conclusion to the overall quality of the review that made it); if the conclusions between different reviews were in agreement, the quality range (lowest and highest) of the reviews in question was presented.

Exploratory meta-analyses of the individual studies were performed for the primary outcome of (re-) injury incidence where possible. Only RCTs were included in pooling. Data (experimental group N and injuries after follow-up, control group N and injuries after follow-up; total dose of exercise (where appropriate)) were entered into the Cochrane Collaboration Review Manager (V.4.2) software program. Study effect estimates were calculated using ORs with 95% CIs. Studies were weighted by sample size. Data were assessed for heterogeneity based on the Q test in conjunction with the I^2 statistic. The significance for χ^2 was set at $p<0.1$. I^2 values >50% were considered to represent substantial heterogeneity.[16] In cases where substantial

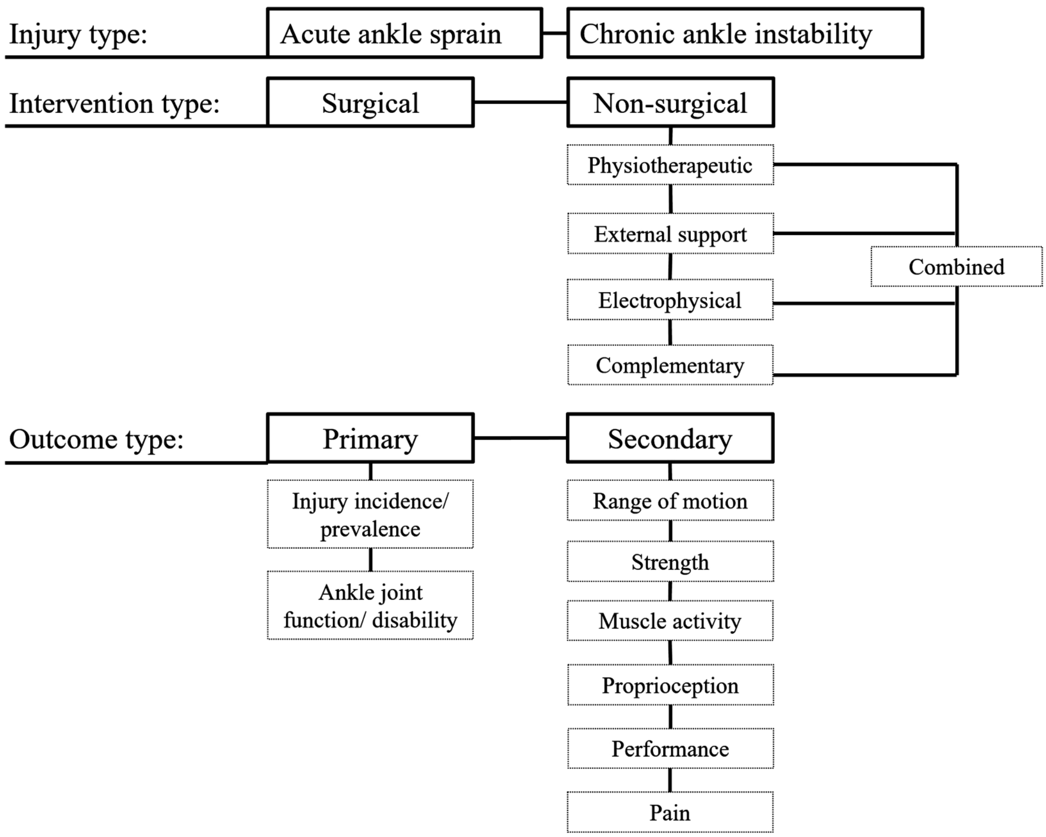

Figure 1 Schematic depicting the injury, intervention and outcome types by which the studies were stratified.

heterogeneity was present, a random-effects model was used. Accordingly, OR values were used to enable several forest plots.

RESULTS

Search results

The initial search strategy produced 2506 articles. A PRISMA diagram of the search strategy is available in figure 2. A total of 46 systematic reviews met the inclusion criteria.[14 17–61] The quality of the included reviews is displayed in table 2.

Forty of the reviews performed some kind of quality assessment of their included studies (see online supplementary table S2).

Following the removal of duplicated papers, these reviews collectively included 309 individual reports. Additional information extracted from these studies segregated by injury and intervention is available in the online supplementary information for this article; due to the large volume of extracted information, only information relating to the primary outcomes (injury (re-) incidence/function) has been presented in the main text; all information related to the individual studies included in the reviews/the secondary outcomes is available in the supplemental documents. Please refer to the online supplementary table S1 for the results of the individual studies with respect to the primary and secondary outcomes.

There was a significant amount of overlap between the reviews regarding the injury type of interest, with 15 reviews being classified as investigating treatment strategies for both acute ankle sprain and CAI.[14 17 19 24 28 32 34 37 41 43 45 50 52 53 60] Twenty reviews investigated treatment strategies for acute ankle sprain specifically.[18 21–23 26 27 29–31 39 40 44 46–49 54 55 58 61] Nine reviews investigated treatment strategies for CAI specifically.[20 33 35 36 42 51 56 57 59] Two reviews investigated treatment strategies for syndesmotic ankle sprain; however, these only included case studies and did not report on either of our primary or secondary outcomes.[25 38] Eight of the reviews evaluated surgical interventions for the treatment of acute ankle sprain[20 25 29 31 38–40 51] with 45 evaluating some kind of non-surgical intervention.[14 17–61] The results and conclusions from the reviews ranking as 'high' quality have been synthesised in a best evidence synthesis table (table 3), stratified by the intervention type.

Acute ankle sprain

Surgical interventions

Six reviews[20 29 31 39 40 51] (quality range=5–10) compared surgical to non-surgical interventions for the treatment of acute ankle sprain. These reviews contained 82 individual (non-duplicate) papers. Of these 82, 33 (32 RCTs, 1 non-RCTs; N=4080; 65% male, 35% female) evaluated a surgical intervention specifically.[62–94]

None of these reviews reported on the primary outcome of recurrence. Function was determined by the time taken to return to activity/work.[20 29 31 39 40 51] Of the six reviews, one (quality=6/11) advocated conservative management (including physiotherapeutic and external support interventions) over surgery,[39] and two (quality=7/11;[40] quality=5/11[31]) identified that surgery had better outcomes when compared with conservative management in the treatment of acute ankle sprain.[31 40] One review (quality=9) found that there was insufficient evidence to determine the relative effectiveness of either surgical or conservative management in the treatment of an acute ankle sprain.[29]

Despite its projected benefits, several of the reviews identified the propensity for a surgical intervention to have a higher risk

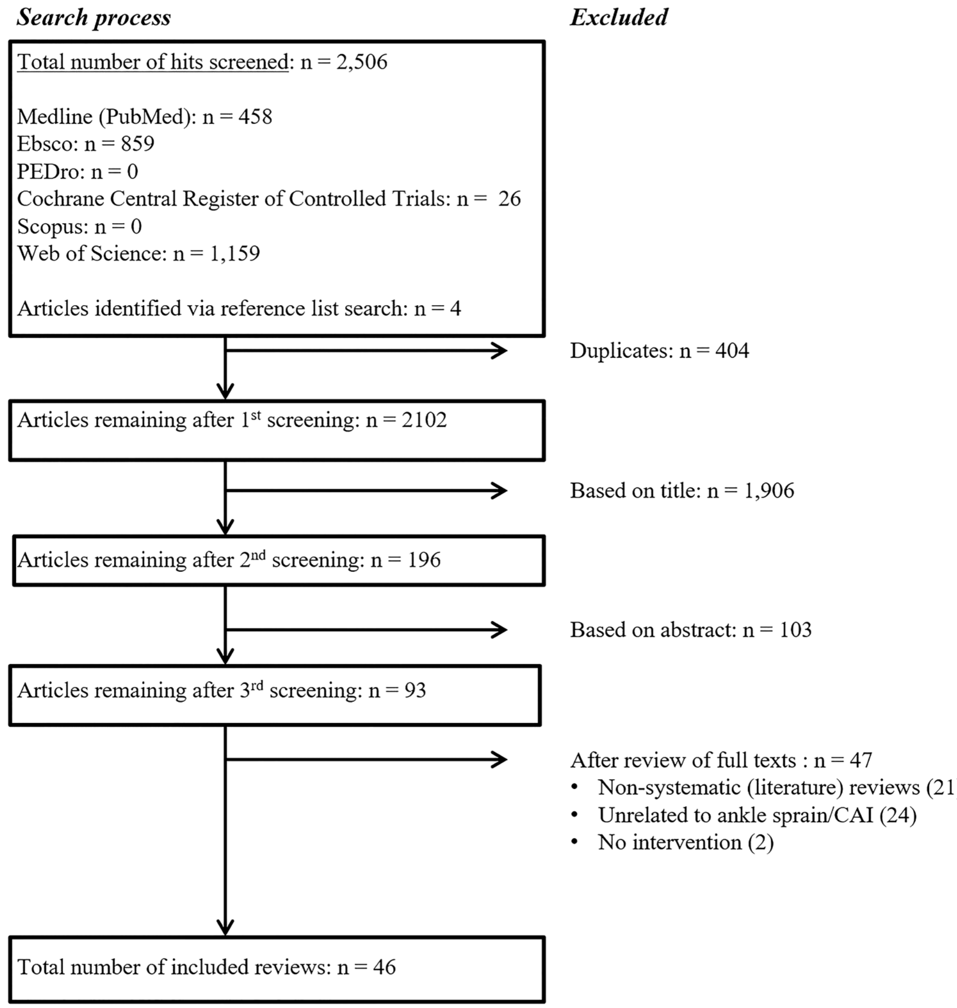

Figure 2 PRISMA flow diagram depicting the search protocol with stepwise article inclusion/exclusion. CAI, chronic ankle instability.

of complication (which included issues such as wound healing, infection, dystrophy, iatrogenic nerve damage leading to sensory deficit and paraesthesia) compared with a conservative intervention.[20 29 31 39 40] A surgical intervention was also associated with greater financial cost.[29 40]

Non-surgical interventions

Physiotherapeutic

Eighteen systematic reviews evaluated a physiotherapeutic intervention for the treatment of acute ankle sprain[14 17 19 23 29 31 32 39 41 44 45 50 52 53 58 60 61 95] (quality range=2–10), which themselves included 118 individual reports were included on removal of papers duplicated between each review. The two main kinds of physiotherapeutic intervention evaluated were exercise therapy and manual therapy.

Exercise therapy

Of the 18 separate systematic reviews, 15[14 17 23 29 31 39 41 44 45 50 52 53 58 60 61] (quality range=2–10) evaluated the effectiveness of exercise therapy for the treatment of acute ankle sprain. Included in these reviews were 41 individual papers (33 RCTs, 8 non-RCTs; N=4680; 68% male, 32% female) where exercise therapy was the primary intervention for the treatment of acute ankle sprain.[82 96–135]

The reviews were unanimous in their consensus that exercise therapy improves self-reported function following acute ankle sprain.[3 14 17 23 41 44 52 53 60 61] Three of the reviews reported on the primary outcome of recurrence in a sample of individuals with acute ankle sprain.[14 39 60] All three confirmed the effectiveness of exercise therapy for the prevention of recurrence following an acute ankle sprain.[4 14 39 60]

Manual therapy

Of the 18 separate systematic reviews that evaluated a physiotherapeutic intervention, 5[14 19 32 45 50] (quality range 5–10) evaluated the effectiveness of manual therapy for the treatment of acute ankle sprain. Included in these reviews were 12[136–147] individual papers (all RCTs, N=687) in which some form of manual therapy technique was used in the treatment of acute ankle sprain.[5]

It is unclear whether manual therapy was beneficial for the primary outcomes of self-reported function or injury recurrence.[6 7 14 19 32 45 50]

Electrophysical agents

Seven systematic reviews evaluated an electrophysical intervention of some kind for the treatment of acute ankle sprain[14 18 45 49 52 53 95] (quality=6.7).[2] Fifty papers (on removal of duplicates) were included in these reviews. Of these 50 papers, 21 (all RCTs, N=1459; 59% male, 41% female) evaluated the effectiveness of an electrophysical agent in the treatment of acute ankle sprain.[8 120 124 148–166]

Applications of ice and compression or the use of elevation do not seem to be effective for improving the primary outcomes

Table 2 Quality of the included reviews as rated on the AMSTAR scale

Author	Year	AMSTAR criteria 1	2	3	4	5	6	7	8	9	10	11	Total
Baltaci	2003	0	0	0	1	0	1	0	0	0	0	0	2
Bleakley	2004	1	0	1	0	0	1	1	1	1	0	0	6
Bleakley	2008	1	0	1	0	0	1	1	1	0	0	0	5
Brantingham	2009	1	1	1	1	1	1	1	1	0	1	1	10
de Vries	2006	1	1	1	0	1	1	1	1	1	1	1	10
Dizon and Reyes	2010	1	1	1	1	0	1	1	1	1	0	1	9
Evans	2012	1	0	1	1	0	1	0	0		0	0	4
Feger	2015	0	0	1	0	1	1	1	1	1	0	0	6
Handoll	2001	1	0	1	1	1	1	1	1	1	1	1	10
Jones	2007	0	0	1	1	0	1	0	0	0	0	0	3
Kemler	2011	0	0	1	0	1	1	1	1	1	0	1	7
Kerkhoffs	2001	1	1	1	1	1	1	1	1	1	0	1	10
Kerkhoffs	2003	1	1	1	1	0	1	1	0	1	0	1	8
Kerkhoffs	2007	1	1	1	0	1	1	1	1	1	0	1	9
Kim	2014	1	1	1	1	1	1	1	1	1	0	1	10
Lihua	2012	1	1	0	0	0	1	1	0	0	1	0	5
Loudon	2014	1	0	1	0	0	1	1	1		1	0	6
Loudon	2008	1	0	0	0	0	1	1	1		0	1	5
McGuine	2003	1	0	1	0	0	1	0	0		0	0	3
Mckeon	2008	1	0	1	0	0	1	1	1	0	0	0	5
O'Driscoll	2011	1	0	1	0	0	1	1	1	1	0	1	7
Park	2013	1	1	1	1	0	1	1	1	1	0	1	9
Parlamas	2013	1	1	1	0	0	1	1	0	0	0	0	5
Petersen	2013	1	0	1	0	0	1	1	1		0	1	6
Pijnenburg	2000	1	0	1	0	1	1	1	1	1	0	0	7
Postle	2012	1	1	1	1	1	1	1	0	1	0	0	8
Refshauge	2003	1	0	0	0	0	0	0	0		0	0	1
Schiftan	2015	1	1	1	0	0	1	1	1	1	0	1	8
Seah	2011	0	0	0	0	0	1	1	1		0	0	3
Terada	2013	1	0	1	1	0	1	1	1	0	0	0	6
Thacker	1999	1	0	1	1	0	0	1	1	1	0	0	6
Thacker	2003	1	0	1	1	0	0	1	1	0	0	0	5
van den Bekerom	2012	1	1	1	1	1	1	1	1	1	1	1	11
van den Bekerom	2011	1	0	1	0	0	1	1	1	1	0	0	6
van der Wees	2006	1	1	1	1	1	1	1	1	1	1	0	10
van Ochten	2014	1	0	1	0	0	1	1	1	1	0	0	6
van Os	2005	1	1	1	0	0	1	1	0	1	0	0	6
van Rijn	2010	1	0	1	0	0	1	1	1	1	0	1	7
Verhagen	2000	1	0	1	0	0	1	1	0		0	0	4
Verhagen	2010	1	0	1	0	0	1	1	1		0	0	5
Webster	2010	1	0	1	0	0	1	1	1	0	0	0	5
Wikstrom	2009	1	0	1	0	1	0	1	1	1	1	1	8
Woitzik	2015	1	0	1	0	0	1	1	1	1	0	1	7
Wortmann	2013	1	0	0	0	0	1	0	0		0	0	2
Zech	2009	1	1	1	0	1	1	1	1	1	0	1	9
Zöch	2003	0	0	1	0	1	1	1	1		0	0	5

Items legend: (1) Was an 'a priori' design provided? (2) Was there duplicate study selection and data extraction? (3) Was a comprehensive literature search performed? (4) Was the status of publication (ie, grey literature) used as an inclusion criterion? (5) Was a list of studies (included and excluded) provided? (6) Were the characteristics of the included studies provided? (7) Was the scientific quality of the included studies assessed and documented? (8) Was the scientific quality of the included studies used appropriately in formulating conclusions? (9) Were the methods used to combine the findings of studies appropriate? (10) Was the likelihood of publication bias assessed? (11) Were potential conflicts of interest included?

of self-reported function or recurrence following acute ankle joint sprain compared with no treatment.[18 95] Three reviews concluded that treatment success was achieved on the basis of an exercise therapy intervention that was often combined with a rest/ice/compression/elevation (RICE) protocol.[52 53 95]

None of the reviews determined any beneficial effect of ultrasound therapy in the treatment of acute ankle sprain.[14 49] However, there are very few trials evaluating the effectiveness of ultrasound therapy for acute ankle sprains,[49] and fewer still have considered the range of intervention parameters available.[14 49] Similarly, the evidence for the efficacy of laser, electrical stimulation and hyperbaric oxygen therapies is limited due to a lack of related research.[14 45]

External support

Six systematic reviews evaluated an external support of some kind for the treatment of acute ankle sprain[26 28 39 44 53 61] (quality range 3–10). These reviews included 46 individual papers. Twenty-four of these (23 RCTs, 1 non-RCT; N=2141, 66% male, 34% female) evaluated some kind of external support (which included taping, bracing and orthoses[9]) in the treatment of acute ankle sprain.[103 105 116 126 135 167–185]

The reviews were unanimous in their consensus that braces and taping are effective in the treatment of acute ankle sprains for the primary outcomes of self-reported function and recurrence.[10 11 26 28 39 44 53 61]

Complementary

Three systematic reviews evaluated some kind of complementary medicine for the treatment of acute ankle sprain[14 30 37] (quality range 5–10). These three reviews included 60 individual papers. There were two papers duplicated between these reviews, leaving 58 individual reports. Of these 58, 35 (all RCTs; N=2358, 67% male, 33% female) evaluated some kind of complementary medicine in the treatment of acute ankle sprain.[186–220] Acupuncture was the primary focus of the reviews however.[14 30 37]

Two of the reviews (quality=5/11;[14] 10/11[30]) reported that there were insufficient data to determine the relative effectiveness of complementary medicine in the treatment of acute ankle sprain for self-reported function or injury recurrence.[12]

The final review (quality=9/11) concluded that acupuncture was likely to have a therapeutic effect in improving acute symptoms, but acknowledged that the results were likely to be overestimated due to the low quality of the included studies.[37]

On this basis, the evidence for the efficacy of complementary therapies in the treatment of acute ankle sprain for the primary outcomes of injury recurrence/self-reported function is inconclusive.

Pharmacological

Three systematic reviews evaluated some kind of pharmacological intervention for the treatment of acute ankle sprain[14 30 44] (quality range 3–10). These reviews included 47 papers (all RCTs; N=6395, 62% male, 38% female). There were no duplicated papers between these reviews. Thirteen papers (N=2423, 47% male, 53% female) evaluated any pharmacological agent (which typically included non-steroidal anti-inflammatory drugs) in the treatment of acute ankle sprain as the primary intervention.[13 136 186 187 196 199 220–226]

Owing to the short follow-up periods in the individual studies, no conclusions could be made for the primary outcomes of self-reported function or injury recurrence.

Table 3 Results of the best evidence synthesis from the reviews deemed as 'high' (≥7 on the AMSTAR tool) quality. Only outcomes, results and conclusions relating to our predefined primary and secondary outcomes are displayed

Study	AMSTAR	Outcome (s)	Intervention	Results	Review conclusion	Summary
Exercise therapy						
de Vries *et al*[20]	10	Functional outcome, subjective stability, recurrent injury, pain, swelling	Any type of treatment for chronic lateral ankle instability was considered	10 included studies; data from 3 out of 4 studies showed a better outcome for neuromuscular training compared with no training	Neuromuscular training alone appears effective in the short term. There is insufficient evidence to support any one surgical intervention over another surgical intervention for CAI but it is likely that there are limitations to the use of dynamic tenodesis.	+
O'Driscoll and Delahunt[36]	7	Reinjury, postural stability, strength, self-reported function	Exercise therapy (neuromuscular)	There is limited to moderate evidence to support improvements in dynamic postural stability, and patient perceived functional stability through neuromuscular training in participants with CAI. There is limited evidence of effectiveness for neuromuscular training for improving static postural stability, active and passive joint position sense, isometric strength, and a reduction in injury recurrence rates.	Strong evidence of effectiveness was lacking for all outcome measures. All but one of the studies included in the review were deemed to have a high risk of bias, and most studies were lacking sufficient power. Therefore, in future we recommend conducting higher quality RCTs using appropriate outcomes to assess for the effectiveness of neuromuscular training in overcoming sensorimotor deficits in participants with CAI.	?
Postle *et al*[41]	8	Reinjury, self-reported function	Exercise therapy (proprioceptive exercise)	The results indicated that there is no statistically significant difference in recurrent injury between the addition of proprioceptive exercises during the rehabilitation of patients following ankle ligament injury ($p<0.68$). The addition of proprioceptive training demonstrated a significant reduction in subjective instability and functional outcomes ($p<0.05$).	Further study is warranted to develop the rigour of the evidence base and to determine the optimal proprioceptive training programme following ankle ligament injury with different populations.	+
Schiftan *et al*[43]	8	Reinjury	Exercise therapy (proprioceptive training)	Results of the meta-analysis combining all participants, irrespective of ankle injury history status, revealed a significant reduction of ankle sprain incidence when proprioceptive training was performed compared with a range of control interventions (RR=0.65, 95% CI 0.55 to 0.77).	Proprioceptive training programmes are effective at reducing the rate of ankle sprains in sporting participants, particularly those with a history of ankle sprain. Current evidence remains inconclusive on the benefits for primary prevention of ankle sprains.	+
van der Wees *et al*[50]	10	Reinjury, postural stability, ROM	Exercise therapy and manual mobilisation	Exercise therapy was effective in reducing the risk of recurrent sprains after acute ankle sprain: RR 0.37 (95% CI 0.18 to 0.74). No effects of exercise therapy were found on postural sway in patients with functional instability: SMD 0.38 (95% CI −0.15 to 0.91). 4 studies demonstrated an initial positive effect of different modes of manual mobilisation on dorsiflexion ROM.	It is likely that exercise therapy, including the use of a wobble board, is effective in the prevention of recurrent ankle sprains. Manual mobilisation has an (initial) effect on dorsiflexion ROM, but the clinical relevance of these findings for physiotherapy practice may be limited.	+
van Rijn *et al*[53]	7	Pain, instability, reinjury	Exercise (additional supervised exercises compared with conventional treatment alone)	There was limited to moderate evidence to suggest that the addition of supervised exercises to conventional treatment leads to faster and better recovery and a faster return to sport at short-term follow-up than conventional treatment alone.	Additional supervised exercises compared with conventional treatment alone have some benefit for recovery and return to sport in patients with ankle sprain, though the evidence is limited or moderate and many studies are subject to bias.	+
Wikstrom *et al*[57]	8	Postural control	Exercise (balance training)	Balance training improves postural control (ES=−0.857, $p<0.0001$).	Balance training improves postural control scores after both acute and lateral ankle trauma. However, further research should determine the optimal dosage, intensity, type of training and a risk reduction/preventative effect associated with balance training after both acute and chronic ankle trauma.	+

Continued

Table 3 Continued

Study	AMSTAR	Outcome (s)	Intervention	Results	Review conclusion	Summary
Woitzik *et al*[58]	7	Self-reported recovery, pain, instability	Exercise	The evidence suggests that for recent lateral ankle sprain: Rehabilitation exercises initiated immediately postinjury are as effective as a similar programme initiated 1 week postinjury; supervised exercise provides no additional benefit when added to education and advice (including home exercises) compared with education and advice (including home exercises) alone.	For recent lateral ankle sprains, similar outcomes are offered between an accelerated exercise programme and exercises given 1 week postinjury.	+
Zech *et al*[60]	9	Recurrent sprains and giving way episodes/ postural control/proprioception/muscle reaction time to sudden perturbation/ankle joint functionality scores/muscle strength/ EMG/oedema	Exercise (proprioceptive/ neuromuscular)	Proprioceptive/neuromuscular exercise was effective at increasing functionality as well as at decreasing the incidence of recurrent injuries and 'giving way' episodes after ankle sprains	It can be concluded that proprioceptive and neuromuscular interventions after ankle injuries can be effective for the prevention of recurrent injuries.	+
Conclusions	There is strong evidence for the use of exercise therapy for preventing ankle reinjury incidence and improving self-reported function. One high-quality review found no evidence for the addition of supervised exercises to unsupervised home-based exercise. There is limited to moderate evidence supporting the use of exercise therapy for improving postural stability (2 reviews supporting and 1 finding no effect).					
Manual therapy						
Brantingham *et al*[19]	10	Self-reported function, ROM, pain, swelling, proprioception, stabilometry	Manual therapy	There is a level of B or fair evidence for manipulative therapy of the ankle and/or foot combined with multimodal or exercise therapy for ankle inversion sprain.	Larger, methodologically improved, and well-funded randomised controlled and clinical trials, as well as observational, clinical, and basic science research, case series, and studies, are both needed and merited.	+
van der Wees *et al*[50]	10	Reinjury, postural stability, ROM	Exercise therapy and manual mobilisation	Exercise therapy was effective in reducing the risk of recurrent sprains after acute ankle sprain: RR 0.37 (95% CI 0.18 to 0.74). No effects of exercise therapy were found on postural sway in patients with functional instability: SMD 0.38 (95% CI −0.15 to 0.91). 4 studies demonstrated an initial positive effect of different modes of manual mobilisation on dorsiflexion ROM.	It is likely that exercise therapy, including the use of a wobble board, is effective in the prevention of recurrent ankle sprains. Manual mobilisation has an (initial) effect on dorsiflexion ROM, but the clinical relevance of these findings for physiotherapy practice may be limited.	?
Conclusions		There is limited evidence supporting the use of manual therapy for treatment of acute ankle sprain injury. At present, there does not appear to be any negative effects of adding manual therapy to an exercise therapy programme. Further research is warranted to determine whether manual therapy results in any long-term benefits in either acute ankle sprains or CAI.				
Surgery						
de Vries *et al*[20]	10	Primary outcomes: functional outcome, subjective stability Secondary outcomes: recurrent injury, pain, swelling	Any type of treatment for chronic lateral ankle instability was considered	10 included studies; data from 3 out of 4 studies showed a better outcome for neuromuscular training compared with no training.	Neuromuscular training alone appears effective in the short term. There is insufficient evidence to support any one surgical intervention over another surgical intervention for CAI but it is likely that there are limitations to the use of dynamic tenodesis.	?
Kerkhoffs *et al*[29]	9	Reinjury; persistent pain; subjective instability	Surgical compared with conservative interventions	There is insufficient evidence available from RCTs to determine the relative effectiveness of surgical and conservative treatment for acute injuries of the lateral ligament complex of the ankle in adults.	Given the risk of operative complications and the higher costs (including those of hospital admission) associated with surgery, the best available option for most patients would be conservative treatment for acute injuries and close follow-up to identify patients who may remain symptomatic. High-quality RCTs of primary surgical repair vs the best available conservative treatment for well-defined injuries are required.	?

Continued

Table 3 Continued

Study	AMSTAR	Outcome (s)	Intervention	Results	Review conclusion	Summary
Pijnenburg *et al*[40]	7	Pain and self-reported function (giving way)	Any	With respect to giving way, a significant difference was noted between operative treatment and functional treatment (RR 0.23; 95% CI 0.17 to 0.31) in favour of operative treatment and a significant difference was also noted between functional treatment and treatment with a cast for 6 weeks (RR 0.69; 95% CI 0.50 to 0.94) in favour of functional treatment. With respect to residual pain, no significant difference was found between operative and functional treatment and a significant difference was found between functional treatment and treatment with a cast for 6 weeks (RR 0.67; 95% CI 0.50 to 0.90).	We concluded that a no-treatment strategy for ruptures of the lateral ankle ligaments leads to more residual symptoms. Operative treatment leads to better results than functional treatment, and functional treatment leads to better results than cast immobilisation for 6 weeks.	+
Conclusions	There is limited evidence supporting surgery for the treatment of lateral ankle ruptures compared with no treatment for self-reported function. However, there are higher risks of complications with surgical interventions.					
External support						
Dizon and Reyes[21]	9	Reinjury	External ankle supports	The main finding was the reduction of ankle sprain by 69% (OR 0.31, 95% CI 0.18 to 0.51) with the use of ankle brace and reduction of ankle sprain by 71% (OR 0.29, 95% CI 0.14 to 0.57) with the use of ankle tape among previously injured athletes.	No type of ankle support was found to be superior than the other.	+
Handoll *et al*[24]	10	Ankle reinjury, instability	External ankle support; ankle disk training; stretching; health education programme and controlled rehabilitation.	The main finding was a significant reduction in the number of ankle sprains in people allocated external ankle support (RR 0.53, 95% CI 0.40 to 0.69). This reduction was greater for those with a previous history of ankle sprain, but still possible for those without prior sprain. There was limited evidence for reduction in ankle sprain for those with previous ankle sprains who did ankle disk training exercises.	Participants with a history of previous sprain can be advised that wearing such supports may reduce the risk of incurring a future sprain.	+
Kemler *et al*[26]	7	Reinjuries, pain, swelling, instability, and functional outcomes	External support (comparison of different types)	Best evidence syntheses only demonstrated a better treatment result in terms of functional outcome for bracing in comparison to other forms of external support. There were no differences for any other outcomes (eg, reinjuries, residual symptoms).	Further research should focus on economic evaluation and on different types of ankle brace, to examine the strengths and weaknesses of ankle braces for the treatment of acute ankle sprains.	+
Kerkhoffs *et al*[28]	8	Swelling, instability	External support (comparison of different types)	Persistent swelling at short-term follow-up was less with lace-up ankle support than with semirigid ankle support (RR 4.2 95% CI 1.3 to 14), an elastic bandage (RR 5.5; 95% CI 1.7 to 18) and tape (RR 4.1; 95% CI 1.2 to 14). One trial reported better results for subjective instability using the semirigid ankle support than the elastic bandage (RR 8.0; 95% CI 1.0 to 62).	We conclude that an elastic bandage is a less effective treatment. Lace-up supports seem better, but the data are insufficient as a basis for definite conclusions.	+
Conclusions	There is strong evidence supporting the use of external support (in the form of taping or bracing) for reducing reinjury incidence and improving self-reported function. There is moderate evidence suggesting bracing may be superior for self-reported function in comparison to taping.					
Complementary (acupuncture)						
Kim *et al*[30]	10	Self-reported function, reinjury	Acupuncture	The currently available evidence from a very heterogeneous group of randomised and quasi-RCTs evaluating the effects of acupuncture for the treatment of acute ankle sprains does not provide reliable support for either the effectiveness or safety	Future rigorous randomised clinical trials with larger sample sizes will be necessary to establish robust clinical evidence concerning the effectiveness and safety of acupuncture treatment for acute ankle sprains.	?

Continued

Table 3 Continued

Study	AMSTAR	Outcome (s)	Intervention	Results	Review conclusion	Summary
				of acupuncture treatments, alone or in combination with other non-surgical interventions; or in comparison with other non-surgical intervention.		
Park *et al*[37]	9	Pain	Acupuncture	Acupuncture was more effective than various controls in relieving pain, facilitating return to normal activity, and promoting quality of life, but these analyses were based on only a small number of studies. Acupuncture did not appear to be associated with adverse events.	Given methodological shortcomings and the small number of high-quality primary studies, the available evidence is insufficient to recommend acupuncture as an evidence-based treatment option. This calls for further rigorous investigations.	+
Conclusions	There is limited evidence based primarily on low-quality studies supporting the use of acupuncture for pain relief in ankle sprain injury. There is limited evidence demonstrating no effect of acupuncture on self-reported function and reinjury incidence.					
Immobilisation						
Pijnenburg *et al*[40]	7	Any	Pain and self-reported function (giving way)	With respect to giving way, a significant difference was noted between operative treatment and functional treatment (RR 0.23; 95% CI 0.17 to 0.31) in favour of operative treatment and a significant difference was also noted between functional treatment and treatment with a cast for 6 weeks (RR 0.69; 95% CI 0.50 to 0.94) in favour of functional treatment. With respect to residual pain, no significant difference was found between operative and functional treatment and a significant difference was found between functional treatment and treatment with a cast for 6 weeks (RR 0.67; 95% CI 0.50 to 0.90).	We concluded that a no-treatment strategy for ruptures of the lateral ankle ligaments leads to more residual symptoms. Operative treatment leads to better results than functional treatment, and functional treatment leads to better results than cast immobilisation for 6 weeks.	–
Kerkhoffs *et al*[27]	10	Pain, swelling, subjective and objective instability, recurrent injury	Immobilisation	There is significant evidence to support functional treatment over immobilisation for multiple outcomes. None of the other results were significantly in favour of immobilisation.	Based on our results, functional treatment currently seems a more appropriate treatment and should be encouraged. Concerning effectiveness, immobilisation, if necessary, should be restricted to certain patients and for short time periods.	–
Conclusions	There is moderate evidence (2 high-quality reviews) opposing the use if immobilisation in the treatment of ankle sprain injury, in comparison to functional treatment. There is limited to moderate evidence opposing immobilisation in comparison to surgical intervention.					
Conventional treatment (RICE)						
van den Bekerom *et al*[48]	11	Pain, swelling, ankle mobility or ROM	RICE therapy	Insufficient evidence is available from RCTs to determine the relative effectiveness of RICE therapy for acute ankle sprains in adults.	Treatment decisions must be made on an individual basis, based on expert opinion and national guidelines.	?
Conclusions	There is not sufficient evidence to draw any conclusions regarding the effectiveness of RICE for the treatment of acute ankle sprains. High-quality RCTs are required before recommendations can be made.					

Reviews have been stratified by intervention type.
+: Evidence supporting intervention.
–: Evidence opposing intervention.
?: Inconclusive evidence.
CAI, chronic ankle instability; EMG, electromyography; ES, effect size; RCT, randomised controlled trial; RICE, rest, ice compression, and elevation; ROM, range of motion; RR, relative risk.

Chronic ankle instability

None of the included reviews evaluated the efficacy of electrophysical agents, pharmacological interventions or complementary medicine for the treatment of CAI or recurrent ankle sprains.

Surgical interventions: CAI

Two reviews[20 51] (quality range 6–10) evaluated the efficacy of surgery for the specified treatment of CAI or recurrent ankle sprains.[14] Included in these reviews were 24 individual papers, 8 of which evaluated a surgical intervention for the treatment of CAI or chronic recurrent ankle sprain (all RCTs; N=533; 64% male, 36% female).[62–64 71 72 94 227 228]

None of the reviews specifically investigated whether a surgical intervention was superior to conservative management for CAI. In the majority of individual studies, a surgical intervention was often implemented provided conservative management had failed.[62–64 94 227 228] Furthermore, none of the individual reports had a non-surgical control group,[51] and none of the studies reported on the primary outcome of reinjury incidence.[15 62–64 71 72 94 227 228]

Non-surgical interventions: CAI

Twenty-three reviews evaluated the efficacy of a physiotherapeutic intervention (which included exercise and manual therapies) in the treatment of CAI or recurrent ankle sprain[17 19 20 23 32–36 41–43 45 46 50 51 54–57 59–61] (quality range 1–10). Following the removal of duplicates, these reviews included 122 individual papers (83 RCTs, 39 non-RCTs; N=26349, 82% male, 18% female).

Exercise therapy

Twenty-two of the included reviews evaluated exercise therapy for treating CAI or recurrent ankle sprain[17 19 20 23 33–36 41–43 45 46 50 51 54–57 59–61] (quality range 1–10). Included in these reviews were 114 individual reports, 61 of these papers evaluated the efficacy of exercise therapy for the treatment of CAI or recurrent ankle sprain specifically (42 RCTs, 19 non-RCTs; N=13963; 70% male, 30% female).[65 96–99 101–104 106 107 110–113 118 119 121–123 128–135 229–261]

Exercise therapy is generally considered effective in the treatment of CAI for the outcomes of self-reported function[20 23 41 45 51 57 60] and reinjury incidence.[16–20 33–36 42 43 46 50 51 54 55 60]

Manual therapy

Five reviews[19 32 45 50 51] (quality range 6–10) evaluated the effect of ankle joint mobilisation in CAI populations. Of the 122 individual papers included in these reviews, 12 (all RCTs, N=340; insufficient data to calculate male:female ratio) evaluated some kind of manual therapy in the treatment of ankle sprain.[137–147 262]

Regarding the primary outcomes of self-reported function or injury recurrence, five of the individual papers included samples with CAI or recurrent ankle sprains[139 142 144 146 262] and one reported on the primary outcome of self-reported function with a follow-up period that was not immediately post-treatment.[21 139]

All the reviews identified that manual mobilisation is likely to have a (initial) positive effect on ankle dorsiflexion ROM.[19 32 45 50 51]

External support

Nine systematic reviews evaluated the efficacy of an external support intervention for the treatment of CAI[21 22 24 34 46 47 54 55 61] (quality range 4–10). These reviews included 115 papers. Of these 115, 63 individual reports were included after removal of papers duplicated between each review. Of the 63 individual reports, 39 (15 RCTs, 24 non-RCTs; N=8734; 90% male, 10% female) evaluated some kind of external support for the treatment of CAI.[108 173 247–262] The primary outcome in all of the reviews was reinjury incidence.

There was unanimous consensus among the reviews that bracing is effective at preventing a recurrence of an ankle sprain.[21 22 24 34 46 47 54 55 61] With regard to taping, two reviews (quality=5/11;[46] 4/11[22]) concluded that its efficacy could not be supported (and that bracing was superior) whereas three reviews (quality=5/11;[55] 4/11;[54] 9/11[21]) advocated its value in the prevention of ankle sprain recurrence. It remains unclear whether bracing or taping are effective interventions for the primary prevention of an ankle sprain.[21 24 54]

The reviews identified that the evidence for modified footwear was inconclusive in the prevention of ankle sprain or its recurrence.[23 46 47 54]

There was a lack of evidence for the value of orthotics in the treatment of CAI or the prevention of ankle sprain recurrence.[22 24]

Meta-analysis

Exercise interventions significantly decreased the risk of sustaining a recurrent ankle sprain (figure 3; OR=0.59, 95% CI 0.51 to 0.68). An exploratory sensitivity analysis by treatment dose (high dose vs low dose using a median split of 900 min) was performed. Removal of interventions with a lower dose of total exercise (<900 min) improved the odds of the exercise intervention for injury risk (figure 4; OR=0.48, 95% CI 0.37 to 0.63). A summary of the exercise therapy interventions (with overall study quality) presented in the individual papers is presented in online supplementary table S3.

External support interventions were also associated with a significantly decreased risk of sustaining a recurrent ankle sprain (figure 5; OR=0.38, 95% CI 0.30 to 0.47).

DISCUSSION

This systematic review of treatment strategies for acute ankle sprain and CAI found 46 reviews which included 309 individual studies. As the conclusions of each review have been presented, the following topics in the treatment of acute ankle sprain/CAI will be clarified and discussed: surgical interventions; conservative interventions; treatment of specific types of ankle sprain.

Surgical interventions

Treatment strategies in the current review were divided into surgical and non-surgical types. The surgical literature is sparse however, and never were the long-term effects of a surgical intervention on the primary outcome of recurrence investigated. The general consensus of the reviews that investigated a surgical intervention was that a trial of conservative treatment should always be attempted before surgery is undertaken, that surgery should be considered only in patients with persistent symptoms, and that it should be considered on an individual basis.[29 39 40]

Study or Subgroup	Exercise Events	Exercise Total	Control Events	Control Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Chaiwanichsiri 2005	1	15	2	17	0.4%	0.54 [0.04, 6.58]
Eils 2010	7	96	21	102	4.2%	0.30 [0.12, 0.75]
Ekstrand 1983	2	90	11	90	2.4%	0.16 [0.04, 0.76]
Emery 2005	1	66	7	61	1.6%	0.12 [0.01, 0.99]
Emery 2007	62	426	76	494	13.2%	0.94 [0.65, 1.35]
Engebretsen 2008	13	102	20	107	3.7%	0.64 [0.30, 1.36]
Heidt 2000	2	42	21	258	1.2%	0.56 [0.13, 2.50]
Holme 1999	3	46	13	46	2.7%	0.18 [0.05, 0.67]
Hupperets 2009	56	254	89	269	14.8%	0.57 [0.39, 0.85]
McGuine & Keene 2006	12	284	23	299	4.7%	0.53 [0.26, 1.09]
Mohammadi 2007	1	20	8	20	1.7%	0.08 [0.01, 0.71]
Nilsson 1983	9	53	9	51	1.7%	0.95 [0.35, 2.64]
Olsen 2005	31	958	47	879	10.4%	0.59 [0.37, 0.94]
Pope 1998	11	549	16	544	3.5%	0.67 [0.31, 1.47]
Pope 2000	19	735	27	803	5.5%	0.76 [0.42, 1.38]
Soderman 2000	13	121	14	100	3.0%	0.74 [0.33, 1.66]
Stasinopoulos 2004	3	17	6	17	1.1%	0.39 [0.08, 1.94]
Tropp 1985	7	146	30	171	5.8%	0.24 [0.10, 0.56]
Van Mechelen 1993	0	159	1	167	0.3%	0.35 [0.01, 8.60]
Van Rijn 2007	13	45	16	47	2.4%	0.79 [0.33, 1.90]
Verhagen 2004	31	641	38	486	9.0%	0.60 [0.37, 0.98]
Wedderkopp 1999	6	111	23	126	4.5%	0.26 [0.10, 0.65]
Wester 1996	6	24	13	24	2.1%	0.28 [0.08, 0.96]
Total (95% CI)		**5000**		**5178**	**100.0%**	**0.57 [0.49, 0.66]**
Total events	309		531			

Heterogeneity: $Chi^2 = 31.38$, df = 22 (P = 0.09); $I^2 = 30\%$
Test for overall effect: Z = 7.34 (P < 0.00001)

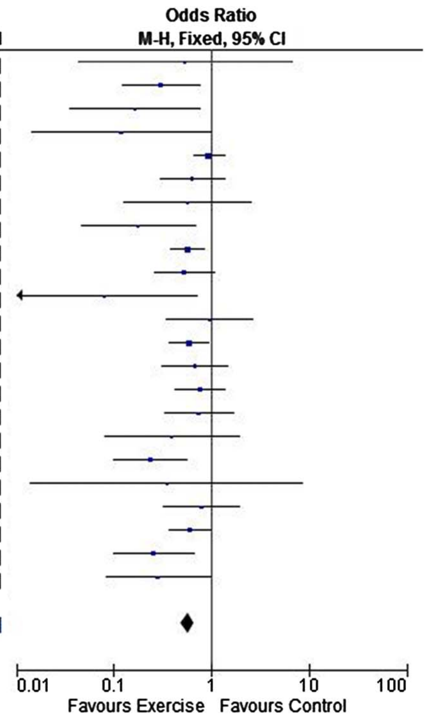

Figure 3 Forest plot depicting the results of the meta-analysis for exercise interventions in the treatment of recurrent ankle sprain injury.

Study or Subgroup	Exercise Events	Exercise Total	Control Events	Control Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Chaiwanichsiri 2005	1	15	2	17	1.1%	0.54 [0.04, 6.58]
Eils 2010	7	96	21	102	12.4%	0.30 [0.12, 0.75]
Ekstrand 1983	2	90	11	90	0.0%	0.16 [0.04, 0.76]
Emery 2005	1	66	7	61	0.0%	0.12 [0.01, 0.99]
Emery 2007	62	426	76	494	0.0%	0.94 [0.65, 1.35]
Engebretsen 2008	13	102	20	107	0.0%	0.64 [0.30, 1.36]
Heidt 2000	2	42	21	258	3.7%	0.56 [0.13, 2.50]
Holme 1999	3	46	13	46	0.0%	0.18 [0.05, 0.67]
Hupperets 2009	56	254	89	269	0.0%	0.57 [0.39, 0.85]
McGuine & Keene 2006	12	284	23	299	14.0%	0.53 [0.26, 1.09]
Mohammadi 2007	1	20	8	20	5.0%	0.08 [0.01, 0.71]
Nilsson 1983	9	53	9	51	0.0%	0.95 [0.35, 2.64]
Olsen 2005	31	958	47	879	0.0%	0.59 [0.37, 0.94]
Pope 1998	11	549	16	544	0.0%	0.67 [0.31, 1.47]
Pope 2000	19	735	27	803	0.0%	0.76 [0.42, 1.38]
Soderman 2000	13	121	14	100	9.0%	0.74 [0.33, 1.66]
Stasinopoulos 2004	3	17	6	17	0.0%	0.39 [0.08, 1.94]
Tropp 1985	7	146	30	171	0.0%	0.24 [0.10, 0.56]
Van Mechelen 1993	0	159	1	167	1.0%	0.35 [0.01, 8.60]
Van Rijn 2007	13	45	16	47	7.3%	0.79 [0.33, 1.90]
Verhagen 2004	31	641	38	486	26.9%	0.60 [0.37, 0.98]
Wedderkopp 1999	6	111	23	126	13.3%	0.26 [0.10, 0.65]
Wester 1996	6	24	13	24	6.4%	0.28 [0.08, 0.96]
Total (95% CI)		**1558**		**1646**	**100.0%**	**0.48 [0.37, 0.63]**
Total events	92		180			

Heterogeneity: $Chi^2 = 9.26$, df = 10 (P = 0.51); $I^2 = 0\%$
Test for overall effect: Z = 5.21 (P < 0.00001)

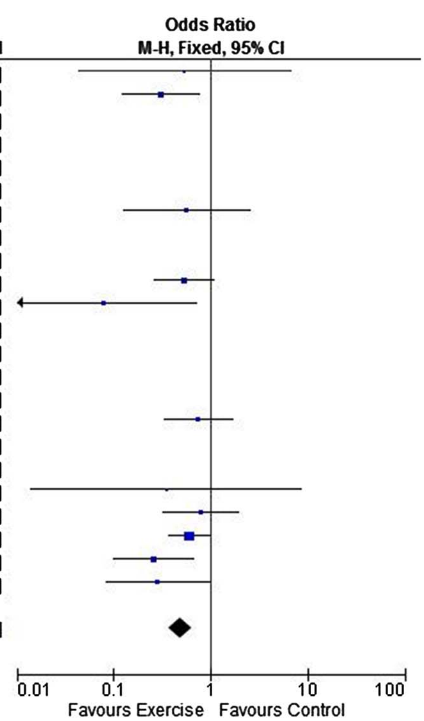

Figure 4 Forest plot depicting the results of the meta-analysis for high-dose exercise interventions only in the treatment of recurrent ankle sprain injury.

Conservative interventions

Meta-analysis

Owing to a significant heterogeneity of outcomes, samples, interventions and follow-up periods, meta-analyses were only undertaken to evaluate the effect of exercise and external support interventions on reinjury in individuals with a history (acute or chronic) of ankle sprain. This analysis elucidated that an exercise intervention can significantly reduce the odds of ankle sprain recurrence, and that this effectiveness is improved if the exercise therapy is given in high (>900 min of exercise therapy training) doses. The other meta-analysis conducted as part of this investigation advocated the use of an external

Study or Subgroup	External Support Events	External Support Total	Control Events	Control Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Amoroso 1998	3	369	9	376	7.1%	0.33 [0.09, 1.24]
Garrick & Requa 1973	17	1163	36	1107	29.1%	0.44 [0.25, 0.79]
Simon 1969	4	73	4	75	3.0%	1.03 [0.25, 4.28]
Sitler 1994	11	87	35	90	24.1%	0.23 [0.11, 0.49]
Surve 1994	48	127	75	131	36.8%	0.45 [0.28, 0.75]
Total (95% CI)		**1819**		**1779**	**100.0%**	**0.40 [0.29, 0.56]**
Total events	83		159			

Heterogeneity: $Chi^2 = 4.22$, df = 4 (P = 0.38); $I^2 = 5\%$
Test for overall effect: Z = 5.59 (P < 0.00001)

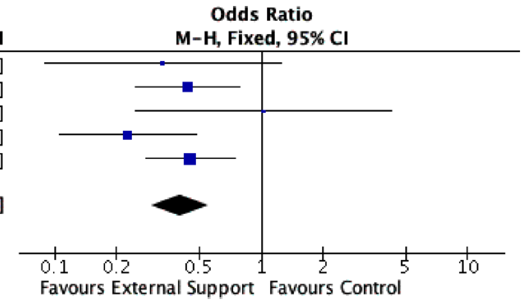

Figure 5 Forest plot depicting the results of the meta-analysis for bracing interventions in the treatment of recurrent ankle sprain injury.

support in reducing the odds of ankle sprain recurrence. The review papers equated the efficacy of taping with bracing[54 55] (with a similar reinjury risk reduction of 50%,[55] while also reducing the severity of the incurred sprain[25 54]).

Exercise therapy

A number of limitations in the available research were acknowledged in the reviews and as such, the findings of the meta-analysis for exercise therapy should be interpreted with caution. First, many of the authors stated that the studies included in their reviews were very heterogeneous.[17 20 36 51 60 61] With regard to the statistical pooling performed as part of the current investigation, reflection of the exercise programmes implemented in the individual papers highlights this heterogeneity (see online supplementary table S2). Additionally, information regarding the intervention parameters was not adequately described in most studies. Furthermore, several reviews endorsed the completion of additional high-quality research to identify the specific parameters (such as the dose, intensity, type) of exercise therapy required to improve long-term outcomes.[35 41 56 57 60] It is also currently unknown as to whether exercise therapies reduce the severity of an ankle reinjury, or increase the number of exposures before an ankle injury occurs.[34] Finally, there is a lack of evidence which links improvements in the primary outcomes with improvements in secondary outcomes[111] (which could elucidate the mechanistic underpinnings of treatment efficacy).

External supports

Generally, the conclusions of the systematic reviews for an external support that included a taping or bracing intervention identified that their benefit could be enhanced with an appropriately designed exercise therapy programme and that the efficacy of these interventions may be 'additive' in the secondary prevention of ankle sprains.[55] Braces were recommended for all athletes with a previous history of ankle sprain, particularly when engaging in high-risk activities such as indoor/court and field sports.[22 24] It was recommended that a brace be worn for a minimum of 6 months after an acute ankle sprain to prevent recurrence,[46 47] and that the benefit of wearing a brace lasts for up to 1 year following the most recent ankle sprain.[54] Next to the recognised preventive effect, the use of external support was considered to result in less severe ankle sprains.[54] With regard to the type of external support recommended, Kerkhoffs *et al*[28] and Seah and Mani-Babu[44] both concluded that lace up ankle supports were superior to semirigid ankle supports.

Manual therapy

Studies on the effect of the physiotherapeutic intervention of manual therapy were limited by short follow-up time frames which impeded extrapolation of the long-term benefits of these techniques for either of the primary outcomes.[19 32 45 50 51]

Electrophysical agents

No review investigated the efficacy of electrophysical agents in the treatment of CAI. Electrophysical agents were not considered effective treatments for acute ankle sprain. However, the standard practice of applying ice and compression (or the use of elevation) is generally administered concurrently with an exercise therapy intervention.[52 53 95] While it is unknown if a RICE protocol augments the effect of exercise,[18] given the strong empirical evidence base and the popularity of cryotherapy treatment (particularly for the secondary outcome of pain), it may be difficult to randomise a participant to a 'no ice' group.[18] In conjunction with this point, a number of reviews recognised the paucity of high-quality studies evaluating an electrophysical agent in the treatment of acute ankle sprain.[14 18 53 95]

Complementary medicine

Similarly, complementary medicine has not been investigated in the treatment of CAI, and is not considered to be effective in the treatment of acute ankle sprain. Both the relevant reviews identified that there seemed to be a short-term benefit of complementary medicine for the secondary outcomes of pain and swelling, but cited that it remains unclear as to whether this is clinically meaningful in the long-term for injury recurrence and self-reported function.[14 30]

Ankle sprain type

Finally, only two of the reviews evaluated treatment strategies in the management of syndesmotic ankle sprain; the individual papers included in these reviews were all case studies and as such, no meaningful results could be drawn from them. No reviews were identified which sought to investigate treatment strategies for medial ankle sprain. The remaining reviews either did not present a specific definition of the type of ankle sprain (lateral/medial/syndesmotic), or focused on the most prevalent subtype of this injury: a lateral ankle sprain.[1] Future research is required to identify the optimal management strategies for medial and syndesmotic ankle sprains.

Limitations with this review

This review itself is not without limitations. First, due to the inherent nature of this type of study design, the latest literature is unlikely to be included in even the most recently published systematic reviews and is therefore omitted from this article. Additionally, data extraction was conducted by only one author; while all the authors were involved in devising the data extraction form and two performed the quality review, our protocol could have been improved if two authors had independently extracted the data. A sample of the studies was randomly selected to be double checked by a second author, to ensure quality. However, due to the volume of data and time-intensive nature of this, it was unfeasible for a second author to double extract the data.

CONCLUSION

This review summarises the evidence base for a number of interventions designed to treat and prevent acute ankle sprain and CAI. The best evidence synthesis of high-quality reviews indicates there is strong evidence for exercise therapy and bracing in preventing recurrence of an ankle sprain. The efficacy of surgery and acupuncture are controversial in the treatment of acute ankle sprains. There is insufficient evidence examining the effectiveness of ultrasound in the treatment of acute ankle sprains.

What are the findings?

- A large number of systematic reviews detail treatment strategies for ankle sprain.
- This makes appraisal of the literature difficult for clinicians.
- The optimal treatment strategy for acute/recurrent ankle sprain is unclear.
- However the best evidence synthesis indicates there is strong evidence for exercise therapy and bracing in preventing ankle sprain recurrence.

How might it impact on clinical practice in the future?

- Exercise therapy and taping/bracing are effective in the management of acute/recurrent ankle sprain.
- There is a lack of evidence for the effectiveness of ultrasound therapy, acupuncture and manual therapy in the treatment of recurrent ankle sprain.
- Surgery for acute/recurrent ankle sprain should only be considered on an individual basis.

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Contributors CD and SH had equal contribution and act as guarantors. They conceived the study and acquired the data. CD, SH and CB analysed the data. All authors drafted the manuscript. All authors critically revised the manuscript pre- and post-peer review.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

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Ankle-Joint Self-Mobilization and CrossFit Training in Patients With Chronic Ankle Instability: A Randomized Controlled Trial

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Context: Ankle-joint mobilization and neuromuscular and strength training have been deemed beneficial in the management of patients with chronic ankle instability (CAI). CrossFit training is a sport modality that involves these techniques.

Objective: To determine and compare the influence of adding self-mobilization of the ankle joint to CrossFit training versus CrossFit alone or no intervention in patients with CAI.

Design: Randomized controlled clinical trial.

Setting: Research laboratory.

Patients or Other Participants: Seventy recreational athletes with CAI were randomly allocated to either self-mobilization plus CrossFit training, CrossFit training alone, or a control group.

Intervention(s): Participants in the self-mobilization plus CrossFit group and the CrossFit training-alone group pursued a CrossFit training program twice a week for 12 weeks. The self-mobilization plus CrossFit group performed an ankle self-mobilization protocol before their CrossFit training, and the control group received no intervention.

Main Outcome Measure(s): Ankle-dorsiflexion range of motion (DFROM), subjective feeling of instability, and dynamic postural control were assessed via the weight-bearing lunge test, Cumberland Ankle Instability Tool, and Star Excursion Balance Test (SEBT), respectively.

Results: After 12 weeks of the intervention, both the self-mobilization plus CrossFit and CrossFit training-alone groups improved compared with the control group ($P < .001$). The self-mobilization plus CrossFit intervention was superior to the CrossFit training-alone intervention regarding ankle DFROM as well as the posterolateral- and posteromedial-reach distances of the SEBT but not for the anterior-reach distance of the SEBT or the Cumberland Ankle Instability Tool.

Conclusions: Ankle-joint self-mobilization and CrossFit training were effective in improving ankle DFROM, dynamic postural control and self-reported instability in patients with CAI.

Key Words: range of motion, balance, rehabilitation

Key Points

- Among patients with chronic ankle instability, ankle-joint self-mobilization was effective in improving the self-reported instability, ankle-dorsiflexion range of motion, and dynamic postural control.
- CrossFit training alone also improved ankle-dorsiflexion range of motion, dynamic postural control, and self-reported instability.
- Adding self-mobilization to CrossFit training produced better results than either intervention alone.

Lateral ankle sprain is the most common sport-related injury. It has been reported[1] that up to 75% of those who have sustained this injury are susceptible to recurrent ankle sprains. Furthermore, an estimated 33% of patients with an ankle sprain will develop chronic ankle instability (CAI),[2] which is characterized by residual symptoms that include episodes of giving way, feelings of ankle-joint instability, chronic pain, recurrent sprains, and swelling.[2] Associated impairments such as a deficit in ankle-dorsiflexion range of motion (DFROM), altered arthrokinematics, and sensorimotor deficits may be present for decades in these patients, resulting in diminished health-related quality of life.[2,3]

Balance training has been widely described in the scientific literature as an effective intervention for patients with CAI.[4] In conjunction with the evolution of the CAI model in recent years, researchers[5–7] have also evaluated strength training, joint mobility, and manual therapy in managing this condition; the results indicate a multifactorial approach is appropriate. Limited ankle DFROM has been associated with deficits in postural control and dynamic balance in those with CAI.[8] Investigators[7,8] have shown the benefits of joint mobilization in improving kinematics and dynamic balance as well as performance on functional tests. In addition to manual therapy, ankle-joint self-mobilization has been applied with positive results.[9,10] Nevertheless, little evidence is available about the effects of combining self-mobilization and neuromuscular training.

Despite the heterogeneity and complexity of CAI symptoms, neuromuscular-training research is usually characterized by single interventions (either strength or balance training).[11] CrossFit (CrossFit, Inc, Santa Cruz, CA) is a form of high-intensity training based on functional exercises that involve weightlifting, gymnastics, and

Table 1. Participant Characteristics and Baseline Comparability of Study Groups

Characteristic	All (n = 70)	CrossFit Plus Self-Mobilization (n = 25)	CrossFit Alone (n = 24)	Control (n = 21)	*P* Value[a]
	No. (%)				
Sex					.298
Male	40 (57.1)	17 (68)	11 (45.8)	12 (57.1)	
Female	30 (42.9)	8 (32)	13 (54.2)	9 (42.9)	
Ankle					.497
Left	26 (37.1)	8 (32)	8 (33.3)	10 (47.6)	
Right	44 (62.9)	17 (68)	16 (66.7)	11 (52.4)	
	Mean ± SD				
Age, y	29.00 ± 8.50	29.16 ± 8.38	27.63 ± 7.42	30.38 ± 9.86	.558
Height, cm	170.97 ± 8.70	170.08 ± 8.02	171.71 ± 8.48	171.19 ± 9.99	.804
Mass, kg	69.25 ± 9.72	69.04 ± 10.35	69.03 ± 9.54	69.77 ± 9.62	.959
Body mass index	23.66 ± 2.62	23.76 ± 2.42	23.42 ± 2.92	23.81 ± 2.61	.863
Baseline scores					
Cumberland Ankle Instability Tool (range = 0–30)	18.91 ± 1.97	18.84 ± 2.08	18.92 ± 1.84	19.00 ± 2.07	.964
Ankle-dorsiflexion range of motion	8.81 ± 1.02	8.72 ± 1.19	8.97 ± 1.01	8.75 ± 0.83	.669
Star Excursion Balance Test Direction					
Anterior	75.47 ± 2.79	75.14 ± 2.42	76.40 ± 2.97	74.80 ± 2.84	.120
Posteromedial	89.64 ± 3.53	89.92 ± 3.05	89.70 ± 4.20	89.22 ± 3.37	.798
Posterolateral	87.19 ± 3.25	86.85 ± 2.41	86.93 ± 4.04	87.90 ± 3.15	.494

[a] *P* value for 1-way analysis-of-variance test for continuous variables or Kruskal-Wallis test for categorical variables.

metabolic workouts.[12] The literature on CrossFit training is limited, although the number of scientific publications has increased lately due to its growing popularity. Until recently, the most frequently studied topic involving CrossFit was the risk of injury.[12–14] However, this sport modality is based on improving strength, joint mobility, and balance, according to the specific features of the exercises performed. Although some authors have reported on core training, hip strengthening, ankle-joint stretching, and peroneal strengthening for improving ankle instability, only in the past few years have combinations of these training options been evaluated.[15,16]

Our hypothesis was that taking part in a CrossFit-based intervention that included self-mobilization techniques would improve DFROM, dynamic postural control, and self-reported instability of patients with CAI.

METHODS

This study was a single-blinded randomized controlled trial with 2 intervention groups: 1 with an ankle-joint self-mobilization plus CrossFit protocol and the other with a CrossFit-based training protocol. Control-group participants received no intervention. Participants were assigned to 1 of the intervention conditions or the control group. The dependent variables were DFROM of the ankle joint assessed by the weight-bearing lunge test (WBLT), dynamic balance evaluated using the Star Excursion Balance Test (SEBT), and self-reported feeling of ankle instability determined by the Cumberland Ankle Instability Tool (CAIT). Participants were assessed before the study and after 12 weeks of intervention. The study (NCT03189784) was approved by the Human Ethics Committee of the University of Jaén and conducted in accordance with the Declaration of Helsinki, good clinical practices, and applicable laws and regulations, and it met the standards of the Consolidated Standards of Reporting Trials guidelines.[17] Informed consent was obtained from all participants enrolled in the study.

Participants

From a sample of 108 participants, 75 physically active participants with CAI were recruited by advertisement and word of mouth at the university's campus, physiotherapy centers, and hospitals. Participants were considered *physically active* if they exercised at least 2 times per week. We assessed participation eligibility using the recommendations of the International Ankle Consortium[5]: (1) a previous ankle sprain at least 6 months before the study, (2) a score of 25 or less on the CAIT to confirm current subjective ankle-joint instability, (3) no history of other musculoskeletal injuries in the lower limbs, and (4) mental and physical ability to participate in CrossFit sessions. Exclusion criteria for participants were (1) self-reported vestibular or balance-related dysfunction, (2) an acute ankle sprain in the previous 6 weeks, (3) recent surgery, or (4) being a habitual CrossFit practitioner. Participants' demographic information can be found in Table 1.

The sample size was calculated using Ene (version 3.0; GlaxoSmithKline, Barcelona, Spain) to ensure a power of 0.80 at a significance level of 95%, based on data from a study[8] of joint-mobilization interventions. A total of 21 participants per group were required. To compensate for possible dropouts during the intervention and assessment process, we recruited 25 patients per group. Participants' data were excluded from the statistical analysis if they missed more than 2 training sessions.

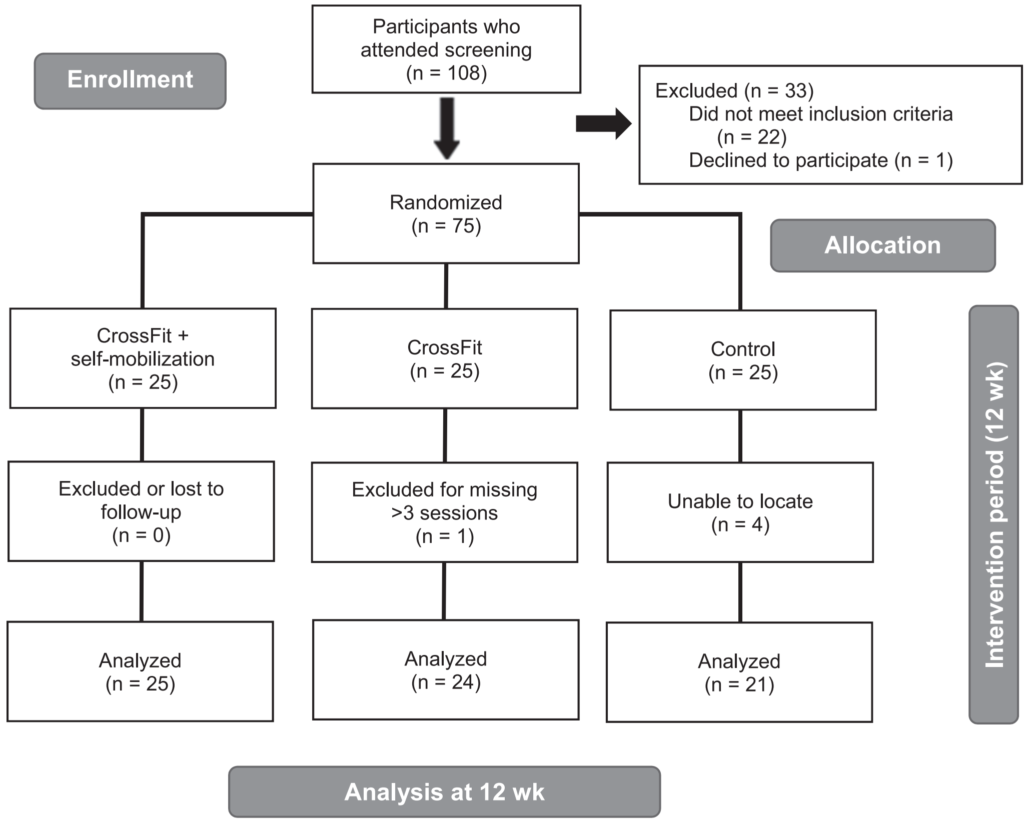

Figure 1. Flow chart of the study design and participant follow-up during the trial.

Randomization

An independent assessor, blinded to data collection, was responsible for the allocation process. A list of computer-generated numbers was used to assign participants to the ankle-joint self-mobilization plus CrossFit group, the CrossFit training group, or the control group. Participants were randomized to each intervention group using sealed opaque envelopes prepared by an independent researcher (uninvolved in the intervention) in a 1 : 1 : 1 ratio before the intervention (Figure 1). Patients were instructed not to discuss the specifics of the intervention with the researchers.

Interventions

Patients who met the inclusion criteria and agreed to enroll in the study were informed about the study protocol and advised to maintain their usual everyday activity. We provided a notebook to each participant to record any adverse event during the study. Dependent variables were measured by an independent assessor (a physiotherapist with more than 5 years of research experience) who was blinded to patient allocation.

CrossFit Training. The session was divided into 3 parts: a warm-up period, a principal training phase (which is known in CrossFit as the Workout of the Day [WOD]), and a cool-down aimed at easing recovery after the effort. The warm-up period consisted of cardiovascular activity, dynamic stretching, and progressive-load strength exercises. The main portion of the training session consisted of exercises to address strength, endurance, agility, and functional mobility. The difficulty level of each exercise was controlled by a certified instructor who monitored the participant's form. Some exercises were based on body weight, such as a squat or burpees, whereas others required specific equipment such as barbells, kettlebells, or medicine balls. The final part of each session consisted of slow cardiovascular activity and foam rolling. The exercises are described in Table 2.

Ankle-Joint Self-Mobilization and CrossFit. This group carried out the same CrossFit protocol in addition to self-mobilization techniques at the beginning of the session and before the warm-up. This protocol was taught by an expert physical therapist who was also certified as a strength coach. The self-mobilization exercises were

- Ankle-joint self-mobilization with a resistance band. Participants placed a resistance band (Rogue Monster Band, Rogue Fitness HQ, Columbus, OH) around the talocrural joint with the affected foot on a step and the opposite leg extended in a lunge position. The band was tied posteriorly to a rack, and patients were told to perform ankle dorsiflexion while avoiding knee valgus.
- Kettlebell dorsiflexion. Participants adopted a kneeling-lunge position with the affected foot firmly placed on the ground. Then they performed maximal ankle dorsiflexion with a kettlebell placed on the bended knee of the anterior leg.
- Band pull. For this exercise, 2 bands were needed. Patients sat on the floor with the affected leg extended. One band was placed around the ankle joint and tied horizontally to a rack, exerting a caudal distraction force on the joint. A second band embraced the sole of the foot, and the patients were told to pull in a cranial direction.

Table 2. CrossFit Training Protocol **Continued on Next Page**

Training Session	Warm-Up	Workout of the Day	Repetitions and Sets or Time
1	Articular mobility Hinge PVC overhead squats Medicine ball slams Bear walk Hindu push-ups 50 Double-unders	Power cleans Burpees Box jumps	3 × 21/15/9 3 × 21/15/9 3 × 21/15/9
2	Articular mobility Hinge PVC overhead squats Medicine ball slams Bear walk Hindu push-ups 50-cal row	As many repetitions as possible 1. Push and press/chest dips 2. Battle rope/plank 3. Ball wall/chest to bar	10 min per station 10 × 10
3	Articular mobility Hinge PVC overhead squats Medicine ball slams Bear walk Hindu push-ups 50 air squats	3 rounds Clean and jerk Strict handstand push-ups/kipping	20 min 30 min 20 min
4	Dynamic articular stretching	Row 250 m Row 500 m Row 1000 m Row 500 m Row 250 m Rest 1 min between efforts	3 rounds
5	Articular mobility Hinge PVC overhead squats Medicine ball slams Bear walk Hindu push-ups 50 double-unders	100 single-unders 20 overhead squats 100 single-unders 12 ring dips 100 single-unders 20 dumbbell snatches 100 single-unders 12 chin-over bar pull-up	2 rounds, 1-min rest
6	Articular mobility Hinge PVC overhead squats Medicine ball slams Bear walk Hindu push-ups 50 burpees	Clean and jerk Bench press	3 × 5 5 × 5
7	Articular mobility Hinge PVC overhead squats Medicine ball slams Bear walk Hindu push-ups 50 goblet squats	Hero WOD Diane Deadlifts, 225 lb/155 lb (102 kg/70 kg) Handstand push-ups Deadlifts, 315 lb/205 lb (143 kg/93 kg) 50-ft (15-m) handstand walk after each set	3 × 21/15/9
8	Articular mobility Hinge PVC overhead squats Medicine ball slams Bear walk Hindu push-ups 50 box jumps	Dumbbell hang clean and jerks Weighted pull-ups	5 × 15/12/9/6/3
9	Articular mobility Hinge PVC overhead squats Medicine ball slams Bear walk Hindu push-ups 1-min plank	15-cal row Push-ups Ball wall	15 cal 15 As many sets as possible in 7 min 50 reps

Table 2. Continued From Previous Page

Training Session	Warm-Up	Workout of the Day	Repetitions and Sets or Time
10	Articular mobility Hinge PVC overhead squats Medicine ball slams Bear walk Hindu push-ups	3 thrusters 3 chest-to-bar pull-ups 6 thrusters 6 chest-to-bar pull-ups 9 thrusters 9 chest-to-bar pull-ups 12 thrusters 12 chest-to-bar pull-ups 15 thrusters 15 chest-to-bar pull-ups 18 thrusters 18 chest-to-bar pull-ups	As many sets as possible in 7 min
11	Articular mobility Hinge PVC overhead squats Medicine ball slams Bear walk Hindu push-ups	Hero WOD Tama 800-m single-arm barbell farmers carry, 45 lb/35 lb (20 kg/16 kg) 31 toes-to-bars 31 push-ups 31 front squats, 95 lb/65 lb (43 kg/30 kg) 400-m single-arm barbell farmers carry, 95 lb/65 lb (43 kg/30 kg) 31 toes-to-bars 31 push-ups 31 hang power cleans, 135 lb/95 lb (61 kg/89 kg) 200-m single-arm barbell farmers carry, 135 lb/95 lb (61 kg/89 kg)	Complete as fast as possible
12	Articular mobility Hinge PVC overhead squats Medicine ball slams Bear walk Hindu push-ups	Hero double Helen Run 800 m 30 kettlebell swings 18 pull-ups	3 rounds of time scored

Abbreviation: PVC, polyvinyl chloride; WOD, workout of the day.

Participants performed 3 sets of 10 repetitions with a 1-minute rest between sets for all the exercises described above (see Figure 2 and Supplemental Video; video available online at http://dx.doi.org/10.4085/1062-6050-181-18.S1). All training sessions were monitored by a certified CrossFit instructor.

Control Group. Participants allocated to the control group received no intervention.

Outcomes

Ankle-dorsiflexion range of motion was assessed by the WBLT. For this test, the participant stands facing a wall with the involved foot parallel to a tape measure that has been attached to the floor and the opposite leg placed behind in tandem stance. A forward lunge is performed until the anterior knee contacts the wall with the heel firmly planted on the ground. The maximum distance the participant can position the foot away from the wall while keeping both the heel flat on the floor and the knee touching the wall is measured in millimeters between the part of the foot that is closest to the wall and the wall itself. Participants performed 3 practice runs and 3 test trials on the involved limb. The average of the 3 test trials was calculated and used for statistical analysis. The WBLT has been shown to have high intrarater ($r = 0.99$) and interrater ($r = 0.98$) reliability.[18] Furthermore, it has already been studied in patients with CAI, and the results were shown to correlate with dynamic postural-control measures.[19]

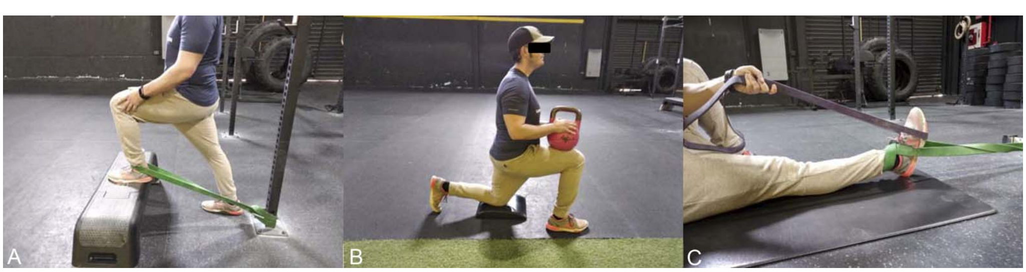

Figure 2. Self-mobilization techniques. A, Band. B, Kettlebell. C, Double band.

Dynamic balance was measured using a simplified version of the SEBT in the anterior-, posteromedial (PM)-, and posterolateral (PL)-reach directions.[20] Patients stood on a single leg with the involved limb at the center of a grid and maintained single-limb stance with both hands on the hips while trying to reach the farthest point possible in the anterior-, PM-, and PL-reach directions with the most distal part of the reach foot, while keeping slight toe contact on the tape measure.[20,21] The SEBT has been reported[21] to be a reliable and valid test for detecting reach deficits both between participants and between the sides of participants with unilateral ankle instability.

Self-reported ankle instability was determined using the CAIT, a 9-item questionnaire with reported discriminative properties for identifying and classifying the severity of ankle instability. This tool was recommended by the International Ankle Consortium.[22,23] The questionnaire is scored from 0 to 30, with lower scores indicating decreased stability and scores $\leq$25 indicating CAI.[24] The Spanish version of the CAIT has high internal consistency (Cronbach $\alpha = 0.766$) and reliability (intraclass correlation coefficient = 0.979; 95% confidence interval [CI] = 0.958, 0.990).[25]

Statistical Analysis

Descriptive statistics were used for the means and standard deviations of continuous variables and frequencies (percentages) for the categorical variables. We performed visual inspections of frequency distributions (histograms) and Shapiro-Wilk tests to confirm the normal distribution of the continuous variables. Concerning participant demographics and baseline measures, separate 1-way analyses of variance (ANOVAs) were performed for continuous variables and Kruskal-Wallis tests for categorical variables. This allowed us to examine the differences among the 3 groups: ankle-joint self-mobilization plus CrossFit, CrossFit alone, and control (no treatment). For each outcome variable (DFROM, SEBT, and CAIT), a 2-way ANOVA (group and time) with repeated measures was conducted to determine treatment effects among the groups. Post hoc Tukey honestly significant difference tests were performed to locate differences in the presence of significant interactions or main effects. To assess within-group effect sizes, change scores were calculated between preintervention and postintervention measurements with Cohen d effect sizes, which were computed by dividing the change score by the pooled standard deviation. Similarly, between-groups effect sizes were examined using change scores from postintervention measurements between 2 of the 3 groups along with the Cohen d. The strength-of-treatment effect was interpreted using the Cohen d effect size: *weak* if $<$0.02, *small* if 0.2 to 0.05, *moderate* if 0.5 to 0.8, or *large* if $>$0.08. The α level was set a priori at $P < .05$. To compare intervention effects across groups, we calculated clinical epidemiologic measures such as probability, relative risk (RR), and numbers needed to treat (NNT).[26] We dichotomized participants as having successful or unsuccessful results based on the change from pre- to postintervention measurements for each outcome variable. A *success* was defined as a change that exceeded the minimal detectable change (MDC) for the WBLT (1.9 cm)[27] and SEBT (anterior = 1.56%, PM = 3.36%, PL = 4.28%)[28] or the minimal clinically important change on the CAIT (3 points).[28] Using the probability values for success (ie, success rate) within the group, we estimated the RR and NNT between 2 of the 3 groups for each outcome, along with their 90% CIs. The 90% CI has been recommended to serve as the 95% credibility interval and an alternative designation that contains the true effect magnitude.[26] Thus, the lower bound of the 90% CI would correspond to the lower limit of the 95% credibility interval that represents a 95% level of certainty about the smallest comparative effect magnitude for the RR point estimate, whereas the upper limit of the 95% CI for the NNT point estimate reflects the smallest effect. The strength of intervention effects (RR) was as follows: *small* if $\geq$1.1, *moderate* if $\geq$1.4, *large* if $\geq$2.0, or *very large* if $\geq$3.3. We used SPSS (version 24.0; IBM Corp, Armonk, NY) for tests of normality and baseline comparisons and an Excel (version 2016; Microsoft Corp, Redmond, WA) spreadsheet to calculate the RR and NNT with their 90% respective CIs.

RESULTS

The groups did not differ in any demographic or baseline measures, indicating that they were similar in their demographic and clinical characteristics (Table 1). Preintervention and postintervention data for each outcome in all 3 groups are presented in Table 3 along with their group means changes. The self-mobilization plus CrossFit group improved in ankle motion (DFROM), dynamic balance (SEBT), and self-reported ankle stability (CAIT). These improvements were large as indicated by Cohen d measures greater than 1.52 and appeared to be true because the associated 95% CI did not cross zero (Table 4). Outcome measures for the CrossFit-alone group improved in comparison with the control group, but the strength-of-treatment effects on balance were somewhat smaller, as illustrated by effect sizes of less than 1 (moderate to large). As expected, the control group did not experience change in any of their outcome variables over time. In addition to the within-group treatment effects, both intervention groups displayed mostly large treatment effects (Cohen d $>$ 1) for all outcome variables when compared with the control group (Table 4).

Regarding the probability of successful results, both intervention groups were more associated than the control group with patients achieving the desirable clinical change (exceeding the MDC for DFROM and the SEBT) or benefit (exceeding the MDIC for the CAIT) for almost all outcomes (Table 5). The effects were at least moderate, given that the probability of success for a patient who was treated with either intervention was higher than for a patient who received no intervention. The 95% credibility lower limits for the RRs ensure that the success rates were at least 1.8 times greater in a patient who pursued the combination of self-mobilization and CrossFit for all outcome variables—and at least 2.3 times greater in a patient treated only with CrossFit except for 1 outcome variable (SEBT-PM) for which the effect was not clear as the associated CI crossed 1. In addition to the RR results, both interventions were beneficial: At most, 4 patients needed to be treated with self-mobilization plus CrossFit to see benefits in 1 patient for all outcome variables. On the other hand, except

Table 3. Within-Group Change Scores Between Pre-and Postintervention Measurements[a]

	Group								
	Self-Mobilization Plus CrossFit			CrossFit			Control		
Outcomes	Baseline	End of Intervention	Within-Group Change (95% CI)	Baseline	End of Intervention	Within-Group Change (95% CI)	Baseline	End of Intervention	Within-Group Change (95% CI)
Dorsiflexion range of motion	8.72 ± 1.19	11.00 ± 0.67	2.28 (1.74, 2.83)	8.97 ± 1.01	10.36 ± 0.98	1.40 (0.95, 1.84)	8.75 ± 0.83	8.71 ± 0.83	−0.04 (−0.09, 0.02)
Star Excursion Balance Test score									
Anterior	75.14 ± 2.42	78.26 ± 1.60	3.11 (2.47, 3.75)	76.40 ± 2.97	78.17 ± 2.93	1.77 (1.38, 2.15)	74.80 ± 2.84	75.17 ± 2.83	0.37 (−0.10, 0.84)
Posteromedial	89.92 ± 3.05	94.57 ± 2.56	4.65 (3.63, 5.67)	89.70 ± 4.20	92.63 ± 3.30	2.93 (2.15, 3.71)	89.22 ± 3.37	90.56 ± 3.80	1.34 (−0.15, 2.83)
Posterolateral	86.85 ± 2.41	92.37 ± 2.82	5.52 (4.54, 6.50)	86.93 ± 4.04	90.44 ± 3.62	3.51 (1.94, 5.08)	87.90 ± 3.15	87.94 ± 3.25	0.04 (−0.48, 0.55)
Cumberland Ankle Instability Tool score (range = 0–30)	18.84 ± 2.08	24.16 ± 1.65	5.32 (4.67, 5.97)	18.92 ± 1.84	23.29 ± 1.27	4.38 (3.53, 5.22)	19.00 ± 2.07	19.10 ± 2.07	0.10 (−0.25, 0.45)

[a] Data are given as mean ± SD.

Table 4. Between-Groups Effect Sizes

	Comparison					
	Self-Mobilization Plus CrossFit Versus Control		CrossFit Versus Control		Self-Mobilization Plus CrossFit Versus CrossFit	
Outcomes	Between-Group Change (95% CI)[a]	Cohen d (95% CI)	Between-Group Change (95% CI)	Cohen d (95% CI)	Between-Group Change (95% CI)	Cohen d (95% CI)[b]
Dorsiflexion range of motion	2.29[c] (1.84, 2.74)	3.07 (2.21, 3.92)	1.65[c] (1.10, 2.20)	1.81 (1.11, 2.50)	0.64[c] (0.16, 1.12)	0.77 (0.19, 1.35)
Star Excursion Balance Test score						
Anterior	3.09[c] (1.75, 4.43)	1.38 (0.73, 2.02)	3.00[c] (1.26, 4.74)	1.04 (0.42, 1.66)	0.09 (−1.26, 1.44)	0.04 (−0.52, 0.60)
Posteromedial	4.01[c] (2.11, 5.91)	1.26 (0.62, 1.89)	2.07[c] (−0.06, 4.20)	0.58 (−0.01, 1.18)	1.94[c] (0.25, 3.63)	0.66 (0.08, 1.23)
Posterolateral	4.43[c] (2.63, 6.23)	1.47 (0.81, 2.12)	2.50[c] (0.42, 4.58)	0.72 (0.12, 1.33)	1.93[c] (0.07, 3.79)	0.60 (0.02, 1.17)
Cumberland Ankle Instability Tool score (range = 0–30)	5.06[c] (3.95, 6.17)	2.73 (1.93, 3.54)	4.19[c] (3.17, 5.21)	2.48 (1.70, 3.26)	0.87 (0.02, 1.72)	0.59 (0.02, 1.16)

[a] Between-groups change scores were calculated using postintervention measurements between 2 of the 3 groups, with positive values indicating that the intervention listed first was more effective.

[b] Cohen d estimates of effect sizes were computed by dividing the change scores by the pooled standard deviations.

[c] A statistically significant change that was greater than the Tukey honestly significant difference.

Table 5. Epidemiologic Measures

Outcomes	Probability, % (Successes)			Relative Risk (or Success; 95% Credibility Interval)			NNT (95% Credibility Interval)		
	Self-Mobilization Plus CrossFit (n = 25)	CrossFit (n = 24)	Control (n = 21)	Self-Mobilization Plus CrossFit Versus CrossFit	Self-Mobilization Plus CrossFit Versus Control	CrossFit Versus Control	Self-Mobilization Plus CrossFit Versus CrossFit	Self-Mobilization Plus CrossFit Versus Control	CrossFit Versus Control
Dorsiflexion range of motion	56 (14)	19 (4)	0 (0)	3.4 (1.5, 7.5)	NA	NA	3 (2–6 NNTB)	2 (1–3 NNTB)	6 (3–46 NNTB)
Star Excursion Balance Test score									
Anterior	88 (22)	67 (16)	10 (2)	1.3 (1.1, 1.7)	9.2 (3.0, 28.1)	7.0 (2.3, 21.7)	5 (3–64 NNTB)	1 (1–2 NNTB)	2 (1–3 NNTB)
Posteromedial	64 (16)	33 (8)	14 (3)	1.9 (1.1, 3.3)	4.5 (1.8, 11.2)	2.3 (0.9, 6.3)	3 (2–14 NNTB)	2 (2–4 NNTB)	5 (44 NNTH ∞ 3 NNTB)
Posterolateral	68 (17)	21 (5)	0 (0)	3.3 (1.6, 6.5)	NA	NA	2 (2–4 NNTB)	1 (1–2 NNTB)	5 (3–18 NNTB)
Cumberland Ankle Instability Tool score (range = 0–30)	96 (24)	83 (20)	0 (0)	1.2 (0.9, 1.4)	NA	NA	8 (42 NNTH ∞ 3 NNTB)	1 (1–2 NNTB)	1 (1–2 NNTB)

Abbreviations: NA, not applicable; NNT, number needed to treat; NNTB, number needed to treat to benefit; NNTTH, number needed to treat to harm.

for the SEBT-PM outcome, 46 patients needed to be treated with CrossFit alone to see improvement.

In comparing the 2 interventions, the combination of self-mobilization and CrossFit appeared to be superior to CrossFit alone for DFROM and SEBT but not for CAIT. The superior effects were small to moderate, and the probability (success rate) for a patient treated with self-mobilization and CrossFit was at least 1.1 times greater than for a patient receiving CrossFit alone. At most, 64 patients needed to be treated with self-mobilization and CrossFit to see benefits compared with CrossFit alone.

DISCUSSION

Participants in both intervention groups showed high adherence to treatment, with only 1 dropout in the CrossFit-alone group and no reported adverse events. The results suggest that both interventions, ankle-joint self-mobilization plus CrossFit and CrossFit training alone, were effective in improving range of motion, dynamic balance, and self-reported ankle instability. Nevertheless, the magnitude of change of both treatment conditions differed depending on the variable.

Limited ankle dorsiflexion was present in those with CAI and associated with deficits in functional performance and balance.[8] Furthermore, DFROM restrictions are considered a risk factor that may increase the injury rate in other structures, such as the anterior cruciate ligament or Achilles tendon.[29] Improved DFROM has been observed after manual therapy and the use of instruments designed to enhance posterior gliding of the talus.[30] The self-mobilization exercises in our study, which were focused on posterior gliding of the talus and enhanced by the active movement of the patient, demonstrated large effects in improving DFROM (Cohen d = 3.07); 56% of successful patients exceeded the MDC, and the NNT was 2 patients. These results agree with those of researchers[7,8] who determined that weight-bearing mobilization with movement was the most effective way to increase ankle DFROM. Although previous investigators did not use the WBLT as an outcome measure for ankle DFROM, after we estimated the equivalence between millimeters and angles, our results seem to be superior to those reported by Kang et al[30] and Jeon et al.[9] Nevertheless, 1 of our major findings was the improved DFROM in the CrossFit-alone group (Cohen d = 1.81): 19% of participants exceeded the MDC, and the NNT was 6. To our knowledge, we are the first to study the influence of CrossFit in improving ankle DFROM. These findings could be explained by the reported effectiveness of some stretching protocols and the effects of the closed kinetic chain on talar displacement during a weight-bearing task.[31] As expected, the self-mobilization group displayed more improvement in ankle DFROM, with an NNT difference of 3 versus 46 patients compared with the CrossFit-alone group. Clinicians who seek to improve ankle DFROM in patients with CAI can now consider including self-mobilization and CrossFit training in their rehabilitation programs.

The influence of ankle-joint mobilization and strength training in improving dynamic postural control has been explored previously.[4,6] According to Kosik et al,[4] both interventions (self-mobilization plus CrossFit and CrossFit alone) were linked with increases in the reach distances on the SEBT due to the influence of joint mobilization and strength training. The improved dynamic balance after 12 weeks of CrossFit training seems to be comparable with the results obtained after neuromuscular training.[32] Our NNT analysis revealed that both interventions can be considered excellent treatments for CAI, but the self-mobilization group achieved better scores than the CrossFit-alone group for the PM and PL reach directions of the SEBT (although not in the anterior direction). The ankle DFROM results of the self-mobilization group were also superior; modified balance-adaptation strategies in patients with CAI are a possible explanation for this finding.

In contrast with single-exercise strengthening programs in patients with CAI,[32] the CrossFit-based intervention does not focus only on the ankle joint. This functional approach may lead to additional benefits linked to the recruitment of larger muscle groups during multijoint exercises, which could positively influence the balance strategies of patients with CAI.[15] These results agree with those of Donovan et al,[33] who developed a multicomponent training protocol for patients with CAI and reported benefits in DFROM and balance.

Another important aspect of patients with CAI is the self-reported feeling of instability. We used the CAIT to assess the severity of the ankle instability of our participants. Previous investigators found that joint mobilization[7] and neuromuscular training[11] were effective in improving self-reported instability. After 12 weeks, the self-mobilization plus CrossFit and CrossFit-alone interventions resulted in similar improvements on the CAIT of >3 points, which has been established as the MDC for monitoring change over time.[28] The NNT value was 1 in both groups and therefore these interventions can be considered perfect treatments. The improvements of 96% and 83% of the participants in the self-mobilization plus CrossFit and CrossFit-alone groups, respectively, can be considered the greatest strength of the present study. In contrast with Shih et al,[34] who reported improvement on the CAIT only in the group allocated to the mobilization plus training protocol, we observed that both interventions were effective in improving self-reported ankle instability. Some of the exercises we included, such as box jumps, barbell lunges, and overhead squats, may be associated with enhanced self-confidence and an improved feeling of stability in patients with CAI. Our results suggest that CrossFit training should be considered an effective treatment option for patients with subjective ankle instability.

Further studies are needed to determine the effectiveness of CrossFit as a therapeutic approach in CAI. The choice of exercises, as well as the total training volume during the intervention, should both be addressed. Adding self-mobilization as a warm-up protocol in other sports could be beneficial when designing rehabilitation programs for patients with CAI. The major limitation of our research was the absence of a follow-up period to monitor the long-term effects of both interventions. The use of a self-reported function questionnaire such as the Foot and Ankle Ability Measure would have provided valuable information about ankle function, but no Spanish version was available at the time of this study.

CONCLUSIONS

We are the first to examine the influence of self-mobilization and CrossFit in patients with CAI. The results suggest that a 12-week program of CrossFit-based training was effective in improving ankle DFROM, dynamic postural control, and self-reported instability. The addition of ankle-joint self-mobilization exercises to the CrossFit training produced additional benefits in ankle DFROM, as well as in PM and PL SEBT reach distances.

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SUPPLEMENTAL MATERIAL

Supplemental Video. Self-mobilization techniques.
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Clinical Practice Guidelines

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Ankle Stability and Movement Coordination Impairments: Lateral Ankle Ligament Sprains Revision 2021

Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability and Health From the Academy of Orthopaedic Physical Therapy of the American Physical Therapy Association

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Summary of Recommendations

CLINICAL COURSE – ACUTE LATERAL ANKLE SPRAIN

B Clinicians should include patient age, body mass index, pain coping strategies, report of instability, history of previous sprain, ability to bear weight, pain with weight bearing, ankle dorsiflexion range of motion (ROM), medial joint-line tenderness, balance, and ability to jump and land (as safely tolerated) in their initial assessment, because of their role in influencing the clinical course and estimation of time to accomplish the goals of an individual with an acute lateral ankle sprain (LAS).

CLINICAL COURSE – CHRONIC ANKLE INSTABILITY

C Clinicians may include previous treatment, number of sprains, pain level, and self-report of function in their evaluation, as well as an assessment of the sensorimotor movement systems of the foot, ankle, knee, and hip during dynamic postural control and functional movements, because of their role in influencing the clinical course and estimation of time to accomplish the goals of an individual with chronic ankle instability (CAI).

DIAGNOSIS/CLASSIFICATION – ACUTE LATERAL ANKLE SPRAIN

B Clinicians should use special tests, including the reverse anterolateral drawer test and anterolateral talar palpation in addition to the traditional anterior drawer test, and a thorough history and physical examination to aid in the diagnosis of a LAS.

DIAGNOSIS/CLASSIFICATION – CHRONIC ANKLE INSTABILITY

B When determining whether an individual has CAI, clinicians should use a reliable and valid discriminative instrument, such as the Cumberland Ankle Instability Tool or the Identification of Functional Ankle Instability, as well as a battery of functional performance tests that have established validity to differentiate between healthy controls and individuals with CAI.

EXAMINATION – OUTCOME MEASURES

A Clinicians should use validated patient-reported outcome measures, such as the Patient-Reported Outcomes Measurement Information System physical function and pain interference scales, the Foot and Ankle Ability Measure, and the Lower Extremity Functional Scale, as part of a standard clinical examination. Clinicians should utilize these before and 1 or more times after the application of interventions intended to alleviate the impairments of body function and structure, activity limitations, and participation restrictions associated with an acute LAS or CAI.

C Clinicians may use the Pain Self-Efficacy Questionnaire in the acute and postacute periods after a LAS to assess effective coping strategies for pain, and the 11-item Tampa Scale of Kinesiophobia and the Fear-Avoidance Beliefs Questionnaire to assess fear of movement and reinjury and fear-avoidance beliefs in those with CAI.

EXAMINATION – PHYSICAL IMPAIRMENT MEASURES

A Clinicians should assess and document ankle swelling, ROM, talar translation, talar inversion, and single-leg balance in patients with an acute LAS, postacute LAS, or CAI at baseline and 2 or more times over an episode of care. Clinicians should specifically include measures of dorsiflexion, using the weight-bearing lunge test, static single-limb balance on a firm surface with eyes closed, and dynamic balance with the Star Excursion Balance Test anterior, anteromedial, posteromedial, and posterolateral reach directions.

C In patients with CAI, clinicians may also assess and document hip abduction, extension, and external rotation strength 2 or more times over an episode of care.

EXAMINATION – ACTIVITY LIMITATION/PHYSICAL PERFORMANCE MEASURES

B Clinicians should assess and document objective and reliable measures of activity limitation, participation restriction, and symptom reproduction at baseline and 2 or more times over an episode of care when evaluating a patient with a LAS or CAI, and specifically include measures of single-limb hopping under timed conditions when appropriate.

INTERVENTIONS – PRIMARY PREVENTION OF FIRST-TIME LATERAL ANKLE SPRAIN

A Clinicians should recommend the use of prophylactic bracing to reduce the risk of a first-time LAS, particularly for those with risk factors for LAS.

C Clinicians may recommend the use of prophylactic balance training exercises to individuals who have not experienced a first-time LAS.

INTERVENTIONS – SECONDARY PREVENTION OF RECURRENT LATERAL ANKLE SPRAINS FOLLOWING AN INITIAL SPRAIN

A Clinicians should prescribe prophylactic bracing and use proprioceptive and balance-focused therapeutic exercise training programs to address impairments identified on physical examination to reduce the risk of a subsequent injury in patients with a first-time LAS.

INTERVENTIONS – ACUTE AND POSTACUTE LATERAL ANKLE SPRAINS: PROTECTION AND OPTIMAL LOADING

A Clinicians should advise patients with an acute LAS to use external supports, such as braces or taping, and to progressively bear weight on the affected limb. The type of external support and gait assistive device recommended should be based on the severity of the injury, phase of tissue healing, level of protection indicated, extent of pain, and patient preference.

A In more severe injuries, immobilization ranging from semi-rigid bracing to below-knee casting may be indicated for up to 10 days post injury.

INTERVENTIONS – ACUTE AND POSTACUTE LATERAL ANKLE SPRAINS: THERAPEUTIC EXERCISE

A Clinicians should implement rehabilitation programs with a structured therapeutic exercise component that can include protected active ROM, stretching exercises, neuromuscular training, postural re-education, and balance training, both in clinic and at home, as determined by injury severity, identified impairments, preferences, learning needs, and social barriers in those with a LAS.

D There is conflicting evidence as to the best way to augment the unsupervised components of a home program in those with a LAS, for example, by written instructions, exercise-based video games, or app-based instruction. Therefore, this can be determined by the individual's specific learning needs and access to relevant technology.

INTERVENTIONS – ACUTE AND POSTACUTE LATERAL ANKLE SPRAINS: OCCUPATIONAL AND SPORTS-RELATED TRAINING

B Clinicians should implement a return-to-work schedule and use a brace early in rehabilitation, occupational or sport-related training, and/or a work-hardening program to mitigate activity limitation and participation restriction following a LAS.

INTERVENTIONS – ACUTE AND POSTACUTE LATERAL ANKLE SPRAINS: MANUAL THERAPY

A Clinicians should use manual therapy procedures, such as lymphatic drainage, active and passive soft tissue and joint mobilization, and anterior-to-posterior talar mobilization procedures within pain-free movement, alongside therapeutic exercise to reduce swelling, improve pain-free ankle and foot mobility, and normalize gait parameters in individuals with a LAS.

INTERVENTIONS – ACUTE AND POSTACUTE LATERAL ANKLE SPRAINS: ACUPUNCTURE

D There is conflicting evidence regarding the use of acupuncture to reduce symptoms associated with an acute LAS.

INTERVENTIONS – ACUTE AND POSTACUTE LATERAL ANKLE SPRAINS: PHYSICAL AGENTS

Cryotherapy

C Clinicians may use repeated intermittent applications of ice in association with a therapeutic exercise program to address symptoms and functioning following an acute LAS.

Diathermy

C Clinicians can utilize pulsating shortwave diathermy for reducing edema and gait deviations associated with acute ankle sprains.

Electrotherapy

D There is moderate evidence both for and against the use of electrotherapy for the management of acute ankle sprains.

Low-Level Laser Therapy

C Clinicians may use low-level laser therapy to reduce pain in the initial phase of an acute LAS.

Ultrasound

A Clinicians should not use ultrasound for the management of acute ankle sprains.

INTERVENTIONS – ACUTE AND POSTACUTE LATERAL ANKLE SPRAINS: NONSTEROIDAL ANTI-INFLAMMATORY MEDICATION

C Clinicians may prescribe nonsteroidal anti-inflammatory medications (as physical therapy practice acts allow) to reduce pain and swelling in those with an acute LAS.

INTERVENTIONS – CHRONIC ANKLE INSTABILITY: EXTERNAL SUPPORT

B Clinicians should not use external support, including braces or taping, as a stand-alone intervention to improve balance and postural stability in individuals with CAI.

INTERVENTIONS – CHRONIC ANKLE INSTABILITY: THERAPEUTIC EXERCISE AND ACTIVITY

A Clinicians should prescribe proprioceptive and neuromuscular therapeutic exercise to improve dynamic postural stability and patient-perceived stability during function in individuals with CAI.

INTERVENTIONS – CHRONIC ANKLE INSTABILITY: MANUAL THERAPY

A Clinicians should use manual therapy procedures, such as graded joint mobilizations, manipulations, and non–weight-bearing and weight-bearing mobilization with movement, to improve weight-bearing ankle dorsiflexion and dynamic balance in the short term for individuals with CAI.

INTERVENTIONS – CHRONIC ANKLE INSTABILITY: DRY NEEDLING

C Clinicians may use dry needling of the fibularis muscle group, in conjunction with a proprioceptive training program, to reduce pain and improve function in individuals with CAI.

INTERVENTIONS – CHRONIC ANKLE INSTABILITY: COMBINED TREATMENTS

B Clinicians may use multiple interventions to supplement balance training over an episode of care for individuals with CAI, to include a combination of exercise and manual therapy procedures as guided by the patient's values and goals, the clinician's judgment, and evidence-based clinical recommendations.

INTERVENTIONS TO ADDRESS PSYCHOLOGICAL FACTORS DURING THE COURSE OF REHABILITATION

E Clinicians may use psychologically informed techniques, such as motivational interviewing, to maximize patients' self-efficacy and to address uncomplicated psychological correlates and mediators of injury adjustment and recovery in order to maximize the effects of treatment in a positive manner for individuals with a LAS and CAI.

List of Abbreviations

ACR: American College of Radiology
ADL: activities of daily living
ADT: anterior drawer test
AII: Ankle Instability Instrument
ALDT: anterolateral drawer test
AOFAS: American Orthopaedic Foot & Ankle Society
APTA: American Physical Therapy Association
ATFL: anterior talofibular ligament
BAR: Bernese ankle rules
BESS: Balance Error Scoring System
BMI: body mass index
CAI: chronic ankle instability
CAIT: Cumberland Ankle Instability Tool
CAT: computer adaptive test
CI: confidence interval
CPG: clinical practice guideline
CT: computed tomography
FAAM: Foot and Ankle Ability Measure
FABQ: Fear-Avoidance Beliefs Questionnaire
FADI: Foot and Ankle Disability Index
FAOS: Foot and Ankle Outcome Score
FFI: Foot Function Index
FPI: Foot Posture Index
HR: hazard ratio
ICD: International Statistical Classification of Diseases and Related Health Problems
ICF: International Classification of Functioning, Disability and Health
IdFAI: Identification of Functional Ankle Instability
***JOSPT*:** *Journal of Orthopaedic & Sports Physical Therapy*
LAS: lateral ankle sprain
LE-FMS: lower extremity Functional Movement Screen
LEFS: Lower Extremity Functional Scale
LRAR: low-risk ankle rules
MCID: minimal clinically important difference
MRI: magnetic resonance imaging
NSAID: nonsteroidal anti-inflammatory drug
OAR: Ottawa ankle rules
OR: odds ratio
PF: physical function
PI: pain interference
PROMIS: Patient-Reported Outcomes Measurement Information System
PSEQ: Pain Self-Efficacy Questionnaire
RALDT: reverse anterolateral drawer test
RCT: randomized clinical trial
ROM: range of motion
SAFAS: Sports Athlete Foot and Ankle Score
SEBT: Star Excursion Balance Test
TSK-11: 11-item Tampa Scale of Kinesiophobia
USI: ultrasound imaging

Introduction

AIM OF THE GUIDELINES

The Academy of Orthopaedic Physical Therapy of the American Physical Therapy Association (APTA) has an ongoing effort to create evidence-based clinical practice guidelines (CPGs) for orthopaedic physical therapy management of patients with musculoskeletal impairments described in the World Health Organization's International Classification of Functioning, Disability and Health (ICF).[476] The purposes of these clinical guidelines are to:

- Describe evidence-based physical therapy practice, including diagnosis, prognosis, intervention, and assessment of outcome, for musculoskeletal disorders commonly managed by orthopaedic physical therapists
- Classify and define common musculoskeletal conditions using the World Health Organization's terminology related to impairments of body function and body structure, activity limitations, and participation restrictions
- Identify interventions supported by current best evidence to address impairments of body function and structure, activity limitations, and participation restrictions associated with common musculoskeletal conditions
- Identify appropriate outcome measures to assess changes resulting from physical therapy interventions in body function and structure as well as in activity and participation of these individuals
- Provide a description to policy makers, using internationally accepted terminology, of the practice of orthopaedic physical therapists
- Provide information for payers and claims reviewers regarding the practice of orthopaedic physical therapy for common musculoskeletal conditions
- Create a reference publication for orthopaedic physical therapy clinicians, academic instructors, clinical instructors, students, interns, residents, and fellows regarding the best current practice of orthopaedic physical therapy

STATEMENT OF INTENT

These guidelines are not intended to be construed or to serve as a standard of medical care. Standards of care are determined on the basis of all clinical data available for an individual patient and are subject to change as scientific knowledge and technology advance and patterns of care evolve. These parameters of practice should be considered guidelines only. Adherence to them will not ensure a successful outcome in every patient, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgment regarding a particular clinical procedure or treatment plan must be made based on clinician experience and expertise in light of the clinical presentation of the patient, the available evidence, available diagnostic and treatment options, and the patient's values, expectations, and preferences. However, we suggest that significant departures from accepted guidelines should be documented in the patient's medical records at the time the relevant clinical decision is made.

SCOPE AND RATIONALE OF THE GUIDELINES

This guideline addresses the distinct but related lower extremity impairments of those with a first-time lateral ankle sprain (LAS) and those with chronic ankle instability (CAI). Studies generally categorize LAS based on chronicity, with the acute period occurring during the first 1 to 2 weeks following injury.[348] In the 2013 CPG,[298] the term "subacute" was used to characterize the time after the acute period and for up to 12 months post injury. In the current 2021 CPG, the term "subacute" was replaced with "postacute" to better characterize the time after the acute period to the 12-month point. Depending on many factors, impairments may continue following injury. While most individuals experience resolution of symptoms, complaints of instability may continue and are defined as CAI. The 2013 CPG[298] reported that the prevalence of CAI varied greatly, from 0% to 73%. A more recent longitudinal study[109] found that 60% of individuals achieve resolution of activity limitations and participation restrictions by the 12-month point, with 40% progressing to develop CAI. Those with CAI are characterized by perceived instability or episodic "giving way" of the ankle that persists for more than 12 months following the initial injury and results in activity limitation and participation restriction.[179] Individuals with CAI may have varying amounts of mechanical instability due to connective tissue impairment, functional instability resulting from sensorimotor impairment, or elements of both.[179] These impairments, which are mediated by intrinsic and extrinsic factors, contribute to activity limitation and restriction of participation. While the International Ankle Consortium has published criteria to identify patients with CAI,[159] these criteria were not consistently used in the literature. When summarizing the literature in this 2021 CPG, conditions described as "recurrent sprains," "ankle instability," "functional ankle instability," and "mechanical ankle instability" greater than 12 months following the first-time injury are categorized as CAI. Therefore, the term "LAS" when used in this CPG is meant to describe those with first-time ankle sprains less than 12 months after injury, and "CAI" is used to describe those with persistent symptoms for 12 months or more after injury. Additionally, the term "ankle sprain" is used in this CPG when specific studies applied that term to their participants. It was assumed that a vast majority of those with "ankle sprains" had a LAS, unless otherwise indicated in those studies. The criteria described above were applied as consistently as possible given the information provided by the studies summarized in this CPG.

Methods

Content experts were appointed by the Academy of Orthopaedic Physical Therapy, APTA, Inc to conduct a review of the literature and develop an updated CPG for ankle stability and movement coordination impairments: lateral ankle ligament sprains. The aims of the revision were to provide a concise summary of the contemporary evidence since publication of the original guideline and to develop new recommendations or revise previously published recommendations to support evidence-based practice. The authors of this guideline revision worked with the CPG editors and medical librarians for methodological guidance. The research librarians were chosen for their expertise in systematic review and rehabilitation literature search and to perform systematic searches for concepts associated with classification, examination, and intervention strategies for ankle stability and movement coordination impairments: lateral ankle ligament sprains. Briefly, the following databases were searched from April 2012 to June 2020: MEDLINE, CINAHL, Cochrane Library, and PEDro (see **APPENDIX A** for full search strategies and **APPENDIX B** for search dates and results, available at www.orthopt.org).

The authors declared relationships and developed a conflict management plan, which included submitting a conflict-of-interest form to the Academy of Orthopaedic Physical Therapy, APTA, Inc. Articles that were authored by a reviewer were assigned to an alternate reviewer. Funding was provided to the CPG development team for travel and expenses for CPG development training by the Academy of Orthopaedic Physical Therapy, APTA, Inc. The CPG development team maintained editorial independence.

Articles contributing to recommendations were reviewed based on specified inclusion and exclusion criteria, with the goal of identifying evidence relevant to physical therapist clinical decision making for adults with ankle stability and movement coordination impairments: lateral ankle ligament sprains. The title and abstract of each article were reviewed independently by 2 members of the CPG development team for inclusion (see **APPENDIX C** for inclusion and exclusion criteria, available at www.orthopt.org). Full-text review was then similarly conducted to obtain the final set of articles for contribution to recommendations. The team leader (R.L.M.) provided the final decision on discrepancies that were not resolved by the review team (see **APPENDIX D** for the flow chart of articles, available at www.orthopt.org). For selected relevant topics that were not appropriate for the development of recommendations, such as incidence and imaging, articles were not subject to the systematic review process and were not included in the flow chart. Evidence tables for this CPG are available on the Clinical Practice Guidelines page of the Academy of Orthopaedic Physical Therapy of the APTA website (www.orthopt.org).

This guideline was issued in 2021 based on the published literature through June 2020, and will be considered for review in 2025, or sooner if new evidence becomes available. Any updates to the guideline in the interim period will be noted on the Academy of Orthopaedic Physical Therapy of the APTA website (www.orthopt.org).

LEVELS OF EVIDENCE

Individual clinical research articles were graded according to criteria adapted from the Centre for Evidence-Based Medicine (Oxford, UK) for diagnostic, prospective, and therapeutic studies. In teams of 2, each reviewer independently assigned a level of evidence and evaluated the quality of each article using a critical appraisal tool (see **APPENDICES E** and **F** for the level-of-evidence table and details on procedures used for assigning levels of evidence, available at www.orthopt.org). The evidence update was organized from the highest level of evidence to the lowest level. An abbreviated version of the grading system is provided below.

I	Evidence obtained from high-quality diagnostic studies, prospective studies, randomized controlled trials, or systematic reviews
II	Evidence obtained from lesser-quality diagnostic studies, prospective studies, systematic reviews, or randomized controlled trials (eg, weaker diagnostic criteria and reference standards, improper randomization, no blinding, less than 80% follow-up)
III	Case-control studies or retrospective studies
IV	Case series
V	Expert opinion

STRENGTH OF EVIDENCE AND GRADES OF RECOMMENDATION

The strength of the evidence supporting the recommendations was graded according to the previously established methods for the original guideline and those provided below. Each team developed recommendations based on the strength of evidence, including how directly the studies addressed the question of ankle stability and movement coordination impairments: lateral ankle ligament sprains. In developing their recommendations, the authors considered the strengths and limitations of the body of evidence and the health benefits, side effects, and risks of tests and interventions.

GRADES OF RECOMMENDATION		STRENGTH OF EVIDENCE	LEVEL OF OBLIGATION
A	Strong evidence	A preponderance of level I and/or level II studies support the recommendation. This must include at least 1 level I study	Must or should
B	Moderate evidence	A single high-quality randomized controlled trial or a preponderance of level II studies support the recommendation	Should
C	Weak evidence	A single level II study or a preponderance of level III and IV studies, including statements of consensus by content experts, support the recommendation	May
D	Conflicting evidence	Higher-quality studies conducted on this topic disagree with respect to their conclusions. The recommendation is based on these conflicting studies	
E	Theoretical/foundational evidence	A preponderance of evidence from animal or cadaver studies, from conceptual models/principles, or from basic sciences/bench research support this conclusion	May
F	Expert opinion	Best practice based on the clinical experience of the guideline development team	May

GUIDELINE REVIEW PROCESS AND VALIDATION

Identified reviewers who are experts in ankle stability and movement coordination impairments and in the management and rehabilitation of ankle sprains reviewed the CPG draft for integrity, accuracy, and to ensure that it fully represented the current evidence for the condition. The guideline draft was also posted for public comment and review on www.orthopt.org, and a notification of this posting was sent to the members of the Academy of Orthopaedic Physical Therapy, APTA, Inc. In addition, a panel of consumer/patient representatives and external stakeholders, such as claims reviewers, medical coding experts, academic educators, clinical educators, physician specialists, and researchers, also reviewed the guideline. All comments, suggestions, and feedback from the expert reviewers, public, and consumer/patient representatives were provided to the authors and editors for consideration and revisions. Guideline development methods, policies, and implementation processes are reviewed at least yearly by the Academy of Orthopaedic Physical Therapy and by APTA's Clinical Practice Guideline Advisory Panel, including consumer/patient representatives, external stakeholders, and experts in physical therapy practice guideline methodology.

DISSEMINATION AND IMPLEMENTATION TOOLS

In addition to publishing these guidelines in the *Journal of Orthopaedic & Sports Physical Therapy* (*JOSPT*), these guidelines will be posted on CPG areas of both the JOSPT and the Academy of Orthopaedic Physical Therapy, APTA, Inc websites, which are free-access website areas, and submitted to be made available (free access) on the ECRI Guidelines Trust (guidelines.ecri.org) and the Physiotherapy Evidence Database (https://pedro.org.au/). The implementation tools planned to be made available for patients, clinicians, educators, payers, policy makers, and researchers, and the associated implementation strategies, are listed in **TABLE 1**.

CLASSIFICATION

The primary International Statistical Classification of Diseases and Related Health Problems (ICD)-10 codes associated with ankle stability and movement coordination impairments are **S93.4 sprain and strain of ankle** and **M24.27 disorder of ligament, ankle and foot**.

The corresponding ICD-9-Clinical Modification codes include **845.00 sprain of ankle, unspecified site**, **845.02 sprain of**

TABLE 1 Planned Strategies and Tools to Support the Dissemination and Implementation of This Clinical Practice Guideline

Tool	Strategy
JOSPT's "Perspectives for Patients" and/or "Perspectives for Practice" articles	Patient-oriented guideline summary available on www.jospt.org
Mobile app of guideline-based exercises for patient/clients and health care practitioners	Marketing and distribution of app using www.orthopt.org
Clinician's Quick-Reference Guide	Summary of guideline recommendations available on www.orthopt.org
JOSPT's Read for Credit℠ continuing education units	Continuing Education Units available for physical therapists and athletic trainers
Webinars and educational offerings for health care practitioners	Guideline-based instruction available for practitioners on www.orthopt.org
Mobile and web-based app of guideline for training of health care practitioners	Marketing and distribution of app using www.orthopt.org
Physical Therapy National Outcomes Data Registry	Support the ongoing usage of data registry for common musculoskeletal conditions (www.ptoutcomes.com)
Non-English versions of the guidelines and guideline implementation tools	Development and distribution of translated guidelines and tools to JOSPT's international partners and global audience
American Physical Therapy Association's CPG+	Dissemination and implementation aids

calcaneofibular (ligament) of ankle, **845.03 sprain of tibiofibular (ligament), distal of ankle**, and **718.87 other joint derangement, not elsewhere classified, ankle and foot**.

The primary ICF body function codes associated with ankle ligament sprain are **b7150 stability of a single joint** and **b7601 control of complex voluntary movements**.

The primary ICF body structures codes associated with ankle stability and movement coordination impairments are **s75023 ligaments and fasciae of ankle and foot**, **s75012 muscles of lower leg**, **s75002 muscles of thigh**, and **s7402 muscles of pelvic region**.

The primary ICF activities and participation codes associated with ankle stability and movement coordination impairments are **d450 walking**, **d4552 running**, **d4553 jumping**, **d4558 exercise tolerance functions, other specified**, and **d9201 sports**.

ORGANIZATION OF THE GUIDELINE

A summary of the updated literature is provided for incidence/prevalence, pathoanatomical features, and differential diagnosis. As described in the Scope and Rationale of the Guideline, the term "LAS" is used to describe those with first-time ankle sprains less than 12 months after injury, and "CAI" is used to describe those with persistent symptoms for 12 months or more after injury. For risk factors, clinical course, diagnosis, examination, and intervention, the summary recommendation and grade of evidence from the 2013 guideline are presented, followed by a synthesis of the recent literature with the corresponding evidence levels. Each of those 5 topics concludes with the 2021 summary recommendation and its updated grade of evidence.

CLINICAL PRACTICE GUIDELINES

Impairment/Function-Based Diagnosis

INCIDENCE/PREVALENCE UPDATE 2021

Acute Lateral Ankle Sprain

It is estimated that approximately 50% of individuals who sustain a LAS seek medical attention, so reports of incidence and prevalence of LAS are suspected to be lower than actual rates of occurrence.[451] Despite this, ankle sprains are still the most common foot-ankle and sports-related injury for which individuals seek medical care,[119,329] including emergency room visits.[213] Level I evidence from a 2014 systematic review with meta-analysis shows a pooled prevalence of 11.88% of individuals with LAS in the general population.[119] Of the patients who do seek care, only 6.8% to 11.0% are referred to a rehabilitation specialist within 30 days of the injury.[132,133]

The same meta-analysis found that the incidence and prevalence of ankle sprains were greatest in children 12 years of age or younger (incidence, 2.85 per 1000 exposures; 95% confidence interval [CI]: 2.51, 3.19; prevalence, 12.62% of injuries).[119] Adolescents (age, 13-17 years) sustained sprains at a rate of 1.94 per 1000 exposures (95% CI: 1.73, 2.14), while adults (18 years of age or older) had a lower rate of ankle sprains, with an incidence of 0.72 per 1000 exposures (95% CI: 0.67, 0.77).[119] The prevalence of ankle sprains in adolescents was reported to be 10.55% of all injuries, which was lower than the prevalence of LAS in adults (11.41% of all injuries).[119] A 2016 study of more than 225 000 individuals who presented to an emergency room with an ankle sprain showed a slightly different distribution of injuries across age levels.[387] This study found that 27% of sprains occurred in individuals under 18 years of age, 40% occurred in individuals who were between 18 and 35 years of age, 18% occurred in individuals aged 36 to 49 years, and 15% occurred in individuals who were older than 49 years old.[387] One study reported the median age of individuals sustaining ankle sprains to be 27 years, with the highest rate of injury occurring in males between the ages of 14 and 37 years.[9]

Females had an estimated incidence rate of 13.6 ankle sprains per 1000 exposures (95% CI: 13.25, 13.94), which is nearly double that of males (6.94 per 1000 exposures; 95% CI: 6.8, 7.09).[119] Prevalence rates between the sexes were similar: prevalence in females was 10.99% and in males was 10.55%.[119] A 2016 study supported the evidence that ankle sprains occur more often in females, reporting that 57% of recorded ankle sprains were sustained by females.[387] A second study with a much smaller sample size reported that the prevalence of LAS was similar between the sexes.[9]

Forty percent of LASs occur during sports.[451] A 2016 study by Halabchi et al[170] reported that 58.5% of professional basketball and football athletes had experienced an ankle sprain. In high school athletes in the United States, ankle sprains occur at a rate of 3.13 per 10 000 exposures.[416] Ankle sprains are the most common injury in amateur student-athletes in Brazil, making up 18.2% of all reported injuries during the 2013 sports seasons.[17] In the United States, ankle sprains accounted for 7.3% of all reported injuries in collegiate athletics between 2009 and 2015, occurring at a rate of 4.95 per 10 000 athlete exposures.[372] Although more than half (57.3%) of these injuries occurred during practice, there was a higher rate of ankle sprains per athletic exposure during competition.[372] Ankle sprains are most common in indoor/court sports such as volleyball and basketball, occurring at a rate of 7 ankle sprains per 1000 athlete exposures.[119] Field sports, such as soccer, football, and rugby, have a much lower pooled incidence, at only 1 ankle sprain per 1000 athlete exposures.[119] Sport-specific prevalence and incidence of LAS have been described for American football,[29,326,337] Australian rules football,[466] baseball,[291,381] basketball,[157,180,288,306,346,368,372,439] dancing,[361,445] fencing,[172] figure skating,[254] floorball,[345,346] futsal,[289] Gaelic football,[370] handball,[4,15,321,322] ice hockey,[72] in-line hockey,[324] lacrosse,[457] netball,[400] rugby,[142,143,362] soccer,[9,17,52,129,135,164,261,408,453,466] surfing,[190] ultimate Frisbee,[181] and volleyball.[17,77,215,322,363] The prevalence and incidence of LAS have also been reported for those in military service.[40,119,344,389,480]

Recurrent Injury and Chronic Ankle Instability

Reports of the prevalence of CAI vary, ranging from 0.7% to 1.1%[178] in young adults, to 20% in adolescent athletes,[123] to 23.4% in high school and collegiate athletes,[420] to 29% in high school students.[191] Recurrent ankle sprains and instability are common among athletes. Female high school and collegiate athletes had significantly higher prevalence of CAI than their male counterparts.[420] A 2014 level IV study found that the prevalence of instability was significantly higher in high school athletes than in collegiate athletes.[420] In collegiate athletes, nearly 12% of reported ankle sprains were recurrent.[372] These recurrent sprains were most often sustained in athletes participating in women's basketball, outdoor track, and field hockey and men's basketball.[372] At the elite and professional levels of competition, recurrent ankle sprains occur at a similar rate, with 14.2% of professional football and basketball players reporting a history of a recurrent sprain[170] and 13.7% of elite soccer players sustaining recurrent LAS.[129] In the only prospective study performed to date, Doherty et al[109] reported that the prevalence of CAI was 40% in individuals who sought care for a first-time LAS. The much higher estimate of CAI from this prospective study[109] compared to results from retrospective studies is likely related to care-seeking behaviors, with the true burden likely underrepresented in the studies that employed retrospective designs.

PATHOANATOMICAL FEATURES UPDATE 2021

Concomitant injuries commonly occur with an acute LAS,[84,310] with bone bruising on magnetic resonance imaging (MRI) being one of the most common findings.[54,216] The extent of ankle effusion present after injury may be associated with more severe associated injuries,[70] but does not necessarily indicate the presence or absence of a fracture.[10] Ankle impingement, which can cause pain and limited motion, was found in 25% of individuals after LAS[212] and potentially results from soft tissue injury and/or posttraumatic tibiotalar osteophytes.[262,313,411] There is also evidence that alterations in the mechanical stiffness of soft tissue around the ankle can lead to abnormal kinematics and symptoms after a LAS,[236,253] including increased talar inversion and rotation,[271,342] that may result from a lengthened anterior talofibular ligament (ATFL)[2,74,217,327] and/or increased ATFL-posterior talofibular ligament angle.[270] The abnormal kinematics that occur after a LAS may contribute to altered joint loading and explain findings of an increase in cartilage stress and degeneration in talocrural,[151,196,238,443,472] subtalar,[222] and talonavicular joints.[293,443] Signs of early arthritis have been related to painful end range of motion (ROM) in individuals with symptoms lasting 6 to 12 months after the initial injury.[443] Symptoms of pain and instability may continue after a LAS and result from coexisting pathologies, including os trigonum syndrome; osteochondral injury; syndesmotic, deltoid, or subtalar ligament injuries; talonavicular, calcaneonavicular, and calcaneocuboid joint injuries; fibularis muscle group injuries; and/or nerve pathologies.[13,56,98,199,210,282,285,340,411,483] In individuals with CAI, intra-articular pathologies may be associated with continued symptoms.[282,411] It should be noted that these coexisting pathologies are seen on diagnostic testing in those who sustain a LAS but do not have symptoms.[147,444] There may also be anatomical factors, such as distal tibiofibular joint variations,[18,237] a flatter subtalar joint,[438] and hindfoot varus alignment,[281] associated with chronic complaints of instability.

Sensorimotor and ROM deficits can occur after a LAS and may lead to movement system abnormalities. While findings may be dependent on measurement technique and subject selection, investigators have found altered movement strategies with balance activities,[28,103,108,112,113,118,154,225,228] gait,[107,136,359] and jumping.[11,110,114,117] These changes may not be limited to the ankle, but can occur proximally at the knee and hip[11,107,108,110,112-114,117,118] as well as in the uninvolved lower extremity.[108,118] Changes in movement strategies on the involved lower extremity may be protective in nature, to prevent reinjury, and include a reliance on the hip and knee to reduce forces at the ankle.[11,110,112,114,117] Specific sensorimotor and ROM deficits at the foot-ankle complex include decreased strength of leg/ankle muscles,[138,347] decreased fibularis muscle reaction time,[188] decreased ankle dorsiflexion and plantar flexion ROM,[1,138,432] increased ankle frontal plane ROM,[39,138] and increased forefoot and midfoot mobility.[138] Due to the heterogeneity of pathomechanics and tissues injured during an inversion sprain, the role of these sensorimotor ROM deficits and movement system abnormalities is debated, as they are not always present or are present to varying degrees, with symptoms frequently lasting from a few weeks to 12 months or longer.[11,24,78,80,85,94,99,204,224,255,320,334,354,413,427,434]

Individuals who recover from a LAS, as defined by returning to at least a moderate level of activity and having a near normal self-reported functional level of activity within 12 months, are identified as "copers," while those who continue to have complaints of instability are identified as having CAI.[468] Attempts to identify the sensorimotor ROM deficits in those with CAI have received considerable attention. While findings may be dependent on measurement technique and subject selection, investigators have generally identified the following sensorimotor ROM deficits at the foot, ankle, knee, and hip: (1) abnormal timing of muscle activation at the ankle, knee, and hip,[5,86,88,122,131,188,205,211,221,241,242,256,264,269,275,319,330,331,383,399,401,403,406,407,430,442,459,460] (2) decreased force output/strength at the ankle[3,59,60,138,235,249,333,343,352,473,481] and hip,[87,249,301,305,333] (3) impaired force and proprioception at the ankle,[22,59,169,219,296,379,404] (4) decreased ankle dorsiflexion ROM,[138,239,352] and (5) increased subtalar and midfoot motion.[138] Research has also found impaired central mediated processes, including spinal-level sensorimotor control/reflex inhibition[36,64,121,145,171,226,227,292,308,338,403,406,407,423,433] and supraspinal corticomotor abnormalities.[171,308,330,332,375,377,424,426,428,458] These impaired sensorimotor and central mediated processes may be evident in both the injured and uninjured limbs and impact the movement system, as seen with static and dynamic balance, walking, stepping, running, jumping, cutting, and kicking.[88,105,108,264,396,403-407]

RISK FACTORS

2013 Condensed Summary

The 2013 CPG[298] examined intrinsic and extrinsic factors of acute LAS and ankle instability. Evidence showed that there was an increased risk of acute LAS in individuals who have a history of LAS and loss of ankle dorsiflexion ROM, do not warm up properly, do not use an external support (bracing and taping), and do not participate in neuromuscular retraining. The risk factors for CAI were less clear than those for LAS in 2013. The authors suggested that, in addition to not using an external support and not participating in a balance program, anatomical factors, such as increased talar curvature, may increase risk for ankle instability.

EVIDENCE UPDATE

Acute Lateral Ankle Sprain: Nonmodifiable Intrinsic Risk Factors

Previous Injury

II There is conflicting evidence that a previous LAS elevates risk for a subsequent LAS. A meta-analysis by Vuurberg et al[451] of studies between 2009 and 2016 found that previous injury was not a significant risk factor for LAS (relative risk = 1.44; 95% CI: 0.96, 2.16). Results from 2 studies not included in this review were consistent with this finding.[20,174] However, 2 other studies reported that individuals with a history of LAS are at increased risk for a subsequent sprain, with a hazard ratio (HR) of 2.21 (95% CI: 1.07, 4.57) when the index sprain occurred within the previous 6 months.[92,355]

III A study of professional basketball players found that players with a history of LAS were 1.41 (95% CI: 1.13, 1.74) times more likely to sustain a subsequent ankle sprain than players who did not have a history of sprain within the previous year.[180] A similar study of professional soccer players also showed that history of LAS increased the risk of future ankle sprain.[57]

Sex

I A 2014 meta-analysis found that female sex was a risk factor for LAS, with a cumulative incidence rate for females of 13.6 per 1000 exposures (95% CI: 13.25, 13.94) versus a cumulative incidence rate for males of 6.94 per 1000 exposures (95% CI: 6.8, 7.09).[119]

II A study of high school lacrosse players showed that females were more likely to sustain a LAS, at a rate of 2.4 per 1000 exposures versus 1.6 per 1000 exposures for males.[457]

III Female sex as a risk factor for LAS was also identified in a meta-analysis by Vuurberg et al.[451] Female athletes with a history of concussion had 1.88 to 2.54 higher odds of also reporting a LAS or knee injury.[193] Conflicting results regarding sex as a risk factor for LAS were found in a case-control study of professional soccer players.[57]

Body Mass Index

II A meta-analysis identified lower body mass index (BMI) as a potential intrinsic risk factor for a LAS.[451] When data from studies published between 2009 and 2016 were pooled, individuals with a lower BMI trended toward a slightly higher rate of sprain (mean difference, −0.08; 95% CI: −0.14, 0.02).[451] Articles not included in this analysis both agreed[365,366] and disagreed with this finding.[92,174]

III A case-control study found that BMI was not a risk factor for LAS in those presenting to emergency departments.[484]

Age

II In elite football and basketball players (age range, 15-40 years), it was noted that each 5-year increase of age was found to increase the odds of sustaining a LAS by 1.51 times (odds ratio [OR] = 1.51; 95% CI: 1.02, 2.25).[353] In contrast, younger age was associated with increased risk of LAS in military recruits undergoing training.[365,366]

III In professional soccer players, it was found that age was not related to LAS injury risk.[57]

Other Nonmodifiable Intrinsic Risk Factors

II Among collegiate athletes, those with a navicular-medial malleolar distance greater than 4.65 cm, measured with a digital caliper in maximal dorsiflexion to represent external rotation of the talus, were 4.14 times more likely to sustain a LAS than athletes with a smaller navicular-medial malleolar distance.[240] Leg-heel angle and foot internal rotation angle in plantar flexion were not found to be associated with risk of a LAS.[240]

III Among soldiers, a Beighton score of 4[21] or greater and narrower bimalleolar width were associated with increased risk of a LAS.[366] Foot Posture Index (FPI) score and all 6 component scores[57] and the Q-angle[484] were not found to be associated with risk of a LAS. Two studies have potentially identified a genetic predisposition to LAS.[360,388]

Acute Lateral Ankle Sprain: Modifiable Intrinsic Risk Factors

Range of Motion

II Asymmetrical ankle dorsiflexion ROM greater than 2.5 cm between sides, as measured with the weight-bearing lunge test, was predictive of LAS in firefighters.[446] Conflicting findings were found in collegiate male athletes.[174] Non–weight-bearing measures of ankle dorsiflexion ROM and inversion/eversion motion were not found to be risk factors for a LAS.[20,92]

Strength

I Decreased hip abductor strength was found to increase the risk of LAS in male soccer players, with a reported OR of 1.10 (95% CI: 1.02, 1.18).[357] When hip abductor strength was less than 33.8% of body weight, the probability of LAS increased from 11.9% to 26.7%.[357]

II Decreased hip extensor strength was associated with a significant (P = .028) increased risk of LAS in youth soccer players.[95]

Functional Performance

II Risk of LAS is generally increased with worse performance on unilateral standing reach tests like the Star Excursion Balance Test (SEBT) and the Y Balance Test. Better performance on the SEBT (posterolateral direction) decreased the risk of LAS (HR = 0.96; 95% CI: 0.92, 0.99).[92] When netball players reached 77.5% or less of their leg length on the posteromedial direction of the SEBT, risk of LAS was increased by more than 4 times (OR = 4.04; 95% CI: 1.00, 16.35).[20] Worse performance on the anterior reach component of the Y Balance Test was associated with increased incidence of LAS in males (but not in females).[174] In adolescent soccer players, the inability to reach at least 76% and 70% of limb length in the posteromedial and posterolateral directions, respectively, during the SEBT represented significant cutoff points indicating increased risk of LAS in the subsequent 10 months.[233] Asymmetrical performance (greater than 2 cm in the anterior direction, greater than 3 cm in the posteromedial and posterolateral directions, right versus left lower extremity) on the Y Balance Test was predictive of LAS in firefighters.[446]

II Athletes who performed the multiple hop test with more than 12 "change-in-support errors" had a 4-fold increased risk of an index LAS.[128] These "change-in-support errors" include shuffling or jumping on the support foot, removing the hands from the iliac crests, and putting the nonsupport foot down.[128]

II A LAS was not associated with performance on the foot-lift test in active university students[92] or in netball players.[20] Single-leg stance quality graded using the Balance Error Scoring System (BESS)[174] and performance on the side recognition test[92] were also not found to be associated with increased risk of LAS. In netball players, vertical jump height and performance on the demi-pointe balance test were not associated with incidence of LAS.[20]

II Adolescent athletes who took greater than 15.4 seconds to complete the single-leg hop test, with 10 repetitions over a 30-cm distance, were at higher risk of sustaining a LAS in the following 10 months.[233]

II In elite soccer players, poor performance (mediolateral force more than 0-0.4 seconds and/or resultant horizontal ground reaction forces more than 3-5 seconds) on a single-leg drop-jump landing was predictive of a LAS within 3 years.[134] Gait abnormalities with earlier peak pressure on the lateral forefoot, higher peak pressure under the first metatarsal, higher peak metatarsal impulse, and more medial pressure at heel-off were associated with higher risk of a LAS in military recruits.[365,366]

II There is a slight increase in the odds of LAS for semiprofessional soccer players with worse performance on the single-leg hop for distance (OR = 1.10; 95% CI: 1.00, 1.23).[307] Composite score on the Soccer Injury Movement Screen (components include anterior reach, single-leg deadlift, in-line lunge, single-leg hop for distance, and tuck jump) does not predict LAS in semiprofessional soccer players.[307]

Acute Lateral Ankle Sprain: Extrinsic Risk Factors

Activity

I A meta-analysis found that risk of LAS was associated with type of sport played: the highest risk was in individuals playing court sports (cumulative incidence of 7 per 1000 exposures; 95% CI: 6.8, 7.2).[119] Another meta-analysis showed that a LAS is more likely to occur in the second half of games during soccer, rugby, futsal, American football, and Gaelic football.[93]

II Elite Gaelic football players are more likely to sustain a LAS during match play versus during training, with the likelihood during match play of 62.2% and during training of 32.4%.[370] In high school lacrosse players, competition, compared to practice, was more likely to elicit a LAS in both males (3.0 per 1000 competition exposures versus 1.0 per 1000 practice exposures) and females (3.8 per 1000 competition exposures versus 1.8 per 1000 practice exposures).[457]

Playing Surface

II There was no difference in LAS risk among Major League Soccer players playing on artificial turf versus natural grass.[47] There was no difference in the rate of ankle sprain in rugby players playing on artificial turf versus grass.[362]

Chronic Ankle Instability: Risk Factors

Physical Characteristics

II In a retrospective study of more than 800 000 young adults serving in the military, increased BMI was found to be associated with CAI in males (overweight: OR = 1.249, *P*<.001; obese: OR = 1.418, *P*<.001) and females (overweight: OR = 1.989, *P*<.001; obese: OR = 2.754, *P*<.001).[178]

II Among athletes returning to sport following a LAS, those whose height was more than 191 cm had 16 times greater odds of sustaining a recurrent sprain that same season. Athletes whose mass was more than 100 kg had 8 times greater odds of sustaining a recurrent sprain in the same season.[304]

III In a large study of 900 healthy individuals aged 8 to 101 years, Baldwin et al[23] found that, for every degree of decreased ankle dorsiflexion ROM, the odds of bilateral ankle instability (defined by a score on the Cumberland Ankle Instability Tool [CAIT] of 25 or less) increased by 3% (95% CI: 0%, 6%). Healthy females with a CAIT score of 25 or less were 2.6 times more likely to have bilateral ankle instability (95% CI: 1.7, 3.8), and the odds of having bilateral ankle instability (defined as a CAIT score of 25 or less) decreased by 2% (95% CI: 1%, 3%) for each year of increasing age. Additionally, the odds of having ankle instability (defined by a CAIT score of 25 or less) were increased by 4% for every centimeter of increased waist size (95% CI: 2%, 6%).[23]

Functional Performance

II Inability to complete jumping and landing tasks within 2 weeks of the initial injury, poorer dynamic postural control, and lower self-reported function at 6 months after the initial injury were predictors of CAI at 6 months.[109]

Other Risk Factors

I Not using prophylactic bracing and not participating in an exercise program that includes balance training are risk factors for a subsequent LAS following a first-time LAS.[33,43,102,336,356,451]

II Participating in sports increases the risk of recurrent ankle sprains, as the odds of sustaining a recurrent ankle sprain were 6.83 times higher (95% CI: 1.35, 34.56) in individuals who participated in sports than in those who did not participate in sports.[293]

2021 Risk Factor Evidence Summary

Female sex, hip abductor and extensor weakness, poor performance on balance and hopping tests, and participating in court sports are risk factors for an acute LAS. Not using prophylactic bracing, not participating in an exercise-balance program, poor functional performance after a LAS, participating in sports, and higher BMI are risk factors for CAI.

CLINICAL COURSE

2013 Condensed Summary Without Recommendation

Following a LAS, there is a rapid decrease in pain and improvement in function in the first 2 weeks after injury. However, 5% to 33% of patients continue to experience pain 1 year or more after the LAS, with 5% to 25% still experiencing pain after 3 years. Fifty percent to 85% of individuals with a LAS report full recovery at approximately 3 years after the injury, independent of sprain severity. When symptoms of instability continue beyond 1 year after a LAS, patients are commonly diagnosed as having CAI. In high-quality studies, continued reports of instability were noted in 0% to 33% of patients in follow-up periods of 3 years or less. Prognosis may also be related to not receiving appropriate treatment after injury, including bracing and rehabilitation. There is higher risk of ankle instability and reinjury in high- compared to low-activity groups.

ACUTE AND POSTACUTE LATERAL ANKLE SPRAIN

Evidence Update

The acute phase is operationally defined as 1 to 2 weeks or less after injury, while the postacute period may last up to 12 months following injury.

I For a faster return to sports, an evidence-based clinical guideline by Vuurberg et al[451] recommended a supervised exercise program to address the strength, coordination, proprioception, and functional deficits that occur after a LAS. This is consistent with a systematic review that found a shorter time to return to sports after an acute ankle sprain following functional treatment, the use of compression stockings, and anteroposterior talocrural joint mobilization.[8]

I An assessment of recovery time in high school athletes after a first-time ankle sprain found that there was a 75% chance of returning to sport within 3 days after the injury and a 95% chance of returning within 10 days, with no difference between new and recurrent ankle sprains.[309] Another study of high school athletes found that more severe injuries involving multiple ligaments resulted in a greater than 3-week loss of participation.[417] In college athletics, 44.4% of individuals returned to play in less than 24 hours after injury.[372] In soccer players, the average time lost after ankle sprain was 12 to 15 days,[129,466] while rugby players returned to participation on average 24 days after injury.[422]

I The Synthesizing a clinical Prognostic Rule for Ankle Injuries in the Emergency Department study, with 682 individuals evaluated within 7 days after an ankle sprain, found older age, higher BMI, higher pain level when resting, higher pain level when bearing weight, inability to bear weight, longer time (days) from injury to assessment, and prior recurrent sprain to be predictors of a poor outcome.[384]

II A systematic review and meta-analysis found that the addition of rehabilitation exercises to standard care significantly reduced reinjury in the 7 to 12 months following injury.[33] Another systematic review and meta-analysis found that bracing and neuromuscular training were not associated with reduced recurrence of ankle sprains at 12 months.[43]

II Despite significant improvements in self-reported function over a 6-week period after a LAS, ankle laxity did not significantly change as assessed with the anterior drawer test (ADT) (P>.05).[74]

II Those with a medial joint bone marrow contusion, on the tibia and/or talus, identified on MRI within 2 weeks after a LAS had a significantly longer recovery time to return to normal walking (25 versus 16 days, P = .0002) and sports (92 versus 56 days, P = .0001).[54] Those with simple or complex LAS, as determined by radiological imaging, did not have different outcomes at 6 months (P>.05).[41]

II At baseline, older age, more severe injury, and less than full weight-bearing status were correlated (adjusted R^2 = 0.341, P<.01), with worse functional status at week 4, while baseline older age, less than full weight-bearing status, and injury mechanism were correlated (adjusted R^2 = 0.20, P<.01) with worse functional status at 4 months.[335] Pain with weight-bearing dorsiflexion and medial joint-line tenderness at 4-week assessment were associated (adjusted R^2 = 0.49, P<.01) with lower function at 4 months.[335]

II Effective coping strategies for pain and lower age (P<.017), but not severity of injury (P>.68), were associated with fewer symptoms and limitations at 3-week follow-up after a LAS.[37] A recent LAS (OR = 8.23) and younger age (OR = 8.41) were independent predictors of a recurrent ankle sprain in a convenience sample (n = 100).[355]

II In a prospective cohort of 70 individuals who sustained a LAS, 60% (n = 42) were categorized as "copers" and recovered, while 40% (n = 28) went on to suffer CAI.[104,109] Inability to complete jumping and landing tasks within 2 weeks after a first-time LAS was predictive of CAI at 6 months (sensitivity, 83%; specificity, 55%; P = .004).[109] Clinical tests of ROM, swelling, ligament laxity, and posterior glide within 2 weeks after injury had limited predictive value (accuracy, 68.8%) in determining those who went on to develop CAI versus becoming a "coper" at 1 year.[104]

III A cohort study in the National Basketball Association found that 56% of those who sustained an ankle sprain did not miss any games. The incidence of ankle sprain among players with a history of prior ankle sprain in the past year was 1.41 times higher than those without a history of ankle sprain in the past year (P = .002).[180]

III Among 44 patients recruited from general practices and physical therapy clinics at 4-year follow-up from a LAS, 18% (n = 8) experienced a subsequent injury, 29.5% (n = 13) reported pain, 45.5% (n = 20) had tenderness on clinical examination, and 25% (n = 11) had limited ankle dorsiflexion ROM.[212] Almost 20% (n = 24) of individuals in another study continued to have ankle complaints of some kind at 5-year follow-up.[294]

III Obesity may influence outcome, as full recovery at 6 months was 65%, 59%, and 52% for those with a BMI of less than 25 kg/m^2, 25 to 30 kg/m^2, and greater than 30 kg/m^2, respectively.[32] In a study of anthropometric and clinical assessments, the highest correlation with a new ankle sprain was the history of a previous sprain (r = 0.265, P<.001).[484]

III A significant decrease in dorsiflexion, plantar flexion, and eversion ROM (26%-27%, P<.002) was found 4 weeks after LAS among 20 patients.[432] Fraser et al[138] found decreased ankle dorsiflexion ROM (P<.001), increased ankle frontal plane ROM (P<.001), and increased forefoot and midfoot mobility (P<.001) in individuals with a history of LAS.

III An assessment of the movement system using static and dynamic balance activities,[28,103,108,112,113,118,154,225,228,354] gait,[107,136,359] and jumping[11,110,114,115,117] can identify abnormal movement strategies at the ankle, knee, and hip caused by sensorimotor ROM deficits.

IV At a 1-year telephone follow-up of those seen in the emergency department after an ankle sprain, those with more severe injuries had more persistent complications (χ^2 = 3.636, P<.05).[163]

IV A case series found that greater severity of injury diagnosed using ultrasound imaging (USI) was predictive of 1-year self-reported outcome following LAS (P<.05).[63]

IV Another case series found that after a LAS, increasing height and weight were associated with a recurrent sprain within the same season.[304]

IV Fair to moderate correlations (r = −0.40 to −0.57, P<.05) were identified between pain levels and reported confidence with weight-bearing lunge and hopping tests.[68]

Evidence Synthesis and Rationale

A full return to participation can be expected from 1 day to a little more than 3 weeks after LAS, depending on the demands of the desired activity or sport. However, full recovery with no symptoms or limitations may take months or years to obtain, and cannot be expected in all patients. There is conflicting evidence for the role of injury severity in the clinical course after a LAS. The update of evidence since 2013 continues to support that a supervised impairment-driven exercise program can allow for a faster recovery and help prevent reinjury, with patient factors being able to help predict the clinical course after LAS.

2021 Recommendation

B Clinicians should include patient age, BMI, pain coping strategies, report of instability, history of previous sprain, ability to bear weight, pain with weight bearing, ankle dorsiflexion ROM, medial joint-line tenderness, balance, and ability to jump and land (as safely tolerated) in their initial assessment because of their role in influencing the clinical course and estimation of time to accomplish the goals of an individual with an acute LAS.

CHRONIC ANKLE INSTABILITY

Evidence Update

II A functional treatment program aimed to improve jumping and landing biomechanics increased self-reported functional status in the treatment group (n = 14) compared to the control group (n = 14). The estimate of effect size using the Foot and Ankle Ability Measure (FAAM) was 1.95 (95% CI: 1.03, 2.86).[14]

III Baseline self-reported functional limitations, decreased single-limb balance, and number of previous ankle sprains were predictive of treatment success in individuals with CAI, with the single-limb balance test being the single best predictor.[469,470] A single-limb balance test greater than or equal to 5 errors was predictive of success with ankle joint mobilizations (positive likelihood ratio = 33.3; 95% CI: 4.1, 274.4), and a test greater than or equal to 2 errors was predictive of success with plantar massage (positive likelihood ratio = 62.5; 95% CI: 8.3, 472.4).[470]

III A systematic review by Al Adal et al[7] reported the presence of pain in 50% to 79% of those with CAI. Pain was usually intermittent, mild, and occurred during vigorous activity.[7] A study not included in that review had similar findings, and also noted that those with more severe perceived ankle instability were more likely to have pain (OR = 5.38, P<.001).[6]

III Individuals with CAI have movement system abnormalities that have been identified during activity such as static and dynamic balance activities, walking,[140] stepping,[49,396] running, jumping, cutting,[139,230,247,248,398] and kicking.[124,367] A systematic review by Rosen et al[376] found deficits in static and dynamic postural control in those with CAI. Similar findings were noted by other studies not included in the review by Rosen et al.[22,89,105,116,138,167,205,239,250,258,260,352,376,392,405,485]

III A systematic review that evaluated the literature on walking and running biomechanics reported that those with CAI had increased ankle and rearfoot inversion, ankle plantar flexion, vertical forces on the lateral part of the foot, and fibularis longus muscle activity.[317] Similar findings were noted by others whose studies were not included in this review.[69,97,100,136,149,220,244,334,401,421,481] There have also been abnormalities noted at the knee and hip with less knee adduction, decreased gluteus medius muscle activity, and altered hip-ankle coordination.[88,89,276,318,401,481] These abnormalities may alter the timing of movements and cause the center of mass to laterally deviate and fall outside the base of support to potentially cause instability.[317]

III In the systematic review by Rosen et al,[376] it was identified that those with CAI had deficits with hopping and jumping activity. Another systematic review that evaluated the literature on landing biomechanics in those with CAI noted the following: (1) dynamic postural stability deficits with longer time to stabilization after landing, (2) altered ankle and knee kinematics while landing with greater knee extension and ankle dorsiflexion, (3) greater vertical and lateral loading rates, and (4) reduction in fibularis longus and brevis muscle activation prior to contact.[397] Similar findings were noted by studies not included in these reviews.[38,127,176,177,192,206,207,221,275,279,319,399,429,430,460] Studies investigating jumping have also found less hip flexion and hip adduction at initial contact, with decreased gluteus medius activity, in addition to a reduced jump height and flight distance.[192,256,305,319] A study by Liu et al[283] found that dynamic postural stability during multidirectional hopping could not accurately differentiate among healthy, coper, and unstable groups. Similar findings were noted by others.[173,301] However, in aggregate, findings suggest that those with CAI may use a landing strategy that relies on proximal joints to protect the ankle from reinjury.[397]

III Those that go on to develop CAI may be differentiated from copers based on their movement patterns, including dynamic balance,[105,116,205,250,352] walking,[50,106,136,456] stepping down,[49,125] running,[259] and landing from a jump,[111] with copers having biomechanics more similar to those of healthy individuals.[49,50,105,116,125,136,205,259,352] The neuromuscular ankle strategies adopted by copers may allow them to prevent recurrent symptoms.

III A decrease in activity and participation and overall health-related quality of life was found in those with CAI[123,138,183,251,297,471] compared to those without CAI and may result from the sensorimotor ROM deficits and altered movement control strategies.[198,395] However, this might not be true for younger individuals (age, 15-16 years), as their reported physical activity level did not seem to be affected by a history of ankle instability.[191]

III In individuals with CAI, significant (P<.001) predictors of a successful improvement with a balance training program were impaired dynamic balance with an SEBT posteromedial reach distance of 85.18% or less and a FAAM activities of daily living (ADL) score or Foot and Ankle Disability Index (FADI) score of 92.55% or less at baseline. For patients who met both criteria, there was a 70% probability of a successful outcome.[42]

III A systematic review–based consensus recommended nonsurgical treatment for 3 to 6 months prior to considering surgery for CAI.[402] A cross-sectional study found that those with CAI who did not seek medical treatment for their LAS had worse subjective function.[197]

III Radiographic measures of a cavus foot type did not discriminate between those with CAI and controls (P>.05).[263]

Evidence Synthesis and Rationale

Those who do not become "copers" after LAS and go on to develop CAI may have sensorimotor and ROM impairments at the trunk, hip, knee, ankle, and foot as well as impaired central mediated processes, as noted in the pathoanatomical section, that may put them at risk for further injury. The sensorimotor system may be assessed clinically with objective and reliable measures of impairments of body function and activity limitation and participation restriction, such as dynamic balance, hopping, running, and jumping. Because of the role of central mediated processes, evaluating the uninjured lower extremity for sensorimotor impairments may be appropriate. Patient factors can help to predict the clinical course in those with CAI.

2021 Recommendation

C Clinicians may include previous treatment, number of sprains, pain level, and self-report of function in their evaluation as well as an assessment of the sensorimotor movement systems of the foot, ankle, knee, and hip during dynamic postural control and functional movements, because of their role in influencing the clinical course and estimation of time to accomplish the goals of an individual with CAI.

DIAGNOSIS/CLASSIFICATION LATERAL ANKLE SPRAIN

2013 Recommendation

B Clinicians should use the clinical findings of level of function, ligamentous laxity, hemorrhaging, point tenderness, total ankle motion, swelling, and pain to classify a patient with acute LAS into the ICD category of sprain and strain of ankle (S93.4), and the associated ICF impairment-based category of ankle stability (b7150 stability of a single joint) and movement coordination impairments (b7601 control of complex voluntary movements).

Evidence Update

II In a prospective, double-blind trial, Li and colleagues[272] compared the diagnostic properties of the ADT, anterolateral drawer test (ALDT), and the reverse anterolateral drawer test (RALDT) between 2 raters in a mixed group of healthy individuals (n = 34) and those with confirmed ATFL injury (n = 38). The results indicated that the RALDT was superior to both the ADT and ALDT in nearly all categories for both raters. Mean sensitivity (averages of raters 1 and 2) was 0.224 for the ADT, 0.473 for the ALDT, and 0.894 for the RALDT. Specificity was at or near 1 for the ADT and ALDT, though only slightly less for the RALDT (0.897). Mean accuracy was 0.590 for the ADT, 0.715 for the ALDT, and 0.896 for the RALDT. Kappa values were also higher for the RALDT (0.639) compared to the ADT (0.196) and ALDT (0.528). The authors concluded that the RALDT was more sensitive and accurate when compared to the ADT and ALDT for diagnosis of ATFL injuries.[104,272]

II Croy et al[73] prospectively evaluated the diagnostic accuracy of the ADT in 66 individuals with a history of a LAS and 20 control individuals against digital USI during mechanical testing. The ADT uses a 5-point ordinal scale to classify degree of laxity (0, hypomobile; 1, normal; 2, mild increased laxity; 3, moderate increased laxity; 4, severe increased laxity). The diagnostic accuracy of the ADT was assessed for 2 thresholds: 2 or greater and 3 or greater. Two thresholds were used for the imaging reference standard: based on the literature (2.3 mm) and twice the standard deviation of the control group

(3.7 mm). Sensitivity of the ADT was 0.74 for the 2.3-mm cutoff and 0.83 for the 3.7-mm cutoff. Specificity of the ADT was 0.38 and 0.40 for the 2.3-mm and 3.7-mm cutoffs, respectively. The authors concluded that the ADT provides a limited ability to detect excessive anterior talocrural laxity. The authors, however, conceded that because a side-to-side comparison was not performed, as is typical in clinical practice, the ADT might provide useful information when used in this manner.[73]

III Wiebking et al[467] compared the diagnostic accuracy of the ADT, arthrometer assessment, and stress ultrasonography in 30 patients with lateral ankle trauma under anesthesia. The investigators were blinded to the diagnosis, and both ankles of all participants were examined. The ADT exhibited a sensitivity of 0.93 and a specificity of 0.67. The arthrometer displayed a sensitivity of 0.80 and a specificity of 0.40, while the stress ultrasonography demonstrated a sensitivity of 0.27 and a specificity of 0.87. The authors concluded that clinical examination with adequate analgesia was superior to both arthrometry and stress ultrasonography for diagnosing acute LAS.[467]

III Gomes et al,[153] in a cross-sectional study, looked at the efficacy of the anterolateral talar palpation test, using palpation to assess for anterior translation of the talus during a traditional ADT, to diagnose ankle instability. Two blinded investigators examined 24 participants (14 patients with confirmed anterior-lateral ligamentous injury and 10 controls). The first examiner performed the traditional ADT and the second examiner performed the anterolateral talar palpation test on all participants. Tests were categorized as positive or negative. The traditional ADT had a sensitivity of 0.50, a specificity of 1.0, a positive predictive value of 100%, a negative predictive value of 56.3%, and an overall accuracy of 69.6%. The anterolateral talar palpation test had a sensitivity of 1.0, a specificity of 0.77, a positive predictive value of 87.5%, a negative predictive value of 100%, and an overall accuracy of 91.3%. The authors concluded that while the results for the anterolateral talar palpation test were encouraging, it should be used as a complement to the traditional ADT to improve diagnostic accuracy in this patient population.[153]

Evidence Synthesis and Rationale

While the traditional ADT seems to have limited reliability and accuracy, it continues to be one of the most common tests used clinically. Adding palpation to assess for anterior translation of the talus during the traditional ADT improves the diagnostic accuracy of the ADT. Therefore, the anterolateral talar palpation test and the RALDT have stronger evidence than the traditional ADT to support their use in diagnosing ATFL injuries after LAS.

2021 Recommendation

B Clinicians should use special tests, including the RALDT and anterolateral talar palpation added to the traditional ADT, in addition to a thorough history and physical examination to aid in the diagnosis of a LAS.

CHRONIC ANKLE INSTABILITY

2013 Recommendation

B Clinicians may incorporate a discriminative instrument, such as the CAIT, to assist in identifying the presence and severity of ankle instability associated with the ICD category of instability secondary to old ligament injury, ankle and foot (M24.27), and the associated ICF impairment-based category of ankle stability (b7150 stability of a single joint) and movement coordination impairments (b7601 control of complex voluntary movements).

Evidence Update

I Rosen and colleagues[376] completed a systematic review with meta-analysis of 29 studies to determine whether functional performance tests could identify individuals with CAI. The authors found level B (moderate to strong) evidence for several functional performance tests. Specifically, the side hop (P = .009, n = 7), timed hop (P = .002, n = 9), multiple hop test (P<.001, n = 13), and the foot-lift test (P = .020, n = 3) were able to discriminate between individuals with CAI and healthy controls. Additionally, components of the SEBT (medial: P = .006, n = 7; anteromedial: P = .022, n = 7; posteromedial: P<.001, n = 13) were also capable of discriminating between the two groups.[376]

I To diagnose mechanical ankle instability and provide objective measures of laxity, arthrometers have been employed to quantify either anterior talocrural displacement and/or inversion ROM. A recent systematic review by Wenning and colleagues[465] identified that while most devices have good to excellent reliability (0.65-0.99), there were only 2 studies reporting the sensitivity and specificity of testing in individuals with CAI.

III In 2013, Donahue and colleagues[120] introduced a new discriminative instrument, the Identification of Functional Ankle Instability (IdFAI). The IdFAI, which consists of 10 questions, combined elements of both the CAIT and the Ankle Instability Instrument (AII). Scores can range from 0 to 37. A score of 11 or greater suggests that the individual is likely to have CAI. Unique to the IdFAI, the instrument has an operational definition of "giving way" at the top of the form. The IdFAI demonstrated an overall test-retest reliability of 0.92 and was significantly related to responses on the Lower Extremity Functional

Scale (LEFS) (Spearman $\rho = -0.38$, $P<.01$).[120] Subsequent investigation of 1127 college-aged individuals found that the IdFAI was able to predict 87.8% of cases in which a person met the minimum criteria for CAI, including a history of at least 1 ankle sprain and an episode of giving way.[394] This prediction percentage was greater than the combined use of the CAIT and AII.[394]

III In 2014, Wright and colleagues[478] revisited the cutoff score for the CAIT. This work was prompted by some investigators noting that individuals who indicated their ankle was relatively asymptomatic were classified as having CAI. Using 2 independent data sets, the authors identified a new cutoff score of 25 or less, down 2 points from what was previously established.[478] The recalibrated cutoff score exhibited a sensitivity of 96.6%, a specificity of 86.8%, a positive likelihood ratio of 7.31, and a negative likelihood ratio of 0.39. Additional work on the CAIT identified the minimal detectable change to be 3.08 and the minimal clinically important difference (MCID) to be 3 points or greater.[479]

III Given the usefulness of these questionnaires, several have been cross-culturally adapted and translated into other languages and formats. Evidence is available to support Arabic,[246] Dutch,[452] French,[148] Greek,[435] Japanese,[257] Persian,[168] Spanish,[75,369] and digital[374] versions of the CAIT. Similarly, evidence exists to support Chinese,[454] Korean,[232] Japanese,[311] Persian,[312,315] and Portuguese[299] versions of the IdFAI. Additionally, reliability of the IdFAI has been established across several adult age groups.[166] Likewise, the AII has been translated into Chinese,[273] French,[286] and Persian,[316] with evidence to support their use. One systematic review questioned the use of validated instruments translated and cross-culturally adapted for Brazilian Portuguese after critical analysis of their psychometric properties.[358]

V The International Ankle Consortium suggested the following criteria to identify individuals with CAI: history of at least 1 significant ankle sprain, subjective reports of the previously injured ankle "giving way," episodes of a subsequent sprain and/or perceptions of ankle instability, and diminished function as measured with the FAAM. Additionally, the consortium recommended confirmation of ankle instability by using a validated ankle-specific questionnaire with an appropriate cutoff score.[159]

Evidence Synthesis and Rationale

While discriminative self-report instruments continue to have the most evidence to support their use in diagnosing CAI, there is also evidence for use of functional performance tests, including hopping and dynamic balance tests. The criteria outlined by the International Ankle Consortium will hopefully unify how individuals with CAI are identified. However, further evidence is needed to support these criteria. The ability of arthrometers to diagnose mechanical ankle instability and provide objective measures of laxity is unclear, and their utility is limited by their lack of practicality in the majority of clinical settings.

2021 Recommendation

B When determining whether an individual has CAI, clinicians should use a reliable and valid discriminative instrument, such as the CAIT or the IdFAI, as well as a battery of functional performance tests that have established validity to differentiate between healthy controls and individuals with CAI.

DIFFERENTIAL DIAGNOSIS
ACUTE LATERAL ANKLE SPRAIN

2013 Recommendation

Clinicians should use diagnostic classifications other than an acute LAS when the patient's reported activity limitations or impairments of body function and structure are not consistent with those presented in the Diagnosis/Classification section of this guideline. Particularly, the Ottawa ankle rules (OAR) and Bernese ankle rules (BAR) should be used to determine whether a radiograph is required to rule out a fracture of the ankle and/or foot.

Evidence Update

The ankle has been cited as the most frequently misdiagnosed region for patients reporting to the emergency department.[323] An inadequate history and/or physical examination and failure to order or interpret radiographs have been identified as the most common reasons for misdiagnosis.[323] To decrease the likelihood of missing a fracture, application of the OAR has been deemed an integral part of the diagnostic process.[414,451]

A recent systematic review and meta-analysis concluded that the OAR are the gold standard of decision rules for excluding fractures after an acute ankle injury.[25] This includes fractures of the distal tibia, distal fibula, base of the fifth metatarsal, and navicular. Utilization of the OAR has been validated in different populations[455] across the lifespan.[130,328] Although some investigators are proponents of the low-risk ankle rules (LRAR) in the pediatric population,[34,35] others have shown that the sensitivity of the LRAR (85.7%) is inferior to that of the OAR (100%) in this demographic.[130] There is evidence that implementation of the OAR in the emergency department decreases costs,[278] patient wait time,[182] length of stay (median, 20 minutes),[182] and radiograph imaging,[182,431] without sacrificing outcomes.[81] Likewise, there is evidence that the OAR can be used during athletic events.[83,158] To improve dissemination and adherence, the use of technology, including apps[339] and electronic clinical decision support tools, has been recommended.[393,419] Collectively, investigators routinely report the OAR to have a high sensitivity (92%-100%), though low to moderate specificity (7.8%-68%).[30,81,209,351,431] Specificity may be improved with other tests such as the BAR.[209] However, the BAR alone have not been advocated for clinical use because of the lower-than-desirable sensitivity.[96] To maintain the level of OAR sensitivity, the OAR should be applied in their entirety. Amiri and colleagues[12] reported that sole utilization of the ability of a patient to bear weight and complete 4 steps in the emergency department, while omitting tenderness at the malleoli, resulted in a lower sensitivity (88%) compared to sensitivity values associated with full application of the OAR. Despite the amount of evidence that supports clinical use of the OAR, not all studies are in agreement,[71] possibly because clinical biases and concern of litigation remain.[16]

In addition to a fracture of the distal tibia, distal fibula, base of the fifth metatarsal, and navicular, soft tissue pathology must be considered when differentially diagnosing a patient who has sustained an acute ankle sprain. To optimize the differential diagnosis of soft tissue injury, the physical exam is most accurate when performed 4 to 5 days after injury.[451] Using MRI, copathologies have been confirmed in 92% of cases following an acute sprain.[84] Differential diagnosis and assessment for copathologies may include:

- Syndesmotic injury[45,162,371]
- Osteochondral lesions[84,371]
- Talar bone contusion[371]
- Deltoid ligament sprain[371]
- Tendinous injuries,[84] including Achilles tendon rupture and fibularis longus/brevis tendon and retinacular injury
- Symptomatic accessory ossicles, including os trigonum syndrome[210]
- Midfoot sprains (eg, talonavicular, calcaneocuboid, and calcaneonavicular ligaments)[10]
- Epiphyseal plate injuries[34,448]

2021 Summary

Clinicians should conduct a thorough patient history and examine the multiple segments of the ankle-foot complex to rule in or out the pathologies that may be present when differentially diagnosing an acute sprain, and utilize the OAR when determining whether a radiograph is necessary after an acute LAS.

CHRONIC ANKLE INSTABILITY

2013 Recommendation

Clinicians should use diagnostic classifications other than ankle instability when the patient's reported activity limitations or impairments of body function and structure are not consistent with those presented in the Diagnosis/Classification section of this guideline.

Evidence Update

While the majority of patients recover after an acute ankle sprain, around 40% may continue to exhibit symptoms consistent with CAI. Concurrent pathologies may explain why symptoms remain problematic for months or longer in some cases. Frequently, these copathologies are documented at the time of surgery following unsuccessful nonsurgical management.[13,282] Coexisting pathology accompanying CAI may include:

- Fibularis muscle pathology[13,199]
- Ankle impingement[13,262]
- Osteochondral lesions[13]
- Synovitis[282]
- Chondral lesions (superficial or deep)[196,265,282]
- Bony or avulsion fragments[282,364]
- Loose bodies[282]
- Syndesmotic injury[65,326]
- Arthritis[293]
- Bifurcate ligament injury[415]
- Symptomatic accessory ossicles,[364] including os trigonum syndrome[98]

2021 Recommendation

Clinicians should consider the presence of pathologies that may coexist or exist in isolation and refer to other appropriate professionals when symptoms and/or function do not fully recover after a LAS.

IMAGING

2013 Condensed Summary

Radiographs may be useful in acute cases when indicated by the OAR and BAR. Generally, patients with suspected ankle sprains are treated nonsurgically for 4 to 6 weeks. For patients with persistent symptoms, including symptoms consistent with ankle instability, radiographs, stress radiographs, MRI, arthrography, computed tomography (CT), USI, and/or bone scan/scintigraphy can be used to assess the integrity of the soft tissue and/or osseous anatomy.

2021 Evidence Update and Summary

The American College of Radiology (ACR) has produced the "ACR Appropriateness Criteria," an evidence-based guideline to assist providers in making the most appropriate imaging choices for specific clinical conditions, including those with acute and chronic ankle injuries (https://www.acr.org/). These ACR Appropriateness Criteria state that if the OAR are positive, an ankle radiograph is the first appropriate imaging study. If radiographs demonstrate potential osteochondral injury or there are persistent symptoms, an MRI or CT scan without contrast is usually appropriate. Leg radiographs, ankle stress radiographs, an MRI scan without contrast, or a CT scan without contrast are usually appropriate for those who have an alignment abnormality suggesting syndesmotic/ligamentous injury or dislocation. Ultrasound imaging is usually not the first imaging study after an acute trauma to the ankle, but may be an appropriate secondary evaluation modality to assess for underlying soft tissue injuries, chondral avulsion fractures in children, or abnormalities with dynamic imaging stress testing. Exclusion criteria from these recommendations include children younger than 5 years of age or those with altered leg sensation (ie, diabetic), altered mental capacity, and/or inability to communicate (https://www.acr.org/).

In those with symptoms that are present for more than 6 weeks, the Appropriateness Criteria note that ankle radiographs are usually appropriate. If ankle radiographs are negative but ankle instability, ankle impingement, osteochondral lesions, and/or tendon injuries are suspected, an MRI without contrast is usually appropriate. Ultrasound imaging may also be appropriate when a tendon injury is suspected, and contrast can be added to MRI when ankle instability is suspected (https://www.acr.org/).

Ultrasound imaging is a growing area of interest in physical therapy. Systematic reviews have found USI to be reliable and accurate in the diagnosis of ATFL and calcaneofibular ligament injuries.[48,266,385,386] Specific studies have supported USI with stress testing[150,314] to be useful to further assess the ATFL to identify the type of injury,[44] grade severity of injury,[63] and assess its thickness.[284] Another systematic review found USI to be accurate in identifying foot fractures,[53] and specifically fifth metatarsal, lateral malleolus, and medial malleolus fractures, in those with a foot and/or ankle sprain.[19] Ultrasound imaging was also found to be accurate and sensitive in detecting tendinous injuries,[380] as well as useful for visual biofeedback to target activation of specific muscles during rehabilitation.[243]

CLINICAL PRACTICE GUIDELINES

Examination

OUTCOME MEASURES

2013 Recommendation

A Clinicians should incorporate validated functional outcome measures, such as the FAAM and the LEFS, as part of a standard clinical examination. These should be utilized before and after interventions intended to alleviate the impairments of body function and structure, activity limitations, and participation restrictions associated with ankle sprain and instability.

Evidence Update

I The Patient-Reported Outcomes Measurement Information System (PROMIS) physical function (PF) computer adaptive test (CAT) performed as well as the FAAM ADL subscale and the 5-point Foot Function Index (FFI) in an assessment of content validity, convergent validity, and item reliability, with less response burden, in 60 (19.4%) individuals scheduled for CAI surgery.[200] In a general orthopaedic population (n = 3069), the MCID values varied depending on methods and were calculated for the PROMIS PF test (range, 3-30; median, 11.3), PROMIS pain interference (PI) test (range, 3-25; median, 8.9), and the FAAM sports subscale (range, 9-77; median, 32.5).[203]

II In a general orthopaedic foot population, the PROMIS PF test, PROMIS PI test, and FAAM sports subscale were sensitive and responsive to changes in patient-reported health, with effect sizes ranging from 0.95 to 1.31 across 4 time points (3, greater than 3, 6, and greater than 6 months).[202] In analyses that included Rasch modeling, the PROMIS PF, mobility, and PI scales were more normally distributed, with fewer floor and ceiling effects, than the Foot and Ankle Outcome Score (FAOS).[245] Additionally, the PROMIS CATs were more precise and had better test-retest reliability than both the FAOS and the Medical Outcomes Study 12-Item Short-Form Health Survey in 19 (6.2%) individuals scheduled for ankle instability surgery.[245]

II There was evidence of validity, reliability, and responsiveness for the Korean version of the American Academy of Orthopaedic Surgeons foot and ankle questionnaire in a study that included 11 (5.3%) individuals with ankle instability.[223]

II The score 5 to 7 days after a LAS on the Pain Self-Efficacy Questionnaire (PSEQ), which assesses a patient's confidence to accomplish activities despite pain, was significantly correlated with function (r = 0.26, P = .017) and pain level (r = 0.32, P<.01) 3 weeks after injury.[37]

III The PROMIS PF CAT was found to be efficient, reliable, valid, and precise, while adequately assessing function in 48 (15%) patients scheduled for ankle instability surgery.[201]

III A difference in FAAM sports subscale score (95 versus 84.8), but not in the ADL subscale score (99 versus 97.2), was noted between "copers" and those with chronic complaints of instability.[152] Slightly different results were noted by Wright et al,[477] as FAAM scores were different in those with chronic complaints of instability compared to "copers" and uninjured participants, with ADL subscale scores of 96.36, 99.54, and 99.79 and sports subscale scores of 89.76, 98.70, and 97.83, respectively.

III The Fear-Avoidance Beliefs Questionnaire (FABQ) correlated (R^2 = 0.18-0.35, P<.028) with measures of balance and joint laxity.[194]

III Evidence to support the use of the 11-item Tampa Scale of Kinesiophobia (TSK-11) to asses fear of movement and reinjury and the FABQ to assess fear-avoidance beliefs is available, as scores on these instruments differentiated those with CAI from healthy controls (P<.001).[195] Other studies have found the TSK-11 scores of controls and "copers" to be different from the scores of those with CAI (P<.001).[138] The TSK-11 scores were also correlated with ankle joint laxity in female athletes (r = 0.285, P = .013), but not in male athletes (r = −0.094, P = .46).[141]

III There is evidence to support the use of a 12-item shortened FAAM, with a combined ADL and sports subscale,[184,185] as well as evidence to support the use of Turkish,[51,441] German,[287] Japanese,[440] Chinese,[155] and Dutch[461] versions of the FAAM for those with a history of an ankle sprain and/or chronic complaints of instability. Evidence is also available to support the use of Chinese,[156] Brazilian Portuguese,[300] Thai,[410] and Italian[447] versions of the FFI in individuals with a history of an ankle sprain.

IV Preliminary research in 26 participants found evidence of validity of the Sports Athlete Foot and Ankle Score (SAFAS) for assessing sports-related ankle injuries in high-performing athletes.[325]

Evidence is available to support a Brazilian Portuguese version of the SAFAS.[79]

IV There is evidence to support a Persian version of the American Orthopaedic Foot & Ankle Society (AOFAS) ankle-hindfoot scale, a reliable and valid instrument for those with ankle ligament injuries.[450]

IV Greater kinesiophobia measured with TSK-11 scores was associated with less confidence on the SEBT (r = −0.46) and vertical jump (r = −0.45).[68]

Evidence Synthesis and Rationale

There continues to be strong evidence to support the use of patient-reported outcome measures over the course of treatment to assess for changes in impairments of body function and structure, activity limitations, and participation restrictions for those with an acute LAS or CAI. The PROMIS PF and PI scales, which can be delivered in a contemporary CAT format, have been supported since the 2013 recommendation. Additionally, there is recent evidence to support instruments to capture various aspects of the patient's psychological status, such as fear of reinjury, kinesiophobia, fear-avoidance beliefs, and reinjury anxiety.

2021 Recommendations

A Clinicians should use validated patient-reported outcome measures, such as the PROMIS PF and PI scales, the FAAM, and the LEFS, as part of a standard clinical examination. Clinicians should utilize these before and 1 or more times after the application of interventions intended to alleviate the impairments of body function and structure, activity limitations, and participation restrictions associated with an acute LAS or CAI.

C Clinicians may use the PSEQ in the acute and postacute periods after a LAS to assess effective coping strategies for pain and the TSK-11 and FABQ to assess fear of movement and reinjury and fear-avoidance beliefs in those with CAI.

PHYSICAL IMPAIRMENT MEASURES

2013 Recommendation

A When evaluating a patient with an acute or subacute LAS over an episode of care, assessment of impairment of body function should include objective and reproducible measures of ankle swelling, ankle ROM, talar translation and inversion, and single-leg balance.

LATERAL ANKLE SPRAIN

Evidence Update

II After an acute LAS, pain with dorsiflexion measured at 4 weeks using the weight-bearing lunge test was associated with a lower functional status at 4 months (unstandardized β = 6.8, P<.005).[335]

III In individuals with LAS symptoms lasting 6 to 12 months, multivariate analysis showed a significant (P<.05) positive association with swelling (OR = 3.58) and a difference in passive plantar flexion ROM (OR = 1.09) to bone edema in the talocrural joint. Differences in passive plantar flexion ROM (OR = 1.07) and pain at the end range of dorsiflexion and/or plantar flexion (OR = 5.23) were associated with osteophytes in the talonavicular joint.[443]

III Bilateral reductions in SEBT reach distances were identified in individuals assessed within 2 weeks after a LAS, with large effect sizes (η^2 = 0.27-0.29) for the involved and uninvolved lower extremities in the posterolateral and posteromedial reach directions, a medium effect size (η^2 = 0.18) for the involved lower extremity in the anterior direction, and a small effect size (η^2 = 0.06) for the uninvolved limbs in the anterior direction.[118] In those after LAS, the SEBT was found to be reliable in all 8 directions (intraclass correlation coefficient range, 0.72-0.93), with minimal clinical difference values of 8.56%, 13.36%, and 13.33% for the anterior, posteromedial, and posterolateral directions, respectively.[349]

III A combination of balance, proprioception, and motor control assessment could differentiate individuals 3.5 months after a LAS from healthy controls.[354] This assessment included clinical measures of dorsiflexion ROM measured with the weight-bearing lunge test, the SEBT, the number of touches or foot lifts in 30 seconds during single-leg balance with eyes closed (foot-lift test), and time to descend stairs. The association between sprain status was best between the SEBT in the anterior direction and single-leg balance with eyes closed (χ^2 = 15.2, P<.001).[354]

III Non–weight-bearing ROM (dorsiflexion, P = .452; plantar flexion, P = .436; inversion, P = .383; and eversion, P = .657), pain level (P = .822), and foot volume measures (P = .654) were not different between those with a first-time LAS and those with recurrent injuries when measured within 5 days after injury.[464]

CHRONIC ANKLE INSTABILITY

III Univariate comparison found that impairment measures of dorsiflexion ROM with the weight-bearing lunge test and number of errors with 20-second single-limb balance on a firm surface with eyes closed could be used to predict treatment success for patients with CAI (P<.10).[469,470]

III Dorsiflexion ROM measured in non–weight bearing with the knee flexed was associated with severity of CAI as assessed with the CAIT (r = 0.22, P = .04).[373]

III Those with CAI have decreased weight-bearing dorsiflexion ROM compared to healthy controls (inclinometer, 48.3° versus 43.3°; P<.05[239]; wall-toe distance, 8.3 versus 10.0 cm; P = .013[250]). Weight-bearing dorsiflexion ROM with the lunge test (measured with a digital inclinometer) was correlated (r = –0.39, P = .002) with lateral step-down performance, as those with poor movement quality had less ankle dorsiflexion ROM than those with good movement quality (36° versus 42°, P = .01).[161] Weight-bearing dorsiflexion ROM was also correlated with movement at the knee during single-leg landing (r = 0.53, P = .04).[186] Different findings were noted by Vomacka et al,[449] as no difference was found in dorsiflexion ROM between those with CAI, copers, and healthy controls (P>.05).

III Rosen et al[376] performed a systematic review with meta-analysis to evaluate balance tests to differentiate healthy individuals from those with CAI, and found the foot-lift test to be a useful static balance test (mean effect size, –0.76; P = .020) and the SEBT to be a useful dynamic balance test in the posteromedial (mean effect size, 0.37; P<.001), medial (mean effect size, 0.37; P = .006), and anteromedial (mean effect size, 0.33; P = .022) reach directions. Included in the review, Ko et al[231] found high intrarater reliability for the foot-lift test (standard error of measurement, 1.3 errors) and SEBT (standard error of measurement, 4.6 cm), while Linens et al[280] found the cutoff scores needed to identify those with CAI from healthy individuals to be 5 errors/touches on the foot-lift test and 91% reach distance on the SEBT in the posteromedial direction.

III Studies not included in the review by Rosen et al[376] found that all 8 directions of the SEBT differentiated between healthy subjects and those with CAI, with the posteromedial and posterolateral directions being the best predictors of CAIT score (P≤.001 and P<.05, respectively).[239,392] Poor performance on the SEBT (less than 85.2% reach distance in the posteromedial direction) was found to be the best single predictor of a successful treatment (OR = 11.32).[42] Other studies support the anterior reach direction[89,208,234,250] as well as the posteromedial direction as being able to differentiate those with CAI from healthy controls.[234,250]

III The SEBT was found to be an accurate and valid measure of dynamic balance in those with CAI, as there was a large and significant correlation (R^2 = 0.98, P<.001) between visual estimation and motion analysis measures of maximum reach distance.[27] While variations in how the SEBT is administered can affect results, one method does not seem superior to another.[76]

III Associations have been identified between dorsiflexion ROM with the weight-bearing lunge test and the anterior reach direction (r = 0.55, P<.001), posterolateral reach direction (r = 0.29, P = .03), and the composite SEBT scores (r = 0.30, P = .02), while there was no association with the posteromedial reach direction (r = 0.01, R^2 = 0.001, P = .47).[26] Terada et al[425] also found a significant correlation between dorsiflexion ROM and SEBT anterior reach distance (r = 0.410, P = .014). Similar findings were found by Gabriner et al,[146] as dorsiflexion ROM measured with the weight-bearing lunge test and plantar cutaneous sensation explained a significant amount of the variance associated with SEBT anterior reach distance (R^2 = 0.16, P = .041), while eversion strength and time to medial-lateral boundary explained a significant amount of the variance associated with SEBT posteromedial reach distance (R^2 = 0.28, P = .002).[146] Weight-bearing dorsiflexion ROM was also correlated with sagittal knee (r = –0.53, P = .04) and frontal trunk (r = 0.62, P = .01) movements, as well as with SEBT anterior reach distance (r = 0.51, P = .05).[187]

III Some studies have found that the SEBT was able to differentiate "copers" from those with CAI,[138,205,250] while another did not.[152]

III A systematic review and meta-analysis found that individuals with CAI had decreased hip abduction, extension, and external rotation strength (P<.001; effect size range, 0.52-0.93), but no difference in knee kinematics, with dynamic balance activities (P = .26).[87] Studies included in this review also found that hip abduction and external rotation strength each explained a significant (R^2 = 0.25, P = .01) amount of the SEBT posteromedial and posterolateral reach directions.[302] Studies not in the review also support a decrease in hip strength in those with CAI.[249]

III The BESS with the eyes closed was significantly different (P = .01) and could distinguish copers (mean ± SD BESS score, 1.12 ± 0.85) from those with CAI (2.7 ± 1.87).[258]

III Foot posture, as measured with the FPI score, may affect static and dynamic postural control in individuals with CAI, as a neutral group had better dynamic postural control, while the pronator group had better static postural control ($P \leq .05$).[189] However, no significant differences in foot posture, arch height index, or foot mobility magnitude have been found in individuals with or without LAS or CAI.[138]

III In those with CAI, measures of static and dynamic postural control (eg, SEBT), dorsiflexion ROM, plantar cutaneous sensation, strength, and ankle-subtalar joint motion contributed significantly (R^2 = 0.18-0.35, $P<.05$) to multiple patient-reported outcome measure score variances.[194]

IV Significant correlations between isokinetic inversion muscle strength and the single-leg balance test, single heel-raise test, and sidestep test (r = 0.23-0.51, $P<.009$) were identified in those with CAI.[343] Postural control evaluation using the modified Romberg test could substitute for dynamometer testing of joint position sense, as these measures were correlated (r = −0.81, $P<.001$) in those with chronic complaints of instability.[59]

Evidence Synthesis and Rationale

A growing body of evidence supports assessing impairments of body function and structures before beginning treatment, and then 2 or more times over an episode of care, to identify limitations, predict treatment success, and define progress over the course of treatment for those with acute LAS or CAI. The role of bilateral lower extremity impairments that result from central mediated processes needs further investigation and may affect how test results comparing injured to uninjured sides are interpreted.

2021 Recommendations

A Clinicians should assess and document ankle swelling, ROM, talar translation, talar inversion, and single-leg balance in patients with an acute LAS, postacute LAS, or CAI at baseline and 2 or more times over an episode of care. Clinicians should specifically include measures of dorsiflexion as measured with the weight-bearing lunge test, static balance with a single limb on a firm surface with eyes closed, and dynamic balance with the SEBT anterior, anteromedial, posteromedial, and posterolateral reach directions.

C In those with CAI, clinicians may also assess and document hip abduction, extension, and external rotation strength 2 or more times over an episode of care.

ACTIVITY LIMITATION – PHYSICAL PERFORMANCE MEASURES

2013 Recommendation

B When evaluating a patient in the postacute period following a recent or recurring LAS, physical therapists/clinicians should assess and document activity limitation, participation restriction, and symptom reproduction using objective and reproducible measures that assess performance with lateral movements, diagonal movements, and directional changes, such as single-limb hop tests.

Evidence Update

III The systematic review and meta-analysis by Rosen et al[376] assessed functional performance tests and found that the timed hop (mean effect size, −1.056; P = .009), side hop (mean effect size, −2.314; P = .001), and multiple hop tests (mean effect size, 1.399; $P<.001$) were able to differentiate healthy individuals from those with CAI. Included in the review by Rosen et al,[376] Ko et al[231] found the single-leg hop test (standard error of measurement, 0.6 seconds) to have high intrarater reliability, with Linens et al[280] identifying a cutoff score of 12.88 seconds as being able to differentiate those with CAI from healthy individuals.

III The lower extremity Functional Movement Screen (LE-FMS) scores differentiated healthy individuals from those with CAI (8.2 versus 6.9, $P<.05$). Both inline lunge (affected side and nonaffected side) and hurdle step (affected side and nonaffected side) were different ($P<.05$), while there was no difference between the two groups in the deep squat ($P>.05$). Also in those with CAI, the total LE-FMS score and inline lunge test correlated to the FADI ADL and sports scores (r = 0.807-0.896, $P<.01$).[62]

III The timed dynamic leap and balance test was able to differentiate those with CAI from controls (51.85 seconds versus 41.12 seconds, $P<.001$).[206]

IV Those with ankle laxity, as assessed with the ADT, had lower hopping for distance (percent body height, 95.03% versus 105.26%; $P<.05$) and performed poorer on a hexagon hopping course (count, 13.21 versus 14.52; $P<.05$) when compared to those with stable ankles.[474]

IV One-leg hopping for distance demonstrated significant side-to-side differences compared with the unaffected ankle (P = .035) and was correlated with joint position sense (r = −0.38 to 0.66, $P<.05$) in those with chronic complaints of instability.[59]

Evidence Synthesis and Rationale

There continues to be strong evidence to support the use of single-limb hopping under timed conditions to assess activity limitation and participation restrictions. Hopping should be performed under safe conditions, and only after a patient has appropriately been progressed along a continuum of activity. Further studies are needed to define the usefulness of more comprehensive movement screens.

2021 Recommendation

B Clinicians should assess and document objective and reliable measures of activity limitation, participation restriction, and symptom reproduction at baseline and 2 or more times during an episode of care when evaluating a patient with a LAS or CAI, and specifically include measures of single-limb hopping under timed conditions when appropriate.

TECHNOLOGY AND INSTRUMENTATION

2021 Evidence Summary

The use of technology (eg, computerized measurement devices) to assess physical impairment as well as activity and functional performance in those with a history of LAS and chronic complaints of ankle instability has been supported.[1,5,58,61,144,252,260,277,392,413,475,482] Research studies have also used motion analysis and a force plate to assess static and dynamic balance, gait, and jumping,[49,50,55,69,85,90,101,103,107,108,110,112-114,116-118,126,136,139,140,167,173,175,176,192,205,218,225,228,256,259,274,276,279,318,350,379,396,398,399,401,409,421,429,430,481] as well as an isokinetic dynamometer to assess strength, joint reposition, and movement detection.[59,60,78,82,264,333,343,347,379,392,404,473]

CLINICAL PRACTICE GUIDELINES

Interventions

Interventions for acute and subacute LAS and CAI were presented in the 2013 CPG[298] using the context of acute and progressive loading/sensorimotor training phases of treatment. Since that time, study samples have become more consistent, using language that is different from that in the initial CPG. The major distinction between the two phases of treatment as described in the 2013 CPG was a time threshold of 72 hours post injury.[1] For the 2021 CPG update, intervention guidelines are presented using a consensus framework that reflects how research evidence has developed since the initial CPG (**TABLE 2**). It uses the terms "acute LAS" and "CAI."[159,160] This evidence update identified specific neuromusculoskeletal impairments, activity limitations, participation restrictions, treatment response, and the mediating intrinsic factors that exist along a spectrum of acute LAS, postacute LAS, and CAI (**FIGURE 1**).

Clinicians should consider the updated evidence-based recommendations provided in this guideline in the appropriate context of clinical experience and patient preference when determining the nature and timing of interventions during the course of rehabilitation for an individual with LAS. Due to heterogeneity of impairment and activity limitation experienced by individuals with LAS and CAI, interventions should be tailored to the specific needs of the patient. Furthermore, intrinsic and environmental factors that mediate outcomes should also be addressed when prescribing interventions for individuals with LAS and CAI. Physical therapists and other rehabilitation specialists are members of larger, multidisciplinary teams while treating patients with LAS and CAI. Engaging other physical therapists, athletic trainers, physicians, surgeons, mental and behavioral health care providers, nurses, strength and conditioning specialists, vocational specialists, and other health disciplines may be warranted for optimal transition to work or sport. Patient-reported and objective clinical and instrumented measures that can capture resolution of ankle-foot impairment, return to activity, and resumption of social participation are paramount to managing the intensity and dose of interventions.

PREVENTION OF LATERAL ANKLE SPRAINS

PRIMARY PREVENTION OF A FIRST-TIME LATERAL ANKLE SPRAIN

2013 Recommendation

None.

Evidence Update

I Leppänen and colleagues[268] conducted a systematic review and meta-analysis to examine the effects of any primary prevention interventions in sports injuries. Ten trials addressing prevention of ankle injuries with external ankle joint supports were included. Pooled results showed a significant reduction in the frequency of ankle injuries compared to no ankle supports (pooled OR = 0.40; 95% CI: 0.30, 0.53). Subjects in these trials (n = 6662) were young male and female athletes in basketball, male athletes in soccer and American football, and military paratroopers. The external ankle supports used were different kinds of stabilizing devices, such as orthoses and braces. Ankle taping was not studied in these randomized clinical trials (RCTs).

TABLE 2 Treatment-Based Classification of LAS: Operational Definitions to Guide Intervention for LAS, Based on History and Physical Examination Findings

	Classification 1	Classification 2
2013 CPG	Acute/protected motion • Within 72 h following inversion mechanism injury • Individuals who demonstrated significant swelling, pain, limited weight bearing, and overt gait deviations (ie, limited stance time, abbreviated/omitted terminal stance phase)	Sensorimotor training • Postacute period • Primary concerns of instability, weakness, limited balance responses, and intermittent swelling
2021 CPG	Acute LAS • Within 72 h following inversion mechanism injury • Individuals who demonstrated significant swelling, pain, limited weight bearing, and overt gait deviations (ie, limited stance time, abbreviated/omitted terminal stance phase)	Chronic ankle instability • History of at least 1 significant ankle sprain within the past 12 mo • A history of the previously injured ankle joint "giving way" and/or recurrent sprain and/or "feelings of instability"

Abbreviations: CPG, clinical practice guideline; LAS, lateral ankle sprain.

I Vuurberg and colleagues[451] reported that the use of an ankle brace or tape reduces the risk of first-time LAS (relative risk = 0.69; 95% CI: 0.49, 0.96), especially in those who participate in sports. When compared to bracing, taping has been suggested to be less advantageous from a cost-benefit perspective.[336] The choice between brace and tape should depend on patient/client preference, the clinician's judgment, and the cost-effectiveness of the interventions. The review of 3 RCTs (n = 3410) assessing the prophylactic effects of low-fitted or high-fitted footwear found that this intervention yielded no significant reduction in ankle sprain risk.

I Bellows and Wong[31] found 3 trials (n = 3581), in a systematic review and meta-analysis, that demonstrated a statistically significant 4.2% absolute risk reduction of ankle sprains with the use of a brace compared to no treatment, corresponding to a 64% reduction of relative risk.

I The Bellows and Wong[31] review also identified 6 trials (n = 3577) that demonstrated a statistically significant 6.5% absolute risk reduction of ankle sprains with a balance training program compared to no treatment, corresponding to a 46% relative risk reduction. The specific nature and level of supervision for balance training exercises demonstrated high variability among the included studies. This review and meta-analysis included studies of individuals with and without a history of prior LAS.

I Vuurberg and colleagues[451] reported that while there is evidence to support the use of exercise for prevention of recurrent sprains, there is a lack of evidence to support the use of prophylactic exercises for the prevention of first-time ankle sprains.

Evidence Synthesis and Rationale

There is strong evidence to support the use of prophylactic bracing and taping for the prevention of first-time ankle sprains. While bracing appears to be more cost-effective than taping, clinician experience and patient preference should be considered when deciding which intervention to employ. There is strong evidence for the use of balance exercise for the prevention of recurrent ankle sprains, yet there is a lack of evidence for the use of these interventions for the primary prevention of first-time ankle sprains at present. However, clinicians may recommend exercise as part of a comprehensive fitness program due to the potential prophylactic benefits and relatively low associated risks. More research is needed to clarify the specific mode and volume of exercise necessary to produce preventive effects. Based on the frequency of injury and morbidity associated with

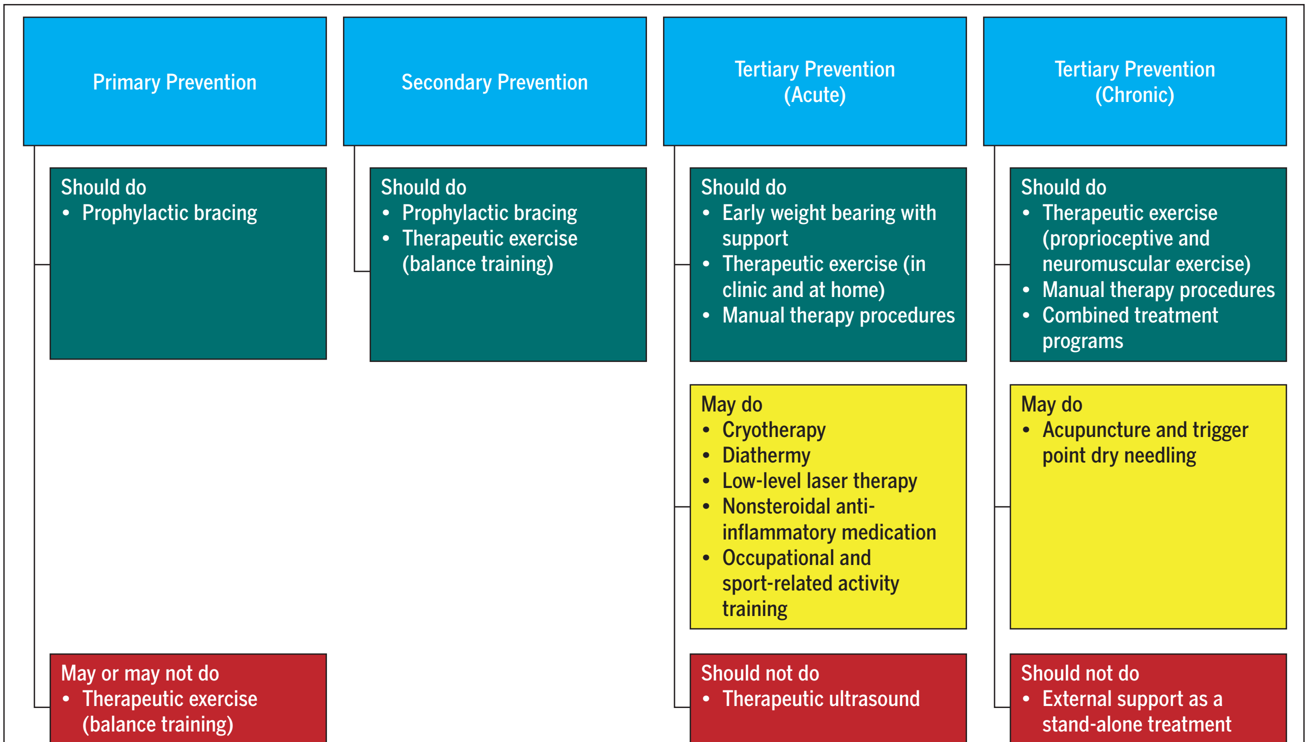

FIGURE 1. Evidence-based interventions by level of prevention. Primary prevention refers to interventions to reduce the risk of a first-time LAS in people exposed to risk factors, secondary prevention refers to interventions to reduce the risk for recurrent LAS after a first-time LAS, and tertiary prevention refers to interventions to reduce the effects and progression of a LAS. Abbreviation: LAS, lateral ankle sprain.

LAS and CAI, prophylactic bracing and taping should be routinely employed in individuals with intrinsic risk factors or those who engage in high-risk activities such as court sports. Further investigation may be needed to define the necessary components of a brace, as well as specific taping techniques that best provide protection.

2021 Recommendations

A Clinicians should recommend the use of prophylactic bracing to reduce the risk of a first-time LAS, particularly for those with risk factors for LAS.

C Clinicians may recommend the use of prophylactic balance training exercises to individuals who have not experienced a first-time LAS.

SECONDARY PREVENTION OF RECURRENT LATERAL ANKLE SPRAIN FOLLOWING AN INITIAL SPRAIN

2013 Recommendation

C Clinicians can implement balance and sport-related activity training to reduce the risk of recurrent ankle sprains in athletes.

Evidence Update

I In a meta-analysis of 3 systematic reviews investigating the effectiveness of exercise interventions for secondary prevention of LAS, Doherty and colleagues[102] found a significantly decreased risk of sustaining a recurrent ankle sprain in the intervention group compared to controls (OR = 0.59; 95% CI: 0.51, 0.68).

I Doherty and colleagues[102] also found consistency among 5 included systematic reviews that bracing was effective at preventing a recurrence of an ankle sprain (OR = 0.40; 95% CI: 0.29, 0.56), especially if the individual engaged in high-risk activity such as indoor court- or field-based athletics.

I Doherty and colleagues[102] concluded from data in 2 systematic reviews that bracing was superior to taping, though 3 systematic reviews advocated for the value of taping. There is limited evidence on mechanisms that lead to these beneficial effects. When compared to bracing, taping has been suggested to be less advantageous from a cost-benefit perspective.[336]

I There is inconclusive evidence from systematic reviews for footwear modification or foot orthoses to prevent a recurrent ankle sprain after an initial LAS among evaluated systematic reviews.[102,356] Furthermore, there is a lack of evidence pertaining to orthotic use in the treatment of CAI or the prevention of ankle sprain recurrence.[102,356]

I Therapeutic exercise involving proprioceptive and balance retraining is associated with reduced frequency of recurrent LAS, based on data from 10 trials (n = 1284), and reduced prevalence of functional ankle instability, based on data from 3 trials (n = 174).[451]

I Based on data from 7 trials (n = 1417), Bleakley and colleagues[33] found a significant reduction in recurrent injury following exercise-based intervention in people with an existing LAS, compared to usual care, at 7 to 12 months post injury (OR = 0.53; 95% CI: 0.38, 0.73). Usual care consisted of 1 or more of protection, rest, ice, and elevation. Although most programs in the included studies emphasized strength and balance training, the specific nature and volume of exercises demonstrated substantial variability.

I Burger and colleagues[43] found a statistically similar rate of recurrence in people with a prior LAS who received neuromuscular exercise compared to bracing, based on a systematic review and meta-analysis (3 trials, n = 144).

Evidence Synthesis and Rationale

There is strong evidence to support the use of prophylactic bracing, taping, and balance training exercises for the prevention of subsequent ankle sprains. While bracing appears to be more cost-effective than taping, clinician experience and patient preference should be considered when deciding which intervention to employ. Footwear modification and orthotic prescription have been shown to be ineffective for general prophylaxis of subsequent ankle sprain; however, the utility of these interventions for addressing specific ankle-foot impairments that contribute to activity limitation following LAS and CAI has yet to be elucidated. The necessary components of a brace, taping technique, footwear, and orthosis that best provide protection may need further investigation.

2021 Recommendation

A Clinicians should prescribe prophylactic bracing and use proprioceptive and balance-focused therapeutic exercise training programs to address impairments identified on physical examination to reduce the risk of a subsequent injury in patients with a first-time LAS.

INTERVENTIONS FOR ACUTE AND POSTACUTE LATERAL ANKLE SPRAINS

PROTECTION AND OPTIMAL LOADING

2013 Recommendation

A Clinicians should advise patients with an acute LAS to use external supports (taping and bracing) and to progressively bear weight on the affected limb. The type of external support and gait assistive device recommended should be based on the severity of the injury, phase of tissue healing, level of protection indicated, extent of pain, and patient preference. In more severe injuries, immobilization, ranging from semi-rigid bracing to below-knee casting, may be indicated.

Evidence Update

I Petersen and colleagues[348] performed a systematic review and meta-analysis of treatment of acute ankle ligament injuries. The authors included a review by Kerkhoffs and colleagues,[214] who compared studies (21 trials, n = 2184 participants) regarding functional treatment and immobilization. Functional treatment promoted significant improvements in return-to-sports rate, time to return to sports, return-to-work rate, time to return to work, swelling, and satisfaction with treatment compared to immobilization. Vuurberg and colleagues[451] also found that a functional approach involving early weight bearing with the ankle braced or taped and inclusion of neuromuscular and proprioceptive exercises led to the fastest resumption of work and ADL compared to immobilization.

I In the review conducted by Vuurberg and colleagues,[451] the authors concluded, based on 3 RCTs (n = 694), that a short period of immobilization of 10 days or less with a plaster cast or rigid support can be of added value in the treatment of grade III sprains, resulting in decreased pain and edema and improved functional outcomes.

I A period of 4 weeks in a lower-leg cast following an acute LAS results in a longer time required, and a lower proportion of patients able, to return to work and sport 4 to 6 weeks after injury compared to individuals treated with functional support and exercise strategies (22 RCTs, n = 2304).[214]

Evidence Synthesis and Rationale

Based on strong evidence, optimized loading should begin in the acute phase and continue into the postacute phase following a LAS. The duration and extent of loading should be dictated by the physical examination and should consider comorbidities, clinician experience, and patient preference when planning care. Treatment with early neuromuscular and proprioceptive exercises in the postacute period appears to be superior to immobilization in optimizing functional outcomes. A period of immobilization may be considered for severe sprains. If immobilization is employed post injury, a period of no more than 10 days is suggested.

2021 Recommendations

A Clinicians should advise patients with an acute LAS to use external supports, such as braces or taping, and to progressively bear weight on the affected limb. The type of external support and gait assistive device recommended should be based on the severity of the injury, phase of tissue healing, level of protection indicated, extent of pain, and patient preference.

A In more severe injuries, immobilization, ranging from semi-rigid bracing to below-knee casting, may be indicated for up to 10 days post injury.

THERAPEUTIC EXERCISE

Therapeutic exercise as described in the literature generally consists of a structured program, with varying components that can include protected active ROM, stretching exercises, neuromuscular training, postural re-education, and balance training.

2013 Recommendation

A Clinicians should implement rehabilitation programs that include therapeutic exercises for patients with severe LAS.

Evidence Update

I In a systematic review and meta-analysis, Vuurberg and colleagues[451] found that exercise therapy programs, initiated early following an acute LAS injury, promoted faster time to recovery with improved objective instability (relative risk = 0.68; 95% CI: 0.49, 0.95) and subjective instability (relative risk = 0.80; 95% CI: 0.64, 1.00). Exercise programs generally consisted of balance retraining, postural re-education, and neuromuscular training, with varying and diverse modes and volumes of exercises.

I Feger and colleagues[133] included 4 trials in a systematic review and meta-analysis. Compared to independent exercise, supervised exercise was associated with less pain and subjective instability at intermediate follow-up (8 weeks after injury), but there were no differences in self-reported outcomes at longer follow-up periods (3 and 12 months after injury); with greater gains in ankle strength and joint position sense but worse postural control at 4-month follow-up; and there were inconclusive results regarding prevention of recurrent ankle sprains at 12 months after injury. The authors concluded that supervised exercise may promote additional clinical benefit in patients with severe LAS compared to mild LAS and to a home exercise program.

I There is conflicting evidence for improved balance responses after virtual reality training in individuals with LAS. Gumaa and Rehan Youssef[165] identified 4 trials through a systematic review that assessed the clinical effectiveness of virtual reality for individuals with LAS (n = 273), which involved a variety of different virtual environments and video games. In 2 of the included RCTs, significant improvements were noted in measures of dynamic balance and postural sway, and no significant differences were noted in the other 2 trials.

Evidence Synthesis and Rationale

Therapeutic exercise consisting of neuromuscular training, postural re-education, and balance training appears to improve subjective and objective talocrural stability, as well as reduce time to return to preinjury activity. Compositions of exercise programs in the literature are diverse, so specific recommendations regarding mode and volume are unfeasible. Clinicians should customize exercise programs to findings from the physical examination and analysis of the task to which the individual will return. There appears to be clinical benefit for exercise to be supervised in individuals with more severe LAS compared to mild LAS. Virtual environments and computerized game applications have mixed effects on measurements of body structures and functions in people with LAS, but may be useful in an adjunctive role for skilled exercise prescription.

2021 Recommendations

A Clinicians should implement rehabilitation programs with a structured therapeutic exercise program, which can include protected active ROM, stretching exercises, neuromuscular training, postural re-education, and balance training, both in clinic and at home, as determined by injury severity, identified impairments, preferences, learning needs, and social barriers in those with a LAS.

D There is conflicting evidence as to the best way to augment the unsupervised components of a home program in those with a LAS: by written instructions, exercise-based video games, or app-based instruction. Therefore, augmentation can be determined by the individual's specific learning needs and access to relevant technology.

OCCUPATIONAL AND SPORT-RELATED ACTIVITY TRAINING

2013 Recommendation

C Clinicians may implement balance and sport-related activity training to reduce the risk of recurrent LAS in athletes.

Evidence Update

I In the systematic review and evidence-based multidisciplinary guidelines developed by Vuurberg and colleagues,[451] the authors recommended that return to sedentary work should occur 2 to 6 weeks following injury, and at 6 to 8 weeks for more physical occupations and sports activities, as outlined in **FIGURE 2**. These specific guidelines should be considered with the contextual factors of in-

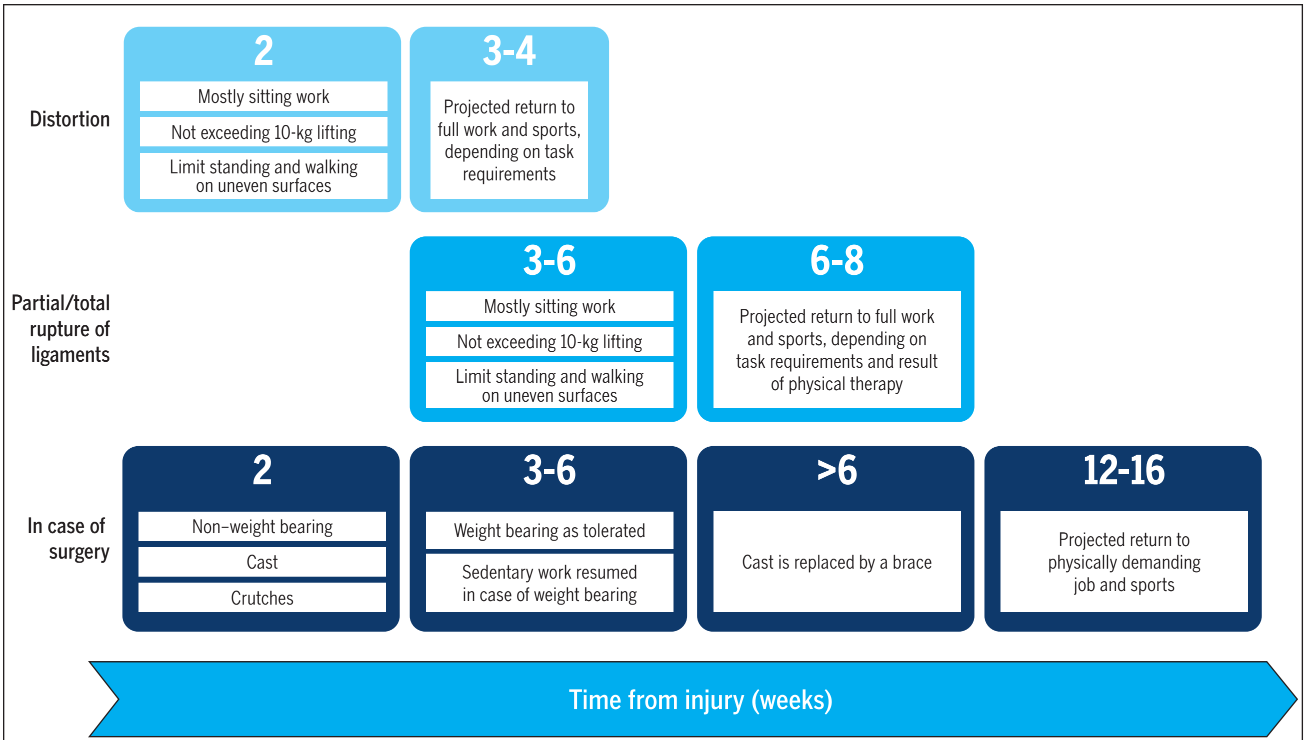

FIGURE 2. Evidence-based guidelines for return to physical occupations and sports activities as outlined by Vuurberg et al.[451]

jury severity, access and response to rehabilitation care, and task requirements.

Evidence Synthesis and Rationale

While the previous literature focused on primary injury prevention, the bulk of the current literature focuses on prevention of recurrent injuries. While further research is needed for specific occupations and sports, return to work and sports can be facilitated with functional treatment earlier in the rehabilitation course, use of a brace, and by employing a return-to-work/sports schedule.

2021 Recommendation

B Clinicians should implement a return-to-work schedule and use a brace early in the rehabilitation, occupational or sport-related training, and/or work-hardening program to mitigate activity limitation and participation restriction following LAS.

MANUAL THERAPY

2013 Recommendation

B Clinicians should use manual therapy procedures, such as lymphatic drainage, active and passive soft tissue and joint mobilization, and anterior-to-posterior talar mobilization procedures, within pain-free movement to reduce swelling, improve pain-free ankle and foot mobility, and normalize gait parameters in individuals with an acute LAS.

Evidence Update

I Vuurberg and colleagues[451] concluded that manual joint mobilization can provide a short-term increase in ankle joint dorsiflexion ROM following acute LAS, based on data from 12 trials (n = 427). Ankle joint mobilization has been reported to decrease pain,[290] and when combined with exercise has resulted in better outcomes compared to exercise therapy alone in 1 well-designed RCT.[67]

I Clar and colleagues[66] reviewed 1 high-, 10 moderate-, and 2 low-quality trials concerning manual therapy after LAS. The authors concluded that there was moderate evidence in favor of manual therapy (mobilization/manipulation) of the knee and/or full kinetic chain and of the ankle and/or foot, combined with multimodal or exercise therapy, for LAS. Data from 12 trials (n = 687) in the review by Doherty and colleagues[102] indicated that manual therapy resulted in equivocal outcomes for self-reported function and injury recurrence.

Evidence Synthesis and Rationale

Additional evidence in favor of manual therapy has emerged that highlights the importance of hands-on treatments to reduce pain and increase short-term ankle dorsiflexion ROM in those with a LAS. Manual therapy combined with exercise appears to stimulate optimal effects on short-term treatment outcomes. Although the effects of manual therapy after LAS are most prominent in the short term, use of manual therapy appears to add value for pain control and movement in the acute period compared to exercise alone or no treatment. Selection of manual therapy techniques should be based on the clinical examination and analysis of the movement requirements of the function to which the individual will return. The clinician should favor slow-velocity techniques that do not provoke symptoms in the acute phase.

2021 Recommendation

A Clinicians should use manual therapy procedures, such as lymphatic drainage, active and passive soft tissue and joint mobilization, and anterior-to-posterior talar mobilization procedures within pain-free movement, alongside therapeutic exercise to reduce swelling, improve pain-free ankle and foot mobility, and normalize gait parameters in individuals with a LAS.

ACUPUNCTURE

2013 Recommendation

None.

Evidence Update

I Doherty and colleagues[102] evaluated 3 systematic reviews involving acupuncture for the treatment of acute LAS. Two of the reviews reported insufficient data to determine the relative effectiveness of complementary medicine in the treatment of acute LAS for self-reported function or injury recurrence. The third review concluded that acupuncture was likely to have a therapeutic effect on improving acute symptoms, yet it acknowledged that the magnitude of the effect was likely to be overestimated due to the low quality of the included studies. Included in the review by Doherty and colleagues,[102] a systematic review and meta-analysis by Park and colleagues[341] included 17 trials (n = 1820). Trial quality was generally poor, with high heterogeneity and risk of bias. Three trials reported adequate methods of randomization and only 1 reported a method of allocation concealment. The benefit of acupuncture remained significant when the analysis was limited to studies with the lowest risk of bias. Specifically, acupuncture was more effective than conventional treatment in relieving pain, facilitating return to normal activity, and promoting quality of life.

Evidence Synthesis and Rationale

There is a paucity of high-quality studies that report complete data on the clinical application of acupuncture in individuals with acute LAS. On this basis, the evidence for the efficacy of acupuncture in the treatment of acute LAS for the primary outcomes of injury recurrence/self-reported function is inconclusive. Observations of clinical benefit were based on only a small number of well-designed studies and require additional replication before a recommendation can be made for this intervention.

2021 Recommendation

D There is conflicting evidence regarding the use of acupuncture to reduce symptoms associated with acute LAS.

PHYSICAL AGENTS: CRYOTHERAPY

2013 Recommendation

A Clinicians should use repeated intermittent applications of ice to reduce pain, decrease the need for pain medication, and improve weight bearing following an acute ankle sprain.

Evidence Update

I Doherty and colleagues[102] concluded that ice, compression, and elevation alone are not effective for improving the primary outcomes of self-reported function or recurrence following acute ankle sprain compared with no treatment. Three systematic reviews included by Doherty and colleagues[102] concluded that treatment success was achieved with exercise therapy combined with rest, ice, compression, and elevation.

I Vuurberg and colleagues[451] reviewed 27 trials (n = 1670) and concluded that there was no evidence to support the isolated use of ice to increase function and decrease swelling and pain at rest in individuals with LAS. The combination of ice and exercise results in significant improvements in ankle function in the short term, allowing patients to increase loading during weight bearing compared with standard functional treatment (1 RCT, n = 101). In combination with exercise therapy, ice has a greater effect on reducing swelling compared with heat application in individuals with LAS (1 trial, n = 30).

Evidence Synthesis and Rationale

Since the initial CPG, strong evidence has emerged that rest, ice, compression, and elevation are insufficient to improve self-reported function and injury recurrence in people with an acute LAS. Use of ice in a combined approach to intervention that involves exercise may improve load tolerance during weight bearing, which can improve the ability of individuals to bear weight on the affected limb. Clinicians should consider individual effects of ice on weight bearing and patient preference to decide whether the application of ice may be warranted.

2021 Recommendation

C Clinicians may use repeated intermittent applications of ice in association with a therapeutic exercise program to address symptoms and functioning following an acute LAS.

PHYSICAL AGENTS: DIATHERMY

2013 Recommendation

C Clinicians can utilize pulsating shortwave diathermy for reducing edema and gait deviations associated with acute ankle sprains.

Evidence Update

None.

2021 Recommendation

No change.

PHYSICAL AGENTS: ELECTROTHERAPY

2013 Recommendation

D There is moderate evidence both for and against the use of electrotherapy for the management of acute ankle sprains.

Evidence Update

None.

2021 Recommendation

No change.

PHYSICAL AGENTS: LOW-LEVEL LASER THERAPY

2013 Recommendation

D There is moderate evidence both for and against the use of low-level laser therapy for the management of acute ankle sprains.

Evidence Update

I In an RCT (n = 40), de Moraes Prianti and colleagues[91] observed significant reductions in pain and swelling in the first 6 days following acute LAS in response to treatment with light-emitting diodes ($\lambda 627 \pm 10$ nm) with an energy density of 10 J/cm^2 combined with a standardized cryotherapy protocol.

III In another RCT (n = 19), Calin and colleagues[46] measured significant improvements in ankle pain and function at 10 days following the initiation of a fractionated irradiation photobiomodulation therapy protocol (635 nm, 15 mW), consisting of 2 sessions (4.5 and 9 J/cm^2) separated by a 30-minute time interval. No significant differences in ankle pain and function were observed at 6-week follow-up.

Evidence Synthesis and Rationale

There remains a paucity of high-quality trials to support the use of low-level laser therapy, including the range of intervention parameters available.

2021 Recommendation

C Clinicians may use low-level laser therapy to reduce pain in the initial phase of an acute LAS.

PHYSICAL AGENTS: ULTRASOUND

2013 Recommendation

A Clinicians should not use ultrasound for the management of acute ankle sprains.

Evidence Update

I Doherty and colleagues[102] concluded from their systematic review and meta-analysis that none of the included studies demonstrated any beneficial effect of ultrasound therapy in the treatment of acute LAS.

Evidence Synthesis and Rationale

There are very few trials evaluating the effectiveness of ultrasound therapy for acute LAS, and even fewer have considered the range of parameters available.

2021 Recommendation

A Clinicians should not use ultrasound for the management of acute ankle sprains.

NONSTEROIDAL ANTI-INFLAMMATORY MEDICATION

2013 Recommendation

None.

Evidence Update

I Vuurberg and colleagues[451] concluded that the use of oral or topical nonsteroidal anti-inflammatory drugs (NSAIDs) results in less pain fewer than 14 days after LAS, without significantly increasing the risk of adverse events, compared with placebo (26 trials, n = 4225). Doherty and colleagues[102] established an equivocal effect of pharmacological agents, typically NSAIDs, on function and recurrent injury in individuals with LAS, based on data from 13 trials (n = 2423).

I Selective NSAIDs (celecoxib 200 mg, 2 times daily) are noninferior to nonselective NSAIDs (eg, ibuprofen, naproxen, or diclofenac) to reduce pain after an acute LAS (4 trials, n = 1490).[451] Diclofenac showed superior results at days 1 and 2 compared with piroxicam (2 trials, n = 201) and ibuprofen (1 trial, n = 60) for reducing pain during motion in patients with mild to severe acute ankle sprains and demonstrated equal adverse event rates.[451] Despite dose differences, the clinical benefit of acetaminophen (paracetamol) is equivalent to NSAIDs for pain, swelling, and ROM after LAS.[451]

Evidence Synthesis and Rationale

Based on available evidence, NSAIDs may be expected to reduce pain in individuals with acute LAS, but are not expected to improve ankle ROM and reduce the likelihood of recurrent injury. Nonsteroidal anti-inflammatory medications may confer benefit over risk within the first 14 days following injury. The observed short-term pain reduction may be important for early weight bearing. Selective NSAIDs, nonselective NSAIDs, and acetaminophen/paracetamol may be considered based on individual needs, given their similar clinical effects.

2021 Recommendation

C Clinicians may prescribe NSAIDs (as physical therapy practice acts allow) to reduce pain and swelling in those with an acute LAS.

INTERVENTIONS FOR CHRONIC ANKLE INSTABILITY EXTERNAL SUPPORT

2013 Recommendation

None.

Evidence

I In a systematic review and network meta-analysis (21 trials, n = 469), Tsikopoulos and colleagues[437] identified moderate evidence that external support of any type, including insoles plus bracing, bracing, insoles, and taping, was no more effective than controls in providing clinical benefit for postural stability and balance performance.

Evidence Synthesis and Rationale

While external supports are recommended for prevention of reinjury, the use of external support as a sole treatment intervention is insufficient to promote sustained improvements in balance and postural stability in people with CAI. The clinician may consider whether the use of external supports, such as taping and bracing, would assist the individual with CAI to achieve short-term goals of rehabilitation through the improved ability to engage in interventions that can promote long-term clinical benefit.

2021 Recommendation

B Clinicians should not use external support, including braces or taping, as a stand-alone intervention to improve balance and postural stability in individuals with CAI.

THERAPEUTIC EXERCISE AND ACTIVITIES

2013 Recommendation

C Clinicians may include therapeutic exercises and activities, such as weight-bearing functional exercises and single-limb balance activities using unstable surfaces, to improve mobility, strength, coordination, and postural control in the postacute period of rehabilitation for ankle sprains.

Evidence Update

I Doherty and colleagues[102] assessed 22 systematic reviews that evaluated exercise therapy for treatment of CAI or recurrent ankle sprain. Therapeutic exercises that have been studied include balance retraining, postural re-education, neuromuscular training, and strengthening of ankle and lower-quarter kinetic-chain muscles using isolated exercises and movement patterns. The authors concluded that exercise therapy is generally considered effective in the treatment of CAI for the outcomes of self-reported function and reinjury incidence.[102]

I In the meta-analysis of 8 RCTs conducted by Powden and colleagues,[356] rehabilitation protocols that focused on balance training effectively improved health-related quality of life, as measured by patient-oriented outcomes, in individuals with CAI.

Evidence Synthesis and Rationale

There is consensus across the literature that therapeutic exercises demonstrate a strong positive clinical benefit in those with CAI. Exercise protocols across studies are substantially heterogeneous and comparisons across studies are infeasible, so specific recommendations currently are not possible for the best mode and volume of exercise to promote clinical benefit.

2021 Recommendation

A Clinicians should prescribe proprioceptive and neuromuscular therapeutic exercise to improve dynamic postural stability and patient-perceived stability during function in individuals with CAI.

MANUAL THERAPY

2013 Recommendation

A Clinicians should include manual therapy procedures, such as graded joint mobilizations, manipulations, and non–weight-bearing and weight-bearing mobilization with movement, to improve ankle dorsiflexion, proprioception, and weight-bearing tolerance in patients recovering from chronic LAS symptoms.

Evidence Update

I In the systematic review and multidisciplinary guideline conducted by Vuurberg and colleagues,[451] a combination of manual therapy interventions with other treatment modalities, such as exercise therapy, enhanced the effectiveness of manual joint mobilization and was recommended in the treatment of CAI.

I Five systematic reviews that investigated manual therapy for the treatment of CAI were included in the study conducted by Doherty and colleagues.[102] Each of these reviews identified that manual mobilization likely has a short-term positive effect on ankle dorsiflexion ROM.

I In the meta-analysis of studies that encompassed manual therapy–focused treatment programs, Powden and colleagues[356] found that interventions such as anterior-to-posterior Maitland grade III joint mobilizations, Mulligan talocrural mobilizations with movement, tibiofibular manipulations, and plantar massage had large, significant pre-to-post treatment effects in improving patient-oriented outcomes in individuals with CAI.

I In the systematic review and meta-analysis conducted by Weerasekara and colleagues,[463] joint mobilization demonstrated clinical benefit in individuals with CAI through immediate improvements in dynamic balance and weight-bearing dorsiflexion ROM in the short term. Joint mobilization did not have an immediate effect on static balance or pain intensity, nor did it affect weight-bearing ankle dorsiflexion ROM in the long term.

I Based on a systematic review and meta-analysis including 4 trials of people with CAI (n = 208), Shi and colleagues[390] found that 6 sessions of manual therapy promoted significant improvements in ankle strength, balance, and functional tests, while a single session of manual therapy did not promote significant improvements in these measurements.

I Stathopoulos and colleagues[412] identified 2 trials (n = 93) involving individuals with CAI who received Mulligan-based mobilization with movement. The trials were characterized by high statistical heterogeneity, and meta-analysis was not undertaken. Qualitative synthesis suggested significant improvement of ankle dorsiflexion ROM after intervention in the included trials. Weerasekara and colleagues[462] identified evidence from 4 trials (n = 201) suggesting significant improvement of weight-bearing ankle dorsiflexion ROM after mobilization with movement compared to sham and no intervention in people with CAI. However, there was insufficient evidence to draw conclusions about long-term effects (6 months or greater) and other outcome measures.

Evidence Synthesis and Rationale

Manual therapy procedures appear effective in improving outcomes in people with CAI, including increased short-term ankle dorsiflexion ROM, ankle strength, balance, and functional test performance. Although these effects are not observed in the long term, short-term effects of intervention may be important to help people with CAI to meet short-term activity participation and rehabilitation goals.

2021 Recommendation

A Clinicians should use manual therapy procedures, such as graded joint mobilizations, manipulations, and non–weight-bearing and weight-bearing mobilization with movement, to improve weight-bearing ankle dorsiflexion and dynamic balance in the short term for individuals with CAI.

DRY NEEDLING

2013 Recommendation

None.

Evidence Update

I The results of a single-blinded RCT (n = 20) assessing trigger point dry needling of the fibularis muscles in individuals with a history of ankle sprain suggest that the intervention may provide some short-term improvements in strength and unilateral balance.[378]

II In an RCT assessing the inclusion of fibularis muscle trigger point dry needling as part of a proprioceptive and strengthening exercise program for individuals with CAI, the treatment group demonstrated better outcomes in pain and function at 1 month following treatment.[382]

III Data from a small cohort study by Rossi and colleagues (n = 20),[378] included in the systematic review and meta-analysis by Mansfield et al,[295] indicated that the addition of lumbar multifidus dry needling in individuals with CAI resulted in no significant differences in ankle plantar flexor-evertor strength, balance, and hop test performance compared to people with CAI who received fibularis muscle trigger point dry needling alone.

Evidence Synthesis and Rationale

Few studies currently exist to support the use of dry needling in people with CAI. Results reported by the included small RCTs and cohort studies were generally favorable for pain, function, strength, and balance.

2021 Recommendation

C Clinicians may use dry needling of the fibularis muscle group in conjunction with a proprioceptive training program to reduce pain and improve function in individuals with CAI.

COMBINED TREATMENTS

Combined treatments include intervention plans that use at least 2 or more types of interventions.

2013 Recommendation

None.

Evidence Update

I In the systematic review and meta-analysis conducted by Powden and colleagues,[356] which synthesized 7 RCTs that employed 2 or more targeted interventions, including stretching, strength training, balance training, vestibular-ocular reflex training, soft tissue mobilization, dry needling, and strain/counterstrain techniques, it was found that combined treatment led to large, statistically significant improvements in patient-reported function in individuals with CAI (summary effect size, 1.14). Combined intervention resulted in slightly improved functional outcomes that were not statistically significant when compared to balance training alone.

I A systematic review and network meta-analysis by Tsikopoulos and colleagues[436] identified that a 4-week supervised rehabilitation program consisting of balance training, strengthening, functional tasks, and ROM exercises resulted in statistically and clinically significant benefit compared to control interventions in people with CAI.

Evidence Synthesis and Rationale

Research evidence supports the clinical benefit of interventions that combine 2 or more treatments, selected based on patient-centered factors, to supplement a balance training program. While these approaches appear to only slightly improve functional outcomes when compared to balance training alone, the adverse events associated with combined approaches were infrequent, transient, and mild. This literature may indicate the potential presence of treatment interactions and caution against one-size-fits-all approaches to clinical management.

2021 Recommendation

B Clinicians may use multiple interventions to supplement balance training over an episode of care for individuals with CAI, to include a combination of exercise and manual therapy procedures as guided by the patient's values and goals, the clinician's judgment, and evidence-based clinical recommendations.

INTERVENTIONS TO ADDRESS PSYCHOLOGICAL FACTORS DURING THE COURSE OF REHABILITATION

2013 Recommendation

None.

Evidence Update

I In the systematic review of studies assessing the effects of the therapeutic alliance on pain conducted by Taccolini Manzoni and colleagues,[418] a lack of evidence pertaining to the therapeutic alliance in rehabilitation of musculoskeletal conditions was found. The authors of this review, which encompassed studies of mixed methodology, concluded that there is a lack of evidence to support the effect of the therapeutic alliance on pain relief.

I In a systematic review studying the effects of the therapeutic alliance in the treatment of patients with persistent pain syndromes, 3 studies suggested that a strong therapeutic alliance between the patient and treating physical therapist may improve outcomes in individuals with chronic musculoskeletal conditions.[137,229] To facilitate a strong therapeutic alliance, physical therapists must understand factors that positively and negatively influence the relationship.[137,229] These may include trust, communication, shared goal setting, identification and mitigation of barriers to care seeking and compliance, individualized and flexible care, respect of persons, and other factors that influence the patient's knowledge, skills, beliefs, and attitudes toward treatment.[137,229]

II In a retrospective case-control study, athletes with a history of recurrent ankle sprains were found to have the highest levels of fear avoidance compared to patients with a first-time ankle sprain or healthy controls.[195] To improve the quality of patient care, Houston and colleagues[195] recommended that clinicians use global, regional, and psychological measures to better evaluate patient status and treatment response, while considering functional deficits and psychological barriers during the rehabilitation course.

III McCann and Gribble[303] detailed how self-efficacy and resiliency can influence outcomes in CAI and proposed a theoretical model of how both intrinsic and extrinsic psychological factors can influence functional outcomes following LAS. In the conceptual model, perceptions of LAS as a benign injury may limit care seeking and negatively influence outcomes.[303] A consequence of nonresolving impairment and activity limitation following injury may contribute to lower self-efficacy and resiliency, further contributing to functional decline.[303] The authors advocate that patients struggling to adhere to rehabilitation may benefit from a repeated evaluation of self-efficacy, or an assessment of other personal and environmental factors.[303]

III Patients who go on to develop chronic ankle-foot disability have been found to have higher levels of neuroticism,[391] anxiety,[391] depression,[391] and kinesiophobia.[267] Fraser and Hertel[137] outlined the importance for physical therapists to evaluate and employ mitigating strategies to address negative psychoemotional factors during rehabilitation of individuals with LAS and CAI.

Evidence Synthesis and Rationale

Clinicians may take purposeful steps to build an effective therapeutic relationship with patients and use psychologically informed elements in the plan of care. These include mutual trust, communication, shared goal setting, identification and mitigation of barriers to care seeking and compliance, individualized and flexible care, respect of persons, and other factors that influence the patient's knowledge, skills, beliefs, and attitudes toward treatment. Global, regional, and psychological measures are recommended to comprehensively evaluate the patient status and treatment response. Targeted interventions, such as education, encouragement, goal setting, and fear mitigation, may help to improve these intrinsic factors and facilitate return to function in this patient population.

2021 Recommendation

E Clinicians may use psychologically informed techniques, such as motivational interviewing, to maximize patients' self-efficacy and address uncomplicated psychological correlates and mediators of injury adjustment and recovery, to maximize the effects of treatment in a positive manner for individuals with LAS and CAI.

Component 1: Medical Screening

↓

Component 2: Classify Condition

Patient examination: acute lateral ankle sprain (LAS)

- Sudden onset with an ankle inversion–related injury
- Negative Ottawa ankle rules
- Positive reverse anterolateral drawer ligamentous test
- Positive anterolateral talar palpation test
- Positive anterior drawer test

Patient examination: chronic ankle instability (CAI)

- History of at least 1 significant ankle sprain
- Reports of "giving way"
- Episode of a subsequent sprain and/or perceptions of ankle instability
- Decreased performance on functional performance tests
- Discriminative instrument scores: Identification of Functional Ankle Instability (IdFAI) score of 11 or greater; Cumberland Ankle Instability Tool (CAIT) score of 25 or less; 4 or more answers of "yes" on the Ankle Instability Instrument (AII)

↓

Component 3: Irritability

↓

Acute LAS: identify level of tissue irritability

↓

Component 4: Outcome Measures

↓

LAS and CAI

- Patient-Reported Outcomes Measurement Information System (PROMIS) physical function computer adaptive test (CAT), Foot and Ankle Ability Measure (FAAM), and/or Lower Extremity Functional Scale (LEFS) as a measure of self-reported activity limitation and participation restriction (A)
- 11-item Tampa Scale of Kinesiophobia (TSK-11) and Fear-Avoidance Beliefs Questionnaire (FABQ) as measures of fear of movement and reinjury and fear-avoidance beliefs (C)
- Pain visual analog scale (VAS) (F)
- Dorsiflexion range of motion (ROM) with the weight-bearing lunge test (A)
- Total ankle ROM (A)
- Talar translation (A)
- Static balance with the single-leg balance test on a firm surface with eyes closed (A)
- Dynamic balance with the Star Excursion Balance Test (SEBT) anterior, anteromedial, posteromedial, and posterolateral reach directions (A)
- Clinical performance assessment with measures of single-limb hopping under timed conditions (A)

Acute LAS

- Ankle swelling (A)

CAI

- Hip strength (C)

↓

Figure continues on page CPG38.

FIGURE 3. Decision tree. Letters in parentheses reflect the grade of evidence on which the recommendation for each item is based: (A) strong evidence, (B) moderate evidence, (C) weak evidence, (D) conflicting evidence, (E) theoretical/foundational evidence, and (F) expert opinion.

Component 5: Intervention Strategies

LAS
- Progressively bear weight with bracing external supports (A)
- Structured rehabilitation programs that include therapeutic exercises, both in clinic and at home, to include protected active ROM, stretching exercises, and neuromuscular training (A)
- Manual therapy procedures, such as lymphatic drainage, active and passive soft tissue and joint mobilization, and anterior-to-posterior talar mobilization procedures, within pain-free movement to reduce swelling, improve pain-free ankle and foot mobility, and normalize gait (A)
- Occupational and sport-related training and work hardening to mitigate activity limitation and participation restriction (B)
- Low-level laser therapy to reduce pain in those with acute symptoms (C)
- Pulsating shortwave diathermy for reducing edema and gait deviations (C)
- Nonsteroidal anti-inflammatory medications to reduce pain and swelling in those with acute symptoms (C)
- Psychologically informed techniques, such as motivational interviewing, to maximize patients' self-efficacy, address uncomplicated psychological correlates, and identify mediators of injury adjustment (E)

CAI
- Proprioceptive and neuromuscular therapeutic exercise to improve dynamic postural stability and patient-perceived stability (A)
- Manual therapy procedures, such as graded joint mobilizations, manipulations, and non–weight-bearing and weight-bearing mobilization with movement, to improve ankle dorsiflexion, proprioception, and weight-bearing tolerance (A)
- Trigger point dry needling of the fibularis (peroneal) muscle group in conjunction with a proprioceptive training program to reduce pain and improve function (C)
- Psychologically informed techniques, such as motivational interviewing, to maximize patients' self-efficacy, address uncomplicated psychological correlates, and identiy mediators of injury adjustment (E)

FIGURE 3 (continued). Decision tree. Letters in parentheses reflect the grade of evidence on which the recommendation for each item is based: (A) strong evidence, (B) moderate evidence, (C) weak evidence, (D) conflicting evidence, (E) theoretical/foundational evidence, and (F) expert opinion.

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APPENDIX A

SEARCH STRATEGIES FOR ALL DATABASES SEARCHED

Limits: 2013 to present (June 1, 2020), human, English, research articles, nonfracture/osteoarthritis studies
Run on June 26, 2018 and updated on June 1, 2020

PubMed

History: June 26, 2018

Search	Query	Items Found, n
#18	#13 AND #8	7264
#17	#9 AND #7 AND #6 AND #1	2230
#16	#13 AND #5	5081
#15	#13 AND #4	1858
#14	#13 AND #3	6093
#13	#1 AND #9 AND #12	12346
#12	#10 OR #11	2483065
#11	((#2 NOT (fracture[tw] NOT (sprains[tw] OR sprain[tw] OR sprained[tw] OR strains[tw] OR strain[tw] OR strained[tw] OR swelling[tw] OR swollen[tw] OR swell[tw] OR "Joint Instability"[Mesh] OR instability[tw] OR instabilities[tw] OR unstable[tw] OR joint effusion[tw] oR "Proprioception"[Mesh] OR proprioception deficit[tw] OR proprioception deficits[tw] OR proprioception deficiency[tw] OR proprioception deficiencies[tw] OR "Postural Balance"[Mesh] OR balance[tw] OR unbalanced[tw] OR musculoskeletal equilibrium[tw] OR postural equilibrium[tw] OR hypermobility[tw] OR hypermobilities[tw] OR laxity[tw] OR laxities[tw] OR tear[tw] OR torn[tw] OR external rotation[tw] OR eversion[tw] OR inversion[tw]))	2424755
#10	((#2 NOT (osteoarthritis[tw] NOT (sprains[tw] OR sprain[tw] OR sprained[tw] OR strains[tw] OR strain[tw] OR strained[tw] OR swelling[tw] OR swollen[tw] OR swell[tw] OR "Joint Instability"[Mesh] OR instability[tw] OR instabilities[tw] OR unstable[tw] OR joint effusion[tw] oR "Proprioception"[Mesh] OR proprioception deficit[tw] OR proprioception deficits[tw] OR proprioception deficiency[tw] OR proprioception deficiencies[tw] OR "Postural Balance"[Mesh] OR balance[tw] OR unbalanced[tw] OR musculoskeletal equilibrium[tw] OR postural equilibrium[tw] OR hypermobility[tw] OR hypermobilities[tw] OR laxity[tw] OR laxities[tw] OR tear[tw] OR torn[tw] OR external rotation[tw] OR eversion[tw] OR inversion[tw]))	2477326
#9	("2013"[Date - Publication]: "3000"[Date - Publication]) NOT (animals[mh] NOT humans[mh]) NOT ("Book Reviews" [Publication Type] OR "Comment" [Publication Type] OR "Editorial" [Publication Type] OR "Letter" [Publication Type] OR "Review" [Publication Type] OR "Meeting Abstracts" [Publication Type] OR "Public Service Announcements" [Publication Type] OR "News" [Publication Type] OR "Newspaper Article" [Publication Type] OR "Case Reports" [Publication Type] OR "Academic Dissertations" [Publication Type] OR "Retracted Publication" [Publication Type]) AND "English"[Language]	4076704
#8	("Diagnosis"[Mesh] OR "diagnosis" [Subheading] OR "Delayed Diagnosis"[Mesh] OR "Early Diagnosis"[Mesh] OR "Diagnosis, Differential"[Mesh] OR "Diagnosis, Computer-Assisted"[Mesh] OR "Diagnostic Techniques and Procedures"[Mesh] OR diagnosis[tw] OR diagnose[tw] OR diagnoses[tw] OR diagnostic[tw] OR "Clinical Decision-Making"[Mesh] OR clinical decision-making[tw] OR clinical decision making[tw] OR medical decision-making[tw] OR medical decision making[tw] OR "Decision Making"[Mesh:NoExp] OR "Diagnostic Imaging"[Mesh] OR diagnostic imaging[tw] OR medical imaging[tw] OR "Radiography"[Mesh] OR radiography[tw] OR diagnostic x-ray[tw] OR diagnostic x ray[tw] OR diagnostic x-rays[tw] OR "Magnetic Resonance Imaging"[Mesh] OR magnetic resonance imaging[tw] OR MRI[tw] OR fMRI[tw] OR NMR imaging[tw] OR MR tomography[tw] OR "Ultrasonography"[Mesh] OR ultrasonography[tw] OR ultrasound[tw] OR ultrasounds[tw] OR ultrasonic[tw] OR "Electromyography"[Mesh] OR electromyography[tw] OR electromyographies[tw] OR electromyogram[tw] OR electromyograms[tw] OR electrophysiologic test[tw] OR electrophysiologic tests[tw] OR electrophysiologic testing[tw] OR "Neural Conduction"[Mesh] OR neural conduction[tw] OR neural conductions[tw] OR nerve conduction[tw] OR nerve conductions[tw] OR "Actigraphy"[Mesh] OR actigraphy[tw])	9523683
#7	("Sensitivity and Specificity"[Mesh] OR sensitivity[tw] OR specificity[tw] OR "Evaluation Studies as Topic"[Mesh] OR evaluation indexes[tw] OR evaluation report[tw] OR evaluation reports[tw] OR evaluation research[tw] OR use-effectiveness[tw] OR use effectiveness[tw] OR prepost tests[tw] OR pre post tests[tw] OR prepost test[tw] OR qualitative evaluation[tw] OR qualitative evaluations[tw] OR quantitative evaluation[tw] OR quantitative evaluations[tw] OR theoretical effectiveness[tw] OR critique[tw] OR critiques[tw] OR evaluation methodology[tw] OR evaluation methodologies[tw] OR "Validation Studies as Topic"[Mesh] OR "Reproducibility of Results"[Mesh] OR reproducibility[tw] OR validity[tw] OR reliability[tw] OR "Data Accuracy"[Mesh] OR data accuracy[tw] OR data accuracies[tw] OR data quality[tw] OR data qualities[tw] OR precision[tw] OR responsiveness[tw] OR consistency[tw] OR consistencies[tw] OR consistent[tw] OR log-likelihood ratio[tw] OR likelihood-ratio[tw] OR likelihood ratio[tw] OR LR test[tiab] OR "Epidemiologic Research Design"[Mesh] OR "Research Design"[Mesh] OR research design[tw] OR research designs[tw] OR research strategy[tw] OR research strategies[tw] OR research techniques[tw] OR research technique[tw] OR research methodology[tw] OR research methodologies[tw] OR experimental design[tw] OR experimental designs[tw])	3694180

Table continues on page CPG55.

APPENDIX A

Search	Query	Items Found, n
#6	(Cumberland ankle instability tool[tw] OR Chronic Ankle Instability Scale[tw] OR Sports Ankle Rating System[tw] OR Ankle Joint Functional Assessment Tool[tw] OR Foot Function Index[tw] OR Foot and Ankle Outcome Score[tw] OR Karlsson Ankle Function Score[tw] OR OR Karlsson Score[tw] OR Kaikkonen scale[tw] OR Kaikkonen score[tw] OR Ottawa ankle rules[tw] OR Buffalo modification[tiab] OR foot and ankle ability measure[tw] OR foot ability measure[tw] OR ankle ability measure[tw] OR foot and ankle disability index[tw] OR lower extremity function scale[tw] OR lower extremity functional scale[tw] OR ankle instability scale[tw] OR sports ankle rating system[tw] OR ankle joint function assessment[tw] OR ankle instability index[tw] OR ankle instability instrument[tw] OR identification of functional ankle instability[tw] OR Tampa scale of kinesiophobia[tw] OR sway index[tw] OR functional reach test[tw] OR Patient Reported Outcome Measurement Information System[tw] OR PROMIS[tiab] OR Health Utilities Index[tw] OR HUI[tiab] OR HUI-III[tiab] OR HUI-3[tiab] OR HUI3[tiab] OR HUI-II[tiab] OR HUI-2[tiab] OR HUI2[tiab] OR HUI-I[tiab] OR HUI-1[tiab] OR HUI1[tiab] OR Visual Analogue Scale[tw] OR European Quality of life 5 Dimensions[tw] OR EuroQol*[tiab] OR EQ-5D[tiab] OR EQ5D*[tiab] OR EQ 5D[tiab] OR EORTC[tiab] OR Rosser[tiab] OR short form health survey[tw] OR short-form health survey[tw] OR SF36[tiab] OR SF-36[tiab] OR SF 36[tiab] OR short form 36[tiab] OR shortform 36[tiab] OR shortform36[tiab] OR 36 item short form[tiab] OR 36-item short form[tiab] OR SF20[tiab] OR SF-20[tiab] OR SF 20[tiab] OR short form 20[tiab] OR shortform 20[tiab] OR shortform20[tiab] OR 20 item short form[tiab] OR 20-item short form[tiab] OR SF12[tiab] OR SF-12[tiab] OR SF 12[tiab] OR short form 12[tiab] OR shortform 12[tiab] OR shortform12[tiab] OR 12 item short form[tiab] OR 12-item short form[tiab] OR SF8[tiab] OR SF-8[tiab] OR SF 8[tiab] OR short form 8[tiab] OR shortform 8[tiab] OR shortform8[tiab] OR 8 item short form[tiab] OR 8-item short form[tiab] OR SF6[tiab] OR SF-6[tiab] OR SF 6[tiab] OR short form 6[tiab] OR shortform 6[tiab] OR shortform6[tiab] OR 6 item short form[tiab] OR 6-item short form[tiab] OR QoL Questionnaire[tw] OR QLQ[tiab] OR health questionnaire[tw] OR Godin leisure time[tw] OR Numeric Pain Scale[tw] OR lateral hopping for distance[tw] OR 6-m crossover hop[tw] OR side hop[tw] OR hopping course[tw] OR square hop[tw] OR cross hop[tw] OR hop test[tw] OR hopping test[tw] OR 40-m walk time[tw] OR 40-m run time[tw] OR figureof-eight run[tw] OR single-limb forward hop[tw] OR single limb forward hop[tw] OR stair hop[tw] OR shuttle run[tw] OR up/down hop[tw] OR hop up[tw] OR hopping up[tw] OR hop down[tw] OR hopping down[tw] OR triple crossover hop[tw] OR single-limb hurdle[tw] OR single limb hurdle[tw] OR single-limb 6-m hop[tw] OR single-limb 30-m hop[tw] OR figureof-eight hop[tw] OR figure of eight hop[tw] OR figure eight hop[tw] OR drop landing[tw] OR vertical jump[tw] OR "Walking Speed"[Mesh] OR "Gait"[Mesh] OR walking speed[tw] OR walking speeds[tw] OR walking gait[tw] OR gait speed[tw] OR gait speeds[tw] OR walking pace[tw] OR walking paces[tw] OR running gait[tw] OR running speed[tw] OR running speeds[tw] OR running pace[tw] OR running paces[tw] OR figure of 8 circumferential measure[tw] OR volumetric measure[tw] OR "Range of Motion, Articular"[Mesh] OR range of motion[tw] OR joint flexibility[tw] OR "Arthrometry, Articular"[Mesh] OR articular arthometry[tw] OR articular goniometry[tw] OR "Supination"[Mesh] OR supination[tw] OR supinations[tw] OR "Pronation"[Mesh] OR pronation[tw] OR pronations[tw] OR tibiopedal dorsiflexion[tw] OR weight-bearing lunge[tw] OR weight bearing lunge[tw] OR algometry[tw] OR "Pain Threshold"[Mesh] OR pain threshold[tw] OR pain thresholds[tw] OR pressurepain threshold[tw] OR pressurepain thresholds[tw] OR cutaneous sensation[tw] OR "Hypesthesia"[Mesh] OR hypesthesia[tw] OR "Hyperesthesia"[Mesh] OR hyperethesia[tw] OR joint position sense[tw] OR "Kinesthesis"[Mesh] OR kinesthesis[tw] OR kinesthesia[tw] OR kinesthesias[tw] OR kinesthetic[tw] OR movement sensation[tw] OR movement sensations[tw] OR isokinetic muscle strength[tw] OR isokinetic test[tw] OR isokinetic tests[tw] OR single-limb balance[tw] OR single limb balance[tw] OR Romberg test[tw] OR balance test[tw] OR balancing test[tw] OR Y balance[tiab] OR Balance Error Scoring System[tw] OR step-down test[tw] OR step down test[tw] OR single leg squat test[tw] OR functional movement screen[tw] OR functional movement screening[tw] OR functional movement screens[tw] OR joint accessory mobility[tw] OR joint play mobility[tw] OR anterior drawer[tw] OR talar tilt inversion[tw] OR talar tilt eversion[tw] OR talar rotation[tw] OR talofibular interval[tw] OR tibiofibular interval[tw] OR distal fibula interval[tw] OR Foot posture Index[tw] OR squeeze test[tiab] OR Cotton test[tiab] OR dorsiflexion maneuver[tw] OR dorsiflexion maneuvers[tw] OR dorsiflexion compression test[tw] OR crossed leg test[tw] OR heel thump test[tw] OR Kleiger dorsiflexion external rotation test[tiab] OR external rotation test[tw] OR Thompson test[tiab] OR function and prognostic score[tw] OR function and prognostic scores[tw] OR ankle function score[tw] OR ankle scoring system[tw] OR de Bie[tiab] OR multisegmented foot[tw] OR ankle-foot complex[tw] OR foot morphology[tw] OR intrinsic foot muscles[tw] OR ankle assessment[tw] OR ankle assessments[tw] OR foot assessment[tw] OR foot assessments[tw] OR feet assessment[tw] OR feet assessments[tw] OR biomechanical assessment[tw] OR biomechanical assessments[tw] OR foot root model[tw] OR ankle root model[tw])	208194
#5	("Risk"[Mesh] OR "Risk Assessment"[Mesh] OR "Risk Factors"[Mesh] OR "Health Risk Behaviors"[Mesh] OR risk[tw] OR risks[tw] OR risk-benefit[tw] OR "Probability"[Mesh] OR probability[tw] OR probabilities[tw] OR likelihood[tw] OR propensity[tw] OR "Logistic Models"[Mesh] OR logistic model[tw] OR logistic models[tw] OR logistic modeling[tw] OR logistic regression[tw] OR logistic regressions[tw] OR "Protective Factors"[Mesh] OR protective factor[tw] OR protective factors[tw] OR "Bayes Theorem"[Mesh] OR Bayes theorem[tw] OR Bayesian[tw] OR "Causality"[Mesh] OR causality[tw] OR causalities[tw] OR causation[tw] OR causations[tw] OR cause[tw] OR causes[tw] OR enabling factor[tw] OR enabling factors[tw] OR reinforcing factor[tw] OR reinforcing factors[tw] OR predisposing factor[tw] OR predisposing factors[tw] OR predisposition[tw] OR "Precipitating Factors"[Mesh] OR precipitating factors[tw] OR precipitating factor[tw] OR predictor[tw] OR predictors[tw] OR odds ratio[tw] OR odds ratios[tw] OR predict[tw] OR prediction[tw] OR predictions[tw] OR predictabilities[tw] OR predictability[tw] OR predicted[tw] OR predictor[tw] OR predictors[tw] OR predictive[tw] OR etiology[tw] OR etiologies[tw] OR etiological[tw] OR etiologic[tw] OR aetiology[tw] OR origin[tw] OR origination[tw] OR originating[tw] OR interact[tw] OR interaction[tw] OR interactions[tw] OR interacting[tw])	7760905
#4	("Incidence"[Mesh] OR incidence[tw] OR incidences[tw] OR "Morbidity"[Mesh] OR morbidity[tw] OR morbidities[tw] OR "Epidemiology"[Mesh] OR epidemiology[tw] OR "epidemiology" [Subheading] OR "Prevalence"[Mesh] OR prevalence[tw] OR prevalent[tw] OR prevalencies[tw])	2968951

Table continues on page CPG56.

APPENDIX A

Search	Query	Items Found, n
#3	("Physical Therapy Modalities"[Mesh] OR physical therapy[tw] OR physical therapies[tw] OR physiotherapy[tw] OR physiotherapies[tw] OR "Recovery of Function"[Mesh] OR recovery[tw] OR restoration[tw] OR reeducation[tw] OR "Rehabilitation"[Mesh] OR "rehabilitation" [Subheading] OR rehabilitation[tw] OR rehab[tw] OR "Early Ambulation"[Mesh] OR early ambulation[tw] OR accelerated ambulation[tw] OR early mobilization[tw] OR therapeutic modality[tw] OR therapeutic modalities[tw] OR "Exercise Therapy"[Mesh] OR exercise therapy[tw] OR therapeutic exercise[tw] OR therapeutic exercises[tw] OR stretching[tw] OR exercise movement[tw] OR strengthen[tw] OR strengthening[tw] OR "Resistance Training"[Mesh] OR resistance training[tw] OR strength training[tw] OR weight-bearing[tw] OR weight-lifting[tw] OR resistance methods[tw] OR training program[tw] OR "Biofeedback, Psychology"[Mesh] OR biofeedback[tw] OR psychophysiologic feedback[tw] OR neuromuscular electrical stimulation[tw] OR neuromuscular reeducation[tw] OR "Pain Management"[Mesh] OR "Pain Measurement"[Mesh] OR pain management[tw] OR pain measurement[tw] OR mobilization[tw] OR mobilizations[tw] OR "Musculoskeletal Manipulations"[Mesh] OR manipulation[tw] OR manipulations[tw] OR ultrasonography[tw] OR ultrasound[tw] OR acupuncture[tw] OR "Patient Education as Topic"[Mesh] OR patient education[tw] OR education of patients[tw] OR iontophoresis[tw] OR "Electric Stimulation"[Mesh] OR "Electric Stimulation Therapy"[Mesh] OR "Transcutaneous Electric Nerve Stimulation"[Mesh] OR electric stimulation[tw] OR nerve stimulation[tw] OR taping[tw] OR tape[tw] OR bracing[tw] OR brace[tw] OR braces[tw] OR orthoses[tw] OR immobilization[tw] OR immobilize[tw] OR orthotic[tw] OR orthotics[tw] OR thermal agent[tw] OR thermal agents[tw] OR diathermy[tw] OR "Range of Motion, Articular"[Mesh] OR range of motion[tw] OR joint flexibility[tw] OR joint movement[tw] OR manual therapy[tw] OR massage[tw] OR massages[tw] OR "Treatment Outcome"[Mesh] OR treatment outcome[tw] OR clinical effectiveness[tw] OR treatment effectiveness[tw] OR treatment efficacy[tw] OR patient outcome[tw] OR patient outcomes[tw])	2846636
#2	("Ankle Injuries"[Mesh] OR "Athletic Injuries"[Mesh] OR "Foot Injuries"[Mesh] OR injuries[tw] OR injury[tw] OR injured[tw] OR "Sprains and Strains"[Mesh] OR sprains[tw] OR sprain[tw] OR sprained[tw] OR strains[tw] OR strain[tw] OR strained[tw] OR swelling[tw] OR swollen[tw] OR swell[tw] OR "Joint Instability"[Mesh] OR instability[tw] OR instabilities[tw] OR unstable[tw] OR joint effusion[tw] OR "Proprioception"[Mesh] OR proprioception deficit[tw] OR proprioception deficits[tw] OR proprioception deficiency[tw] OR proprioception deficiencies[tw] OR "Postural Balance"[Mesh] OR balance[tw] OR unbalanced[tw] OR musculoskeletal equilibrium[tw] OR postural equilibrium[tw] OR hypermobility[tw] OR hypermobilities[tw] OR laxity[tw] OR laxities[tw] OR tear[tw] OR torn[tw] OR external rotation[tw] OR eversion[tw] OR inversion[tw] OR "Injury Severity Score"[Mesh] OR "Abbreviated Injury Scale"[Mesh])	2484080
#1	("Ankle"[Mesh] OR ankle[tw] OR ankles[tw] OR regio tarsalis[tw] OR talus[tw] OR tarsus[tw] OR "Metatarsus"[Mesh] OR metatarsus[tw] OR metatarsal[tw] OR "Ankle Joint"[Mesh] OR "Subtalar Joint"[Mesh] OR subtalar joint[tw] OR talocalcaneal joint[tw] OR talonavicular joint[tw] OR talocrural[tw] OR articulatio talocruralis[tw] OR "Tarsal Joints"[Mesh] OR tarsal joints[tw] OR tarsal joint[tw] OR midtarsal joint[tw] OR midtarsal joints[tw] OR intertarsal joint[tw] OR intertarsal joints[tw] OR intertarsal articulation[tw] OR articulationes intertarseae[tw]OR articulationes intertarsales[tw] OR "Lateral Ligament, Ankle"[Mesh] OR "Ligaments, Articular"[Mesh] OR "Collateral Ligaments"[Mesh] OR ankle lateral ligament[tw] OR ligamentum laterale articulationis talocruralis[tw] OR calcaneofibular[tw] OR tibiofibular[tw] OR tibiotalar[tw] OR tibionavicular[tw] OR tibiocalcaneal[tw] OR talofibular[tw] OR talonavicula[tw] OR calcaneocuboid[tw] OR bifurcate* ligament*[tw] OR inferior transverse ligament*[tw] OR deltoid ligament*[tw] OR medial ligament*[tw] OR interosseous ligament*[tw] OR dorsal interossei[tw] OR plantar interossei[tw] OR "Tibial Nerve"[Mesh] OR tibial nerve[tw] OR peroneal nerve[tw] OR peroneus nerve[tw] OR saphenous nerve[tw] OR medial plantar nerve[tw] OR lateral plantar nerve[tw] OR fibular nerve[tw] OR fibularis tertius[tw] OR "Achilles Tendon"[Mesh] OR achilles tendon[tw] OR calcaneal[tw] OR calcaneus[tw] OR interosseous membrane[tw] OR interosseous membranes[tw] OR syndesmosis[tw] OR syndesmoses[tw] OR syndesmotic[tw] OR tibialis anterior[tw] OR fibularis longus[tw] OR fibularis brevis[tw] OR peroneus tertius[tw] OR peroneus longus[tw] OR peroneus brevis[tw] OR flexor hallucis longus[tw] OR flexor digitorum longus[tw] OR extensor digitorum longus[tw] OR tibialis posterior[tw] OR soleus[tw] OR peroneal[tw] OR gastrocnemius[tw] OR abductor halluces[tw] OR adductor halluces[tw] OR flexor hallucis brevis[tw] OR abductor digiti minimi [tw]OR flexor digiti minimi[tw] OR lumbricals[tw] OR quadratus plantae[tw] OR flexor digitorum brevis[tw] OR gluteus medius[tw] OR gluteus maximus[tw] OR gluteal[tw] OR hip abductor[tw] OR hip rotator[tw]) OR ("Foot"[Mesh] OR foot[tw] OR feet[tw] OR articulationes pedis[tw] OR "Foot Joints"[Mesh] OR "Metatarsophalangeal Joint"[Mesh] OR metatarsophalangeal[tw] OR "Heel"[Mesh] OR heel[tw] OR heels[tw] OR sinus tarsi[tw] OR sinus tarsus[tw] OR rearfoot[tw] OR midfoot[tw])	253599

Embase

History: June 26, 2018

Search	Query	Items Found, n
#18	#13 AND #8	6182
#17	#9 AND #7 AND #6 AND #1	1931
#16	#13 AND #5	4759
#15	#13 AND #4	2211
#14	#13 AND #3	6959
#13	#1 AND #9 AND #12	10741
#12	#10 OR #11	2420321

Table continues on page CPG57.

APPENDIX A

Search	Query	Items Found, n
#11	#2 NOT (fracture NOT ('sprain'/exp OR sprains OR sprain OR sprained OR 'strain'/exp OR strains OR strains OR strain OR strained OR 'swelling'/exp OR swelling OR swollen OR swell OR 'instability'/exp OR instability OR instabilities OR unstable OR 'joint effusion'/exp OR 'joint effusion' OR 'proprioception deficit' OR 'proprioception deficits' OR 'proprioception deficiency' OR 'proprioception deficiencies' OR 'balance'/exp OR balance OR unbalanced OR 'musculoskeletal equilibrium'/exp OR 'musculoskeletal equilibrium' OR 'postural equilibrium'/exp OR 'postural equilibrium' OR 'hypermobility'/exp OR hypermobility OR hypermobilities OR laxity OR laxities OR 'tear'/exp OR tear OR torn OR 'external rotation'/exp OR 'external rotation' OR 'eversion'/exp OR 'inversion'/exp OR eversion OR inversion)) AND [embase]/lim	2350966
#10	#2 NOT (osteoarthritis NOT ('sprain'/exp OR sprains OR sprain OR sprained OR 'strain'/exp OR strains OR strains OR strain OR strained OR 'swelling'/exp OR swelling OR swollen OR swell OR 'instability'/exp OR instability OR instabilities OR unstable OR 'joint effusion'/exp OR 'joint effusion' OR 'proprioception deficit' OR 'proprioception deficits' OR 'proprioception deficiency' OR 'proprioception deficiencies' OR 'balance'/exp OR balance OR unbalanced OR 'musculoskeletal equilibrium'/exp OR 'musculoskeletal equilibrium' OR 'postural equilibrium'/exp OR 'postural equilibrium' OR 'hypermobility'/exp OR hypermobility OR hypermobilities OR laxity OR laxities OR 'tear'/exp OR tear OR torn OR 'external rotation'/exp OR 'external rotation' OR 'eversion'/exp OR 'inversion'/exp OR eversion OR inversion)) AND [embase]/lim	2411921
#9	(2013:py OR 2014:py OR 2015:py OR 2016:py OR 2017:py OR 2018:py) NOT ([animals]/lim NOT [humans]/lim) NOT ('book'/it OR 'chapter'/it OR 'conference abstract'/it OR 'conference paper'/it OR 'conference review'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it OR 'press release'/it OR 'short survey'/it) AND [embase]/lim AND [english]/lim	3288905
#8	('diagnosis'/exp OR diagnosis OR diagnose OR diagnoses OR 'diagnostic'/exp OR diagnostic OR 'clinical decision-making'/exp OR 'clinical decision-making' OR 'clinical decision making'/exp OR 'clinical decision making' OR 'medical decision-making'/exp OR 'medical decision-making' OR 'medical decision making'/exp OR 'medical decision making' OR 'diagnostic imaging'/exp OR 'diagnostic imaging' OR 'medical imaging'/exp OR 'medical imaging' OR 'radiography'/exp OR radiography OR 'diagnostic x-ray' OR 'diagnostic x ray' OR 'diagnostic x-rays' OR 'magnetic resonance imaging'/exp OR 'magnetic resonance imaging' OR 'mri'/exp OR mri:ti,ab OR 'fmri'/exp OR fmri:ti,ab OR 'nmr imaging'/exp OR 'nmr imaging' OR 'mr tomography' OR 'ultrasonography'/exp OR ultrasonography OR 'ultrasound'/exp OR ultrasound OR ultrasounds OR 'ultrasonic'/exp OR ultrasonic OR 'electromyography'/exp OR electromyography OR electromyographies OR 'electromyogram'/exp OR electromyogram OR electromyograms OR 'electrophysiologic test' OR 'electrophysiologic tests' OR 'electrophysiologic testing' OR 'neural conduction'/exp OR 'neural conduction' OR 'neural conductions' OR 'nerve conduction'/exp OR 'nerve conduction' OR 'nerve conductions' OR 'actigraphy'/exp OR actigraphy) AND [embase]/lim	6600819
#7	('sensitivity'/exp OR sensitivity OR 'specificity'/exp OR specificity OR 'evaluation indexes'/exp OR 'evaluation indexes' OR 'evaluation report'/exp OR 'evaluation report' OR 'evaluation reports' OR 'evaluation research'/exp OR 'evaluation research' OR 'use effectiveness'/exp OR 'use effectiveness' OR prepost tests' OR 'pre post tests'/exp OR 'pre post tests' OR 'prepost test' OR 'qualitative evaluation'/exp OR 'qualitative evaluation' OR 'qualitative evaluations' OR 'quantitative evaluation'/exp OR 'quantitative evaluation' OR 'quantitative evaluations' OR 'theoretical effectiveness'/exp OR 'theoretical effectiveness' OR 'critique'/exp OR critique OR critiques OR 'evaluation methodology'/exp OR 'evaluation methodology' OR 'evaluation methodologies' OR 'reproducibility'/exp OR reproducibility OR 'validity'/exp OR validity OR 'reliability'/exp OR reliability OR 'data accuracy'/exp OR 'data accuracy' OR 'data accuracies' OR 'data quality'/exp OR 'data quality' OR 'data qualities' OR 'precision'/exp OR precision OR 'responsiveness'/exp OR responsiveness OR 'consistency'/exp OR consistency OR consistencies OR consistent OR 'log-likelihood ratio' OR 'likelihood-ratio' OR 'likelihood ratio'/exp OR 'likelihood ratio' OR 'research design'/exp OR 'research design' OR 'research designs' OR 'research strategy' OR 'research strategies' OR 'research techniques' OR 'research technique' OR 'research methodology'/exp OR 'research methodology' OR 'research methodologies' OR 'experimental design'/exp OR 'experimental design' OR 'experimental designs') AND [embase]/lim	5719204

Table continues on page CPG58.

APPENDIX A

Search	Query	Items Found, n
#6	('cumberland ankle instability tool'/exp OR 'cumberland ankle instability tool' OR 'chronic ankle instability scale' OR 'ankle joint functional assessment tool' OR 'foot function index'/exp OR 'foot function index' OR 'foot and ankle outcome score' OR 'karlsson ankle function score' OR 'karlsson score' OR 'kaikkonen scale' OR 'kaikkonen score' OR 'ottawa ankle rules'/exp OR 'ottawa ankle rules' OR 'buffalo modification' OR 'foot and ankle ability measure'/exp OR 'foot and ankle ability measure' OR 'foot ability measure' OR 'ankle ability measure' OR 'foot and ankle disability index'/exp OR 'foot and ankle disability index' OR 'lower extremity function scale'/exp OR 'lower extremity function scale' OR 'lower extremity functional scale' OR 'ankle instability scale' OR 'sports ankle rating system' OR 'ankle joint function assessment' OR 'ankle instability index' OR 'ankle instability instrument' OR 'identification of functional ankle instability' OR 'tampa scale of kinesiophobia'/exp OR 'tampa scale of kinesiophobia' OR 'sway index' OR 'functional reach test'/exp OR 'functional reach test' OR 'patient reported outcome measurement information system'/exp OR 'patient reported outcome measurement information system' OR 'short form health survey' OR 'short-form health survey' OR 'Short Form 36'/exp OR 'Short Form 12'/exp OR 'Short Form 20'/exp OR 'Short Form 8'/exp OR 'short form health survey' OR 'short-form health survey' OR 'Visual Analogue Scale' OR 'health utilities index'/exp OR 'health utilities index' OR HUI:ti,ab OR HUI-III:ti,ab OR HUI-3:ti,ab OR HUI3:ti,ab OR HUI-II:ti,ab OR HUI-2:ti,ab OR HUI2:ti,ab OR HUI-I:ti,ab OR HUI-1:ti,ab OR HUI1:ti,ab OR 'european quality of life 5 dimensions'/exp OR 'European Quality of life 5 Dimensions' OR EuroQol*:ti,ab OR EQ-5D:ti,ab OR EQ5D*:ti,ab OR EQ 5D:ti,ab OR EORTC:ti,ab OR Rosser:ti,ab OR SF36:ti,ab OR SF-36:ti,ab OR 'SF 36':ti,ab OR 'short form 36':ti,ab OR 'shortform 36':ti,ab OR shortform36:ti,ab OR '36 item short form':ti,ab OR '36-item short form':ti,ab OR SF20:ti,ab OR SF-20:ti,ab OR 'SF 20':ti,ab OR 'short form 20':ti,ab OR 'shortform 20':ti,ab OR shortform20:ti,ab OR '20 item short form':ti,ab OR '20-item short form':ti,ab OR SF12:ti,ab OR SF-12:ti,ab OR 'SF 12':ti,ab OR 'short form 12':ti,ab OR 'shortform 12':ti,ab OR shortform12:ti,ab OR '12 item short form':ti,ab OR '12-item short form':ti,ab OR SF8:ti,ab OR SF-8:ti,ab OR 'SF 8':ti,ab OR 'short form 8':ti,ab OR 'shortform 8':ti,ab OR shortform8:ti,ab OR '8 item short form':ti,ab OR '8-item short form':ti,ab OR SF6:ti,ab OR SF-6:ti,ab OR 'SF 6':ti,ab OR 'short form 6':ti,ab OR 'shortform 6':ti,ab OR shortform6:ti,ab OR '6 item short form':ti,ab OR '6-item short form':ti,ab OR 'QoL Questionnaire' OR QLQ:ti,ab OR 'health questionnaire' OR 'godin leisure time' OR 'numeric pain scale'/exp OR 'numeric pain scale' OR 'lateral hopping for distance' OR '6-m crossover hop' OR 'side hop' OR 'hopping course' OR 'square hop' OR 'cross hop' OR 'hop test' OR 'hopping test' OR '40-m walk time' OR '40-m run time' OR 'figureof-eight run' OR 'single-limb forward hop' OR 'single limb forward hop' OR 'stair hop' OR 'shuttle run' OR 'up/down hop' OR 'hop up' OR 'hopping up' OR 'hop down' OR 'hopping down' OR 'triple crossover hop' OR 'single-limb hurdle' OR 'single limb hurdle' OR 'single-limb 6-m hop' OR 'single-limb 30-m hop' OR 'figureof-eight hop' OR 'figure of eight hop' OR 'figure eight hop' OR 'drop landing' OR 'vertical jump'/exp OR 'vertical jump' OR 'walking speed'/exp OR 'walking speed' OR 'walking speeds' OR 'walking gait' OR 'gait speed'/exp OR 'gait speed' OR 'gait speeds' OR 'walking pace' OR 'walking paces' OR 'running gait' OR 'running speed'/exp OR 'running speed' OR 'running speeds' OR 'running pace' OR 'running paces' OR 'figure of 8 circumferential measure' OR 'volumetric measure' OR 'range of motion'/exp OR 'range of motion' OR 'joint flexibility'/exp OR 'joint flexibility' OR 'articular arthometry' OR 'articular goniometry' OR 'supination'/exp OR supination OR supinations OR 'pronation'/exp OR pronation OR pronations OR 'tibiopedal dorsiflexion' OR 'weight-bearing lunge' OR 'weight bearing lunge' OR 'algometry'/exp OR algometry OR 'pain threshold'/exp OR 'pain threshold' OR 'pain thresholds' OR 'pressurepain threshold'/exp OR 'pressurepain threshold' OR 'pressurepain thresholds' OR 'cutaneous sensation'/exp OR 'cutaneous sensation' OR 'hypesthesia'/exp OR hypesthesia OR hyperethesia OR 'joint position sense'/exp OR 'joint position sense' OR 'kinesthesis'/exp OR kinesthesis OR 'kinesthesia'/exp OR kinesthesia OR kinesthesias OR kinesthetic OR 'movement sensation' OR 'movement sensations' OR 'isokinetic muscle strength' OR 'isokinetic test' OR 'isokinetic tests' OR 'single-limb balance' OR 'single limb balance' OR 'romberg test'/exp OR 'romberg test' OR 'balance test'/exp OR 'balance test' OR 'balancing test' OR 'y balance' OR 'balance error scoring system'/exp OR 'balance error scoring system' OR 'step-down test' OR 'step down test'/exp OR 'step down test' OR 'single leg squat test' OR 'functional movement screen'/exp OR 'functional movement screen' OR 'functional movement screening' OR 'functional movement screens' OR 'joint accessory mobility' OR 'joint play mobility' OR 'anterior drawer' OR 'talar tilt inversion' OR 'talar tilt eversion' OR 'talar rotation' OR 'talofibular interval' OR 'tibiofibular interval' OR 'distal fibula interval' OR 'foot posture index'/exp OR 'foot posture index' OR 'squeeze test'/exp OR 'squeeze test' OR 'cotton test' OR 'dorsiflexion maneuver' OR 'dorsiflexion maneuvers' OR 'dorsiflexion compression test' OR 'crossed leg test' OR 'heel thump test' OR 'kleiger dorsiflexion external rotation test' OR 'external rotation test' OR 'thompson test' OR 'function and prognostic score' OR 'function and prognostic scores' OR 'ankle function score' OR 'ankle scoring system' OR 'multisegmented foot' OR 'ankle-foot complex' OR 'foot morphology' OR 'intrinsic foot muscles' OR 'ankle assessment' OR 'ankle assessments' OR 'foot assessment' OR 'foot assessments' OR 'feet assessment' OR 'feet assessments' OR 'biomechanical assessment' OR 'biomechanical assessments' OR 'foot root model' OR 'ankle root model') AND [embase]/lim	188148
#5	('risk'/exp OR risk OR risks OR 'risk benefit' OR 'probability'/exp OR probability OR probabilities OR likelihood OR propensity OR 'logistic model'/exp OR 'logistic model' OR 'logistic models' OR 'logistic modeling' OR 'logistic regression'/exp OR 'logistic regression' OR 'logistic regressions' OR 'protective factor' OR 'protective factors'/exp OR 'protective factors' OR 'bayes theorem'/exp OR 'bayes theorem' OR bayesian OR 'causality'/exp OR causality OR causalities OR causation OR causations OR cause OR causes OR 'enabling factor' OR 'enabling factors' OR 'reinforcing factor' OR 'reinforcing factors' OR 'predisposing factor'/exp OR 'predisposing factor' OR 'predisposing factors' OR 'predisposition'/exp OR predisposition OR 'precipitating factors'/exp OR 'precipitating factors' OR 'precipitating factor' OR 'odds ratio'/exp OR 'odds ratio' OR 'odds ratios' OR predict OR 'prediction'/exp OR prediction OR predictions OR predictabilities OR 'predictability'/exp OR predictability OR predicted OR predictor OR 'predictors'/exp OR predictors OR predictive OR 'etiology'/de OR etiology OR etiologies OR etiological OR etiologic OR aetiology OR 'origin'/exp OR origin OR origination OR originating OR interact OR interaction OR interactions OR interacting) AND [embase]/lim	9316738
#4	('incidence'/exp OR incidence OR incidences OR morbidity OR morbidities OR 'epidemiology'/exp OR epidemiology OR 'prevalence'/exp OR prevalence OR prevalent OR prevalencies) AND [embase]/lim	3694481

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APPENDIX A

Search	Query	Items Found, n
#3	('physical therapy'/exp OR 'physical therapy' OR 'physical therapies' OR 'physiotherapy'/exp OR physiotherapy OR physiotherapies OR 'recovery'/exp OR recovery OR restoration OR reeducation OR 'rehabilitation'/exp OR rehabilitation OR rehab OR 'early ambulation'/exp OR 'early ambulation' OR 'accelerated ambulation' OR 'early mobilization'/exp OR 'early mobilization' OR 'exercise therapy'/exp OR 'exercise therapy' OR 'therapeutic exercise'/exp OR 'therapeutic exercise' OR 'therapeutic exercises' OR 'therapeutic modality' OR 'therapeutic modalities' OR 'stretching'/exp OR stretching OR 'exercise movement' OR strengthen OR strengthening OR 'resistance training'/exp OR 'resistance training' OR 'strength training'/exp OR 'strength training' OR 'weight bearing'/exp OR weight-bearing OR 'weight lifting'/exp OR weight-lifting OR 'resistance methods' OR 'training program'/exp OR 'training program' OR 'biofeedback'/exp OR biofeedback OR 'psychophysiologic feedback' OR 'neuromuscular electrical stimulation'/exp OR 'neuromuscular electrical stimulation' OR 'neuromuscular reeducation' OR 'pain management'/exp OR 'pain management' OR 'pain measurement'/exp OR 'pain measurement' OR 'mobilization'/exp OR mobilization OR mobilizations OR 'manipulation'/exp OR manipulation OR manipulations OR 'ultrasonography'/exp OR ultrasonography OR ultrasound OR 'acupuncture'/exp OR acupuncture OR 'patient education'/exp OR 'patient education' OR 'education of patients' OR 'iontophoresis'/exp OR iontophoresis OR 'electric stimulation'/exp OR 'electric stimulation' OR 'nerve stimulation'/exp OR 'nerve stimulation' OR 'tape'/exp OR taping OR tape OR 'bracing'/exp OR 'brace'/exp OR bracing OR brace OR braces OR orthoses OR 'immobilization'/exp OR immobilization OR immobilize OR 'orthotics'/exp OR orthotic OR orthotics OR 'thermal agent' OR 'thermal agents' OR 'diathermy'/exp OR diathermy OR 'range of motion'/exp OR 'range of motion' OR 'joint flexibility'/exp OR 'joint flexibility' OR 'joint movement'/exp OR 'joint movement' OR 'manual therapy'/exp OR 'manual therapy' OR 'massage'/exp OR massage OR massages OR 'treatment outcome'/exp OR 'treatment outcome' OR 'clinical effectiveness'/exp OR 'clinical effectiveness' OR 'treatment effectiveness' OR 'treatment efficacy' OR 'patient outcome'/exp OR 'patient outcome' OR 'patient outcomes') AND [embase]/lim	3750588
#2	('injury'/de OR injuries OR injury OR injured OR 'sprain'/exp OR sprains OR sprain OR sprained OR 'strain'/exp OR strains OR strains OR strain OR strained OR 'swelling'/exp OR swelling OR swollen OR swell OR 'instability'/exp OR instability OR instabilities OR unstable OR 'joint effusion'/exp OR 'joint effusion' OR 'proprioception deficit' OR 'proprioception deficits' OR 'proprioception deficiency' OR 'proprioception deficiencies' OR 'balance'/exp OR balance OR unbalanced OR 'musculoskeletal equilibrium'/exp OR 'musculoskeletal equilibrium' OR 'postural equilibrium'/exp OR 'postural equilibrium' OR 'hypermobility'/exp OR hypermobility OR hypermobilities OR laxity OR laxities OR 'tear'/exp OR tear OR torn OR 'external rotation'/exp OR 'external rotation' OR 'eversion'/exp OR 'inversion'/exp OR eversion OR inversion) AND [embase]/lim	2422429
#1	('ankle'/exp OR ankle OR ankles OR 'regio tarsalis' OR 'tarsus'/exp OR talus OR tarsus OR 'metatarsus'/exp OR metatarsus OR metatarsal OR 'subtalar joint'/exp OR 'subtalar joint' OR 'talonavicular joint'/exp OR 'talocalcaneal joint'/exp OR 'talocalcaneal joint' OR talocrural OR 'articulatio talocruralis' OR 'tarsal joint'/exp OR 'tarsal joints' OR 'tarsal joint' OR 'midtarsal joint'/exp OR 'midtarsal joint' OR 'midtarsal joints' OR 'intertarsal joint'/exp OR 'intertarsal joint' OR 'intertarsal joints' OR 'intertarsal articulation'/exp OR 'intertarsal articulation' OR 'articulationes intertarseae' OR 'articulationes intertarsales' OR 'ligamentum laterale articulationis talocruralis' OR calcaneofibular OR tibiofibular OR tibiotalar OR tibionavicular OR tibiocalcaneal OR talofibular OR talonavicula OR calcaneocuboid OR 'ankle lateral ligament'/exp OR 'ankle lateral ligament' OR 'bifurcate* ligament*' OR 'inferior transverse ligament*' OR 'deltoid ligament*' OR 'medial ligament*' OR 'interosseous ligament*' OR 'peroneus nerve'/exp OR 'tibial nerve'/exp OR 'tibial nerve' OR 'peroneal nerve' OR 'peroneus nerve' OR 'saphenous nerve'/exp OR 'saphenous nerve' OR 'medial plantar nerve'/exp OR 'medial plantar nerve' OR 'lateral plantar nerve'/exp OR 'lateral plantar nerve' OR 'fibular nerve'/exp OR 'fibular nerve' OR 'fibularis tertius' OR 'achilles tendon'/exp OR 'achilles tendon' OR calcaneal OR calcaneus OR 'interosseous membrane'/exp OR 'interosseous membrane' OR 'interosseous membranes' OR 'dorsal interossei' OR 'plantar interossei' OR syndesmosis OR syndesmoses OR syndesmotic OR 'tibialis anterior' OR 'fibularis longus' OR 'fibularis brevis' OR 'peroneus tertius' OR 'peroneus longus'/exp OR 'peroneus longus' OR 'peroneus brevis'/exp OR 'peroneus brevis' OR 'flexor hallucis longus'/exp OR 'flexor hallucis longus' OR 'flexor digitorum longus'/exp OR 'flexor digitorum longus' OR 'extensor digitorum longus' OR 'tibialis posterior' OR 'soleus'/exp OR soleus OR peroneal OR 'gastrocnemius'/exp OR gastrocnemius OR 'abductor hallucis'/exp OR 'abductor hallucis' OR 'adductor hallucis' OR 'flexor hallucis brevis'/exp OR 'flexor hallucis brevis' OR 'abductor digiti minimi'/exp OR 'abductor digiti minimi' OR 'flexor digiti minimi' OR 'lumbricals' OR 'quadratus plantae' OR 'flexor digitorum brevis' OR 'gluteus muscle'/exp OR 'gluteus medius' OR 'gluteus maximus' OR 'gluteal' OR 'hip abductor' OR 'hip rotator') OR ('foot'/exp foot OR feet OR 'foot muscle'/exp OR 'flexor digitorum brevis'/exp OR 'flexor digitorum brevis muscle'/exp OR 'plantaris muscle'/exp OR 'plantaris muscle' OR 'articulationes pedis' OR metatarsophalangeal OR 'heel'/exp OR heel OR heels OR 'sinus tarsi' OR 'sinus tarsus' OR 'rearfoot'/exp OR rearfoot OR 'midfoot'/exp OR midfoot) AND [embase]/lim	208854

CINAHL

History: June 26, 2018

Search	Query	Items Found, n
#14	#9 AND #8 AND [Published Date: 20130101-20181231, Source Types: Academic Journals, Language: English]	1991
#13	#7 AND #6 AND #1 AND [Published Date: 20130101-20181231, Source Types: Academic Journals, Language: English]	582
#12	#9 AND #5 AND [Published Date: 20130101-20181231, Source Types: Academic Journals, Language: English]	2066
#11	#9 AND #4 AND [Published Date: 20130101-20181231, Source Types: Academic Journals, Language: English]	179
#10	#9 AND #3 AND [Published Date: 20130101-20181231, Source Types: Academic Journals, Language: English]	2238
#9	#1 AND #2 AND [Published Date: 20130101-20181231, Source Types: Academic Journals, Language: English]	5128

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APPENDIX A

Search	Query	Items Found, n
#8	(MH "Diagnosis" OR MH "Diagnosis, Computer Assisted" OR MH "Diagnosis, Delayed" OR MH "Diagnosis, Differential" OR MH "Early Diagnosis" OR MM "Diagnosis, Musculoskeletal" OR MH "Diagnostic Imaging" OR diagnosis OR diagnose OR diagnoses OR diagnostic OR "clinical decision-making" OR "clinical decision making" OR "medical decision-making" OR "medical decision making" OR "diagnostic imaging" OR "medical imaging" OR MH "Magnetic Resonance Imaging" OR MH "Ultrasonography" OR MH "Tomography, X-Ray" OR MH "Radiography" OR radiography OR "diagnostic x-ray" OR "diagnostic x ray" OR "diagnostic x-rays" OR "magnetic resonance imaging" OR MRI OR fMRI OR "NMR imaging" OR "MR tomography" OR ultrasonography OR ultrasound OR ultrasounds OR ultrasonic OR MH "Electromyography" OR electromyography OR electromyographies OR electromyogram OR electromyograms OR "electrophysiologic test" OR "electrophysiologic tests" OR "electrophysiologic testing" OR "neural conduction" OR "neural conductions" OR "nerve conduction" OR "nerve conductions" OR MH "Actigraphy" OR actigraphy OR MH "Physical Therapy Assessment")	934241
#7	(MH "Sensitivity and Specificity" OR sensitivity OR specificity OR MH "Evaluation Research" OR "evaluation indexes" OR "evaluation report" OR "evaluation reports" OR "evaluation research" OR use-effectiveness OR "use effectiveness" OR "prepost tests" OR "pre post tests" OR "prepost test" OR "qualitative evaluation" OR "qualitative evaluations" OR "quantitative evaluation" OR "quantitative evaluations" OR "theoretical effectiveness" OR critique OR critiques OR "evaluation methodology" OR "evaluation methodologies" OR MH "Reproducibility of Results" OR reproducibility OR MH "Validity+" OR validity OR MH "Reliability" OR reliability OR MH "Reliability and Validity" OR "data accuracy" OR "data accuracies" OR "data quality" OR "data qualities" OR MH "Precision" OR precision OR responsiveness OR consistency OR consistencies OR consistent OR "log-likelihood ratio" OR "likelihood-ratio" OR "likelihood ratio" OR MH "Study Design" OR "research design" OR "research designs" OR "research strategy" OR "research strategies" OR "research techniques" OR "research technique" OR MH "Research Methodology" OR "research methodology" OR "research methodologies" OR "experimental design" OR "experimental designs")	524735
#6	(ZQ "cumberland ankle instability tool" OR ZQ "cumberland ankle instability tool (cait)" OR "Cumberland ankle instability tool" OR ZQ "chronic ankle instability scale (cais)" OR "Chronic Ankle Instability Scale" OR ZQ "sports ankle rating system" OR "Sports Ankle Rating System" OR ZQ "ankle joint functional assessment tool" OR "Ankle Joint Functional Assessment Tool" OR ZQ "foot function index" OR ZQ "foot function index (ffi)" OR "Foot Function Index" OR ZQ "foot and ankle outcome score" OR ZQ "foot and ankle outcome score (faos)" OR ZQ "foot and ankle outcome scores (faos)" OR "Foot and Ankle Outcome Score" OR ZQ "karlsson score" OR "Karlsson Ankle Function Score" OR "Karlsson Score" OR ZQ "kaikkonen scale" OR "Kaikkonen scale" OR "Kaikkonen score" OR ZQ "ottawa ankle rules" OR ZQ "ottawa ankle rules (oar)" OR "Ottawa ankle rules" OR "Buffalo modification" OR ZQ "foot and ankle ability measure (faam)" OR "foot and ankle ability measure" OR "foot ability measure" OR "ankle ability measure" OR ZQ "foot and ankle disability index (fadi)" OR "foot and ankle disability index" OR ZQ "lower extremity functional scale (lefs)" OR "lower extremity functional scale" OR "ankle instability scale" OR "sports ankle rating system" OR ZQ "ankle joint functional assessment tool (ajfat)" OR "ankle joint function assessment" OR ZQ "ankle instability index" OR "ankle instability index" OR ZQ "ankle instability instrument" OR "ankle instability instrument" OR "identification of functional ankle instability" OR ZQ "tampa scale for kinesiophobia (tsk)" OR "Tampa scale of kinesiophobia" OR "sway index" OR ZQ "functional reach test" OR ZQ "functional reach test (frt)" OR "functional reach test" OR ZQ "patient reported outcomes measurement information system (promis)" OR "Patient Reported Outcome Measurement Information System" OR MH "Short Form-36 Health Survey (SF-36)" OR ZQ "short form health survey (sf-36)" OR ZQ "short form health survey" OR "short form health survey" OR "short-form health survey" OR ZQ "visual analogue scale" OR ZQ "visual analogue scale (vas)" OR "Visual Analogue Scale" OR ZQ "health utilities index (hui)" OR "health utilities index" OR "European Quality of life 5 Dimensions" OR EuroQol OR "short form 36" OR "shortform 36" OR shortform36 OR "36 item short form" OR "36-item short form" OR "short form 20" OR "shortform 20" OR shortform20 OR "20 item short form" OR "20-item short form" OR "short form 12" OR "shortform 12" OR shortform12 OR "12 item short form" OR "12-item short form" OR "short form 8" OR "shortform 8" OR shortform8 OR "8 item short form" OR "8-item short form" OR "short form 6" OR "shortform 6" OR shortform6 OR "6 item short form" OR "6-item short form" OR "QoL Questionnaire" OR "health questionnaire" OR ZQ "godin leisure time exercise questionnaire" OR ZQ "godin leisure time exercise questionnaire (glteq)" OR "Godin leisure time" OR ZQ "numeric pain scale" OR "Numeric Pain Scale" OR ZQ "hop test" OR "lateral hopping for distance" OR "6-m crossover hop" OR "side hop" OR "hopping course" OR "square hop" OR "cross hop" OR "hop test" OR "hopping test" OR "40-m walk time" OR "40-m run time" OR "figure-of-eight run" OR "single-limb forward hop" OR "single limb forward hop" OR "stair hop" OR "shuttle run" OR "up/down hop" OR "hop up" OR "hopping up" OR "hop down" OR "hopping down" OR "triple crossover hop" OR "single-limb hurdle" OR "single limb hurdle" OR "single-limb 6-m hop" OR "single-limb 30-m hop" OR "figureof-eight hop" OR "figure of eight hop" OR "figure eight hop" OR "drop landing" OR "vertical jump" OR "walking speed" OR "walking speeds" OR "walking gait" OR "gait speed" OR "gait speeds" OR "walking pace" OR "walking paces" OR "running gait" OR "running speed" OR "running speeds" OR "running pace" OR "running paces" OR "figure of 8 circumferential measure" OR "volumetric measure" OR MH "Range of Motion" OR "range of motion" OR "joint flexibility" OR "articular arthometry" OR "articular goniometry" OR MH "Supination" OR supination OR supinations OR MH "Pronation" OR pronation OR pronations OR "tibiopedal dorsiflexion" OR "weight-bearing lunge" OR "weight bearing lunge" OR MH "Algometry" OR algometry OR MH "Pain Threshold" OR "pain threshold" OR "pain thresholds" OR "pressurepain threshold" OR "pressurepain thresholds" OR "cutaneous sensation" OR MH "Hypesthesia" OR hypesthesia OR hyperethesia OR "joint position sense" OR MH "Kinesthesis" OR kinesthesis OR kinesthesia OR kinesthesias OR kinesthetic OR "movement sensation" OR "movement sensations" OR "isokinetic muscle strength" OR "isokinetic test" OR "isokinetic tests" OR "single-limb balance" OR "single limb balance" OR ZQ "romberg test" OR ZQ "romberg's test" OR "Romberg test" OR ZQ "balance test" OR "balance test" OR "balancing test" OR ZQ "y balance test" OR "Y balance" OR ZQ "balance error scoring system (bess)" OR "Balance Error Scoring System" OR ZQ "step-down test"OR "step-down test" OR "step down test" OR "single leg squat test" OR ZQ "functional movement screen" OR ZQ "functional movement screen (fms)" OR "functional movement screen" OR "functional movement screening" OR "functional movement screens" OR "joint accessory mobility" OR "joint play mobility" OR ZQ "anterior drawer test" OR "anterior drawer" OR "talar tilt inversion" OR "talar tilt eversion" OR "talar rotation" OR "talofibular interval" OR "tibiofibular interval" OR "distal fibula interval" OR ZQ "foot posture index" OR ZQ "foot posture index (fpi)"OR "foot posture index" OR "squeeze test" OR "Cotton test" OR "dorsiflexion maneuver" OR "dorsiflexion maneuvers" OR "dorsiflexion compression test" OR "crossed leg test" OR "heel thump test" OR "Kleiger dorsiflexion external rotation test" OR "external rotation test" OR ZQ "thompson test" OR "Thompson test" OR "function and prognostic score" OR "function and prognostic scores" OR ZQ "ankle function score" OR "ankle function score" OR "ankle scoring system" OR "multisegmented foot" OR "ankle-foot complex" OR "foot morphology" OR "intrinsic foot muscles" OR "ankle assessment" OR "ankle assessments" OR "foot assessment" OR "foot assessments" OR "feet assessment" OR "feet assessments" OR "biomechanical assessment" OR "biomechanical assessments" OR "foot root model" OR "ankle root model")	67776

Table continues on page CPG61.

APPENDIX A

Search	Query	Items Found, n
#5	(MH "Risk Assessment" OR MH "Risk Factors" OR risk OR risks OR risk-benefit OR MH "Probability" OR probability OR probabilities OR likelihood OR propensity OR MH "Multiple Logistic Regression" OR "logistic model" OR "logistic models" OR "logistic modeling" OR "logistic regression" OR "logistic regressions" OR "protective factor" OR "protective factors" OR "Bayes theorem" OR Bayesian OR MH "Causal Attribution" OR causality OR causalities OR causation OR causations OR cause OR causes OR "enabling factor" OR "enabling factors" OR "reinforcing factor" OR "reinforcing factors" OR "predisposing factor" OR "predisposing factors" OR predisposition OR "precipitating factors" OR "precipitating factor" OR predictor OR predictors OR MH "Odds Ratio" OR "odds ratio" OR "odds ratios" OR predict OR prediction OR predictions OR predictabilities OR predictability OR predicted OR predictor OR predictors OR predictive OR etiology OR etiologies OR etiological OR etiologic OR aetiology OR origin OR origination OR originating OR MH "Interaction (Research)" OR interact OR interaction OR interactions OR interacting)	1409663
#4	(MH "Incidence" OR incidence OR incidences OR MH "Morbidity" OR morbidity OR morbidities OR MH "Epidemiology" OR epidemiology OR MH "Prevalence" OR prevalence OR prevalent OR prevalencies)	178273
#3	(MH "Physical Therapy" OR "physical therapy" OR "physical therapies" OR physiotherapy OR physiotherapies OR MH "Recovery" OR MH "Recovery, Exercise" OR recovery OR restoration OR reeducation OR MH "Rehabilitation" OR rehabilitation OR rehab OR MH "Early Ambulation" OR "early ambulation" OR "accelerated ambulation" OR "early mobilization" OR MH "Therapeutic Exercise OR "exercise therapy" OR "therapeutic exercise" OR "therapeutic exercises" OR "therapeutic modality" OR "therapeutic modalities" OR stretching OR "exercise movement" OR MH "Gait Training" OR strengthen OR strengthening OR MH "Resistance Training" OR MH "Muscle Strengthening" OR "resistance training" OR "strength training" OR weight-bearing OR weight-lifting OR "resistance methods" OR "training program" OR MH "Biofeedback" OR biofeedback OR "psychophysiologic feedback" OR "neuromuscular electrical stimulation" OR "neuromuscular reeducation" OR MH "Pain Management" OR MH "Pain Measurement" OR "pain management" OR "pain measurement" OR MH "Joint Mobilization" OR mobilization OR mobilizations OR manipulation OR manipulations OR MH "Ultrasonography" OR ultrasonography OR ultrasound OR MH "Acupuncture" OR acupuncture OR MH "Patient Education"OR "patient education" OR "education of patients" OR MH "Iontophoresis" OR iontophoresis OR MH "Electrotherapy" OR "electric stimulation" OR "nerve stimulation" OR MH "Taping and Strapping" OR taping OR tape OR MH "Orthoses" OR orthoses OR bracing OR brace OR braces OR immobilization OR immobilize OR orthotic OR orthotics OR "thermal agent" OR "thermal agents" OR diathermy OR "range of motion" OR "joint flexibility" OR "joint movement" OR MH "Manual Therapy" OR "manual therapy" OR MH "Massage" OR massage OR massages OR MH "Treatment Outcomes" OR "treatment outcome" OR "clinical effectiveness" OR "treatment effectiveness" OR "treatment efficacy"OR MH "Outcomes (Health Care)"OR "patient outcome" OR "patient outcomes")	640059
#2	(MH "Wounds and Injuries" OR MH "Athletic Injuries+" OR MH "Leg Injuries" OR MH "Ligament Injuries" OR MH "Ankle Injuries+" OR MH "Foot Injuries+" OR MH "Tendon Injuries+"OR injuries OR injury OR injured OR MH "Ankle Sprain, Syndesmosis" OR MH "Sprains and Strains+" OR MH "Calf Strain" OR sprains OR sprain OR sprained OR strains OR strain OR strained OR swelling OR swollen OR swell MH "Joint Instability+" OR instability OR instabilities OR unstable OR "joint effusion" OR "proprioception deficit" OR "proprioception deficits" OR "proprioception deficiency" OR "proprioception deficiencies" OR MH "Balance, Postural" OR balance OR unbalanced OR "musculoskeletal equilibrium" OR "postural equilibrium" OR hypermobility OR hypermobilities OR laxity OR laxities OR MH "Tears and Lacerations+" OR tear OR torn OR "external rotation" OR MH "Eversion" OR MH "Inversion" OR eversion OR inversion)	352935
#1	(MH "Ankle"OR ankle OR ankles OR regio tarsalis OR MH "Talus" OR talus OR tarsus OR metatarsus OR metatarsal OR MH "Ankle Joint" OR "subtalar joint" OR "talocalcaneal joint" OR talocrural OR "articulatio talocruralis" OR "tarsal joints" OR "tarsal joint" OR "midtarsal joint" OR "midtarsal joints" OR "intertarsal joint" OR "intertarsal joints" OR "intertarsal articulation" OR "articulationes intertarseae" OR "articulationes intertarsales" OR "ligamentum laterale articulationis talocruralis" OR calcaneofibular OR tibiofibular OR tibiotalar OR tibionavicular OR tibiocalcaneal OR talofibular OR talonavicula OR calcaneocuboid OR MH "Lateral Ligament, Ankle" OR "ankle lateral ligament" OR "bifurcate* ligament*" OR "inferior transverse ligament*" OR "deltoid ligament*" OR "medial ligament*" OR "interosseous ligament*" OR MH "Tibial Nerve" OR "tibial nerve" OR MH "Peroneal Nerve" OR "peroneal nerve" OR "saphenous nerve" OR "medial plantar nerve" OR "lateral plantar nerve" OR "fibular nerve" OR "fibularis tertius" OR MH "Achilles Tendon" OR "achilles tendon" OR calcaneal OR calcaneus OR "interosseous membrane" OR "interosseous membranes" OR "dorsal interossei" OR "plantar interossei" OR syndesmosis OR syndesmoses OR syndesmotic OR "tibialis anterior" OR "fibularis longus" OR "fibularis brevis" OR "peroneus tertius" OR "peroneus longus" OR "peroneus brevis" OR "flexor hallucis longus" OR "flexor digitorum longus" OR "extensor digitorum longus" OR "tibialis posterior" OR MH "Soleus Muscles" OR soleus OR peroneal OR MH "Gastrocnemius Muscle" OR gastrocnemius OR "abductor hallucis" OR "adductor hallucis" OR "flexor hallucis brevis" OR "abductor digiti minimi" OR "flexor digiti minimi" OR "lumbricals" OR "quadratus plantae" OR "flexor digitorum brevis" OR MH "Gluteal Muscles" OR "gluteus medius" OR "gluteus maximus" OR "gluteal" OR "hip abductor" OR "hip rotator") OR (foot OR MH "Foot" OR feet OR "articulationes pedis" OR metatarsophalangeal OR MH "Heel" OR heel OR heels OR "sinus tarsi" OR "sinus tarsus" OR rearfoot OR midfoot)	68058

Cochrane Library

History: June 26, 2018

Search	Query	Items Found, n
#14	#9 AND #8 AND [Publication Year from 2013 to 2018]	538
#13	#7 AND #6 AND #1 AND [Publication Year from 2013 to 2018]	183
#12	#9 AND #5 AND [Publication Year from 2013 to 2018]	754
#11	#9 AND #4 AND [Publication Year from 2013 to 2018]	250
#10	#9 AND #3 AND [Publication Year from 2013 to 2018]	1299
#9	#1 AND #2 AND [Publication Year from 2013 to 2018]	1980

Table continues on page CPG62.

APPENDIX A

Search	Query	Items Found, n
#8	(diagnosis OR diagnose OR diagnoses OR diagnostic OR "clinical decision-making" OR "clinical decision making" OR "medical decision-making" OR "medical decision making" OR "diagnostic imaging" OR "medical imaging" OR radiography OR "diagnostic x-ray" OR "diagnostic x ray" OR "diagnostic x-rays" OR "magnetic resonance imaging" OR MRI OR fMRI OR "NMR imaging" OR "MR tomography" OR ultrasonography OR ultrasound OR ultrasounds OR ultrasonic OR electromyography OR electromyographies OR electromyogram OR electromyograms OR "electrophysiologic test" OR "electrophysiologic tests" OR "electrophysiologic testing" OR "neural conduction" OR "neural conductions" OR "nerve conduction" OR "nerve conductions" OR actigraphy)	158649
#7	(sensitivity OR specificity OR "evaluation indexes" OR "evaluation report" OR "evaluation reports" OR "evaluation research" OR use-effectiveness OR "use effectiveness" OR "prepost tests" OR "pre post tests" OR "prepost test" OR "qualitative evaluation" OR "qualitative evaluations" OR "quantitative evaluation" OR "quantitative evaluations" OR "theoretical effectiveness" OR critique OR critiques OR "evaluation methodology" OR "evaluation methodologies" OR reproducibility OR validity OR reliability OR "data accuracy" OR "data accuracies" OR "data quality" OR "data qualities" OR precision OR responsiveness OR consistency OR consistencies OR consistent OR "log-likelihood ratio" OR "likelihood-ratio" OR "likelihood ratio" OR "research design" OR "research designs" OR "research strategy" OR "research strategies" OR "research techniques" OR "research technique" OR "research methodology" OR "research methodologies" OR "experimental design" OR "experimental designs")	127277
#6	("Cumberland ankle instability tool" OR "Chronic Ankle Instability Scale" OR "Sports Ankle Rating System" OR "Ankle Joint Functional Assessment Tool" OR "Foot Function Index" OR "Foot and Ankle Outcome Score" OR "Karlsson Ankle Function Score" OR "Karlsson Score" OR "Kaikkonen scale" OR "Kaikkonen score" OR "Ottawa ankle rules" OR "Buffalo modification" OR "foot and ankle ability measure" OR "foot ability measure" OR "ankle ability measure" OR "foot and ankle disability index" OR "lower extremity functional scale" OR "ankle instability scale" OR "sports ankle rating system" OR "ankle joint function assessment" OR "ankle instability index" OR "ankle instability instrument" OR "identification of functional ankle instability" OR "Tampa scale of kinesiophobia" OR "sway index" OR "functional reach test" OR "Patient Reported Outcome Measurement Information System" OR "short form health survey" OR "short-form health survey" OR "Visual Analogue Scale" OR "health utilities index" OR "European Quality of life 5 Dimensions" OR EuroQol OR "short form 36" OR "shortform 36" OR shortform36 OR "36 item short form" OR "36-item short form" OR "short form 20" OR "shortform 20" OR shortform20 OR "20 item short form" OR "20-item short form" OR "short form 12" OR "shortform 12" OR shortform12 OR "12 item short form" OR "12-item short form" OR "short form 8" OR "shortform 8" OR shortform8 OR "8 item short form" OR "8-item short form" OR "short form 6" OR "shortform 6" OR shortform6 OR "6 item short form" OR "6-item short form" OR "QoL Questionnaire" OR "health questionnaire" OR "Godin leisure time" OR "Numeric Pain Scale" OR "lateral hopping for distance" OR "6-m crossover hop" OR "side hop" OR "hopping course" OR "square hop" OR "cross hop" OR "hop test" OR "hopping test" OR "40-m walk time" OR "40-m run time" OR "figureof-eight run" OR "single-limb forward hop" OR "single limb forward hop" OR "stair hop" OR "shuttle run" OR "up/down hop" OR "hop up" OR "hopping up" OR "hop down" OR "hopping down" OR "triple crossover hop" OR "single-limb hurdle" OR "single limb hurdle" OR "single-limb 6-m hop" OR "single-limb 30-m hop" OR "figureof-eight hop" OR "figure of eight hop" OR "figure eight hop" OR "drop landing" OR "vertical jump" OR "walking speed" OR "walking speeds" OR "walking gait" OR "gait speed" OR "gait speeds" OR "walking pace" OR "walking paces" OR "running gait" OR "running speed" OR "running speeds" OR "running pace" OR "running paces" OR "figure of 8 circumferential measure" OR "volumetric measure" OR "range of motion" OR "joint flexibility" OR "articular arthometry" OR "articular goniometry" OR supination OR supinations OR pronation OR pronations OR "tibiopedal dorsiflexion" OR "weight-bearing lunge" OR "weight bearing lunge" OR algometry OR "pain threshold" OR "pain thresholds" OR "pressurepain threshold" OR "pressurepain thresholds" OR "cutaneous sensation" OR hypesthesia OR hyperethesia OR "joint position sense" OR kinesthesis OR kinesthesia OR kinesthesias OR kinesthetic OR "movement sensation" OR "movement sensations" OR "isokinetic muscle strength" OR "isokinetic test" OR "isokinetic tests" OR "single-limb balance" OR "single limb balance" OR "Romberg test" OR "balance test" OR "balancing test" OR "Y balance" OR "Balance Error Scoring System" OR "step-down test" OR "step down test" OR "single leg squat test" OR "functional movement screen" OR "functional movement screening" OR "functional movement screens" OR "joint accessory mobility" OR "joint play mobility" OR "anterior drawer" OR "talar tilt inversion" OR "talar tilt eversion" OR "talar rotation" OR "talo-fibular interval" OR "tibiofibular interval" OR "distal fibula interval" OR "foot posture index" OR "squeeze test" OR "Cotton test" OR "dorsiflexion maneuver" OR "dorsiflexion maneuvers" OR "dorsiflexion compression test" OR "crossed leg test" OR "heel thump test" OR "Kleiger dorsiflexion external rotation test" OR "external rotation test" OR "Thompson test" OR "function and prognostic score" OR "function and prognostic scores" OR "ankle function score" OR "ankle scoring system" OR "multisegmented foot" OR "ankle-foot complex" OR "foot morphology" OR "intrinsic foot muscles" OR "ankle assessment" OR "ankle assessments" OR "foot assessment" OR "foot assessments" OR "feet assessment" OR "feet assessments" OR "biomechanical assessment" OR "biomechanical assessments" OR "foot root model" OR "ankle root model")	50924
#5	(risk OR risks OR risk-benefit OR probability OR probabilities OR likelihood OR propensity OR "logistic model" OR "logistic models" OR "logistic modeling" OR "logistic regression" OR "logistic regressions" OR "protective factor" OR "protective factors" OR "Bayes theorem" OR Bayesian OR causality OR causalities OR causation OR causations OR cause OR causes OR "enabling factor" OR "enabling factors" OR "reinforcing factor" OR "reinforcing factors" OR "predisposing factor" OR "predisposing factors" OR predisposition OR "precipitating factors" OR "precipitating factor" OR predictor OR predictors OR "odds ratio" OR "odds ratios" OR predict OR prediction OR predictions OR predictabilities OR predictability OR predicted OR predictor OR predictors OR predictive OR etiology OR etiologies OR etiological OR etiologic OR aetiology OR origin OR origination OR originating OR interact OR interaction OR interactions OR interacting)	355072
#4	(incidence OR incidences OR morbidity OR morbidities OR epidemiology OR prevalence OR prevalent OR prevalencies)	144274

Table continues on page CPG63.

APPENDIX A

Search	Query	Items Found, n
#3	("physical therapy" OR "physical therapies" OR physiotherapy OR physiotherapies OR recovery OR restoration OR reeducation OR rehabilitation OR rehab OR "early ambulation" OR "accelerated ambulation" OR "early mobilization" OR "exercise therapy" OR "therapeutic exercise" OR "therapeutic exercises" OR "therapeutic modality" OR "therapeutic modalities" OR stretching OR "exercise movement" OR strengthen OR strengthening OR "resistance training" OR "strength training" OR weight-bearing OR weight-lifting OR "resistance methods" OR "training program" OR biofeedback OR "psychophysiologic feedback" OR "neuromuscular electrical stimulation" OR "neuromuscular reeducation" OR "pain management" OR "pain measurement" OR mobilization OR mobilizations OR manipulation OR manipulations OR ultrasonography OR ultrasound OR acupuncture OR "patient education" OR "education of patients" OR iontophoresis OR "electric stimulation" OR "nerve stimulation" OR taping OR tape OR bracing OR brace OR braces OR immobilization OR immobilize OR orthotic OR orthotics OR "thermal agent" OR "thermal agents" OR diathermy OR "range of motion" OR "joint flexibility" OR "joint movement" OR "manual therapy" OR massage OR massages OR "treatment outcome" OR "clinical effectiveness" OR "treatment effectiveness" OR "treatment efficacy" OR "patient outcome" OR "patient outcomes")	312688
#2	(injuries OR injury OR injured OR sprains OR sprain OR sprained OR strains OR strain OR strained OR swelling OR swollen OR swell OR instability OR instabilities OR unstable OR "joint effusion" OR "proprioception deficit" OR "proprioception deficits" OR "proprioception deficiency" OR "proprioception deficiencies" OR balance OR unbalanced OR "musculoskeletal equilibrium" OR "postural equilibrium" OR hypermobility OR hypermobilities OR laxity OR laxities OR tear OR torn OR "external rotation" OR eversion OR inversion)	92252
#1	(ankle OR ankles OR regio tarsalis OR talar OR tarsus OR metatarsus OR metatarsal OR "subtalar joint" OR "talocalcaneal joint" OR talocrural OR "articulatio talocruralis" OR "tarsal joints" OR "tarsal joint" OR "midtarsal joint" OR "midtarsal joints" OR "intertarsal joint" OR "intertarsal joints" OR "intertarsal articulation" OR "articulationes intertarseae" OR "articulationes intertarsales" OR "ligamentum laterale articulationis talocruralis" OR calcaneofibular OR tibiofibular OR tibiotalar OR tibionavicular OR tibiocalcaneal OR talofibular OR talonavicula OR calcaneocuboid OR "bifurcate* ligament*" OR "inferior transverse ligament*" OR "deltoid ligament*" OR "medial ligament*" OR "interosseous ligament*" OR "tibial nerve" OR "peroneal nerve" OR "saphenous nerve" OR "medial plantar nerve" OR "lateral plantar nerve" OR "fibular nerve" OR "fibularis tertius" OR "achilles tendon" OR calcaneal OR calcaneus OR "interosseous membrane" OR "interosseous membranes" OR "dorsal interossei" OR "plantar interossei" OR syndesmosis OR syndesmoses OR syndesmotic OR "tibialis anterior" OR "fibularis longus" OR "fibularis brevis" OR "peroneus tertius" OR "peroneus longus" OR "peroneus brevis" OR "flexor hallucis longus" OR "flexor digitorum longus" OR "extensor digitorum longus" OR "tibialis posterior" OR soleus OR peroneal OR gastrocnemius OR "abductor hallucis" OR "adductor hallucis" OR "flexor hallucis brevis" OR "abductor digiti minimi" OR "flexor digiti minimi" OR "lumbricals" OR "quadratus plantae" OR "flexor digitorum brevis" OR "gluteus medius" OR "gluteus maximus" OR "gluteal" OR "hip abductor" OR "hip rotator") OR (foot OR feet OR "articulationes pedis" OR metatarsophalangeal OR heel OR heels OR "sinus tarsi" OR "sinus tarsus" OR rearfoot OR midfoot)	18648

PEDro Advanced Search

History: June 26, 2018

Search	Query	Items Found, n
#14	Abstract & Title: diagnos* Body Part: Foot OR Ankle Published Since: 2013	41
#13	Abstract & Title: inversion Body Part: Foot OR Ankle Published Since: 2013	10
#12	Abstract & Title: eversion Body Part: Foot OR Ankle Published Since: 2013	8
#11	Abstract & Title: external rotation Body Part: Foot OR Ankle Published Since: 2013	1
#10	Abstract & Title: tear Body Part: Foot OR Ankle Published Since: 2013	2
#9	Abstract & Title: equilibrium Body Part: Foot OR Ankle Published Since: 2013	3
#8	Abstract & Title: balance Body Part: Foot OR Ankle Published Since: 2013	109
#7	Abstract & Title: proprioception Body Part: Foot OR Ankle Published Since: 2013	12

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APPENDIX A

Search	Query	Items Found, n
#6	Abstract & Title: swell* Body Part: Foot OR Ankle Published Since: 2013	11
#5	Abstract & Title: injury Body Part: Foot OR Ankle Published Since: 2013	70
#4	Abstract & Title: strain* Body Part: Foot OR Ankle Published Since: 2013	3
#3	Abstract & Title: sprain* Body Part: Foot OR Ankle Published Since: 2013	51
#2	Abstract & Title: unstable Body Part: Foot OR Ankle Published Since: 2013	6
#1	Abstract & Title: instability Body Part: Foot OR Ankle Published Since: 2013	50

PubMed Update

Updated Searches From June 26, 2018 to June 1, 2020

Search	Query	Items Found, n
#14	#1 AND #9 AND #12 AND #13	5070
#13	#3 OR #4 OR #5 OR (#6 AND #7) OR #8	16889026
#12	#10 OR #11	2724576
#11	(#2 NOT (fracture[tw] NOT (sprains[tw] OR sprain[tw] OR sprained[tw] OR strains[tw] OR strain[tw] OR strained[tw] OR swelling[tw] OR swollen[tw] OR swell[tw] OR "Joint Instability"[Mesh] OR instability[tw] OR instabilities[tw] OR unstable[tw] OR joint effusion[tw] OR "Proprioception"[Mesh] OR proprioception deficit[tw] OR proprioception deficits[tw] OR proprioception deficiency[tw] OR proprioception deficiencies[tw] OR "Postural Balance"[Mesh] OR balance[tw] OR unbalanced[tw] OR musculoskeletal equilibrium[tw] OR postural equilibrium[tw] OR hypermobility[tw] OR hypermobilities[tw] OR laxity[tw] OR laxities[tw] OR tear[tw] OR torn[tw] OR external rotation[tw] OR eversion[tw] OR inversion[tw]))	2660096
#10	(#2 NOT (osteoarthritis[tw] NOT (sprains[tw] OR sprain[tw] OR sprained[tw] OR strains[tw] OR strain[tw] OR strained[tw] OR swelling[tw] OR swollen[tw] OR swell[tw] OR "Joint Instability"[Mesh] OR instability[tw] OR instabilities[tw] OR unstable[tw] OR joint effusion[tw] OR "Proprioception"[Mesh] OR proprioception deficit[tw] OR proprioception deficits[tw] OR proprioception deficiency[tw] OR proprioception deficiencies[tw] OR "Postural Balance"[Mesh] OR balance[tw] OR unbalanced[tw] OR musculoskeletal equilibrium[tw] OR postural equilibrium[tw] OR hypermobility[tw] OR hypermobilities[tw] OR laxity[tw] OR laxities[tw] OR tear[tw] OR torn[tw] OR external rotation[tw] OR eversion[tw] OR inversion[tw]))	2717587
#9	("2018/06/01"[Date - Publication]: "3000"[Date - Publication]) NOT (animals[mh] NOT humans[mh]) NOT ("Book Reviews"[Publication Type] OR "Comment"[Publication Type] OR "Editorial"[Publication Type] OR "Letter"[Publication Type] OR "Review"[Publication Type] OR "Meeting Abstracts"[Publication Type] OR "Public Service Announcements"[Publication Type] OR "News"[Publication Type] OR "Newspaper Article"[Publication Type] OR "Case Reports"[Publication Type] OR "Academic Dissertations"[Publication Type] OR "Retracted Publication"[Publication Type]) AND "English"[Language]	1896226
#8	("Diagnosis"[Mesh] OR "diagnosis"[Subheading] OR "Delayed Diagnosis"[Mesh] OR "Early Diagnosis"[Mesh] OR "Diagnosis, Differential"[Mesh] OR "Diagnosis, Computer-Assisted"[Mesh] OR "Diagnostic Techniques and Procedures"[Mesh] OR diagnosis[tw] OR diagnose[tw] OR diagnoses[tw] OR diagnostic[tw] OR "Clinical Decision-Making"[Mesh] OR clinical decision-making[tw] OR clinical decision making[tw] OR medical decision-making[tw] OR medical decision making[tw] OR "Decision Making"[Mesh:NoExp] OR "Diagnostic Imaging"[Mesh] OR diagnostic imaging[tw] OR medical imaging[tw] OR "Radiography"[Mesh] OR radiography[tw] OR diagnostic x-ray[tw] OR diagnostic x ray[tw] OR diagnostic x-rays[tw] OR "Magnetic Resonance Imaging"[Mesh] OR magnetic resonance imaging[tw] OR MRI[tw] OR fMRI[tw] OR NMR imaging[tw] OR MR tomography[tw] OR "Ultrasonography"[Mesh] OR ultrasonography[tw] OR ultrasound[tw] OR ultrasounds[tw] OR ultrasonic[tw] OR "Electromyography"[Mesh] OR electromyography[tw] OR electromyographies[tw] OR electromyogram[tw] OR electromyograms[tw] OR electrophysiologic test[tw] OR electrophysiologic tests[tw] OR electrophysiologic testing[tw] OR "Neural Conduction"[Mesh] OR neural conduction[tw] OR neural conductions[tw] OR nerve conduction[tw] OR nerve conductions[tw] OR "Actigraphy"[Mesh] OR actigraphy[tw])	10339439

Table continues on page CPG65.

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Search	Query	Items Found, n
#7	("Sensitivity and Specificity"[Mesh] OR sensitivity[tw] OR specificity[tw] OR "Evaluation Studies as Topic"[Mesh] OR evaluation indexes[tw] OR evaluation report[tw] OR evaluation reports[tw] OR evaluation research[tw] OR use-effectiveness[tw] OR use effectiveness[tw] OR prepost tests[tw] OR pre post tests[tw] OR prepost test[tw] OR qualitative evaluation[tw] OR qualitative evaluations[tw] OR quantitative evaluation[tw] OR quantitative evaluations[tw] OR theoretical effectiveness[tw] OR critique[tw] OR critiques[tw] OR evaluation methodology[tw] OR evaluation methodologies[tw] OR "Validation Studies as Topic"[Mesh] OR "Reproducibility of Results"[Mesh] OR reproducibility[tw] OR validity[tw] OR reliability[tw] OR "Data Accuracy"[Mesh] OR data accuracy[tw] OR data accuracies[tw] OR data quality[tw] OR data qualities[tw] OR precision[tw] OR responsiveness[tw] OR consistency[tw] OR consistencies[tw] OR consistent[tw] OR log-likelihood ratio[tw] OR likelihood-ratio[tw] OR likelihood ratio[tw] OR LR test[tiab] OR "Epidemiologic Research Design"[Mesh] OR "Research Design"[Mesh] OR research design[tw] OR research designs[tw] OR research strategy[tw] OR research strategies[tw] OR research techniques[tw] OR research technique[tw] OR research methodology[tw] OR research methodologies[tw] OR experimental design[tw] OR experimental designs[tw])	4082712
#6	(Cumberland ankle instability tool[tw] OR Chronic Ankle Instability Scale[tw] OR Sports Ankle Rating System[tw] OR Ankle Joint Functional Assessment Tool[tw] OR Foot Function Index[tw] OR Foot and Ankle Outcome Score[tw] OR Karlsson Ankle Function Score[tw] OR Karlsson Score[tw] OR Kaikkonen scale[tw] OR Kaikkonen score[tw] OR Ottawa ankle rules[tw] OR Buffalo modification[tiab] OR foot and ankle ability measure[tw] OR foot ability measure[tw] OR ankle ability measure[tw] OR foot and ankle disability index[tw] OR lower extremity function scale[tw] OR lower extremity functional scale[tw] OR ankle instability scale[tw] OR sports ankle rating system[tw] OR ankle joint function assessment[tw] OR ankle instability index[tw] OR ankle instability instrument[tw] OR identification of functional ankle instability[tw] OR Tampa scale of kinesiophobia[tw] OR sway index[tw] OR functional reach test[tw] OR Patient Reported Outcome Measurement Information System[tw] OR PROMIS[tiab] OR Health Utilities Index[tw] OR HUI[tiab] OR HUI-III[tiab] OR HUI-3[tiab] OR HUI3[tiab] OR HUI-II[tiab] OR HUI-2[tiab] OR HUI2[tiab] OR HUI-I[tiab] OR HUI-1[tiab] OR HUI1[tiab] OR Visual Analogue Scale[tw] OR European Quality of life 5 Dimensions[tw] OR EuroQol*[tiab] OR EQ-5D[tiab] OR EQ5D*[tiab] OR EQ 5D[tiab] OR EORTC[tiab] OR Rosser[tiab] OR short form health survey[tw] OR short-form health survey[tw] OR SF36[tiab] OR SF-36[tiab] OR SF 36[tiab] OR short form 36[tiab] OR shortform 36[tiab] OR shortform36[tiab] OR 36 item short form[tiab] OR 36-item short form[tiab] OR SF20[tiab] OR SF-20[tiab] OR SF 20[tiab] OR short form 20[tiab] OR shortform 20[tiab] OR shortform20[tiab] OR 20 item short form[tiab] OR 20-item short form[tiab] OR SF12[tiab] OR SF-12[tiab] OR SF 12[tiab] OR short form 12[tiab] OR shortform 12[tiab] OR shortform12[tiab] OR 12 item short form[tiab] OR 12-item short form[tiab] OR SF8[tiab] OR SF-8[tiab] OR SF 8[tiab] OR short form 8[tiab] OR shortform 8[tiab] OR shortform8[tiab] OR 8 item short form[tiab] OR 8-item short form[tiab] OR SF6[tiab] OR SF-6[tiab] OR SF 6[tiab] OR short form 6[tiab] OR shortform 6[tiab] OR shortform6[tiab] OR 6 item short form[tiab] OR 6-item short form[tiab] OR QoL Questionnaire[tw] OR QLQ[tiab] OR health questionnaire[tw] OR Godin leisure time[tw] OR Numeric Pain Scale[tw] OR lateral hopping for distance[tw] OR 6-m crossover hop[tw] OR side hop[tw] OR hopping course[tw] OR square hop[tw] OR cross hop[tw] OR hop test[tw] OR hopping test[tw] OR 40-m walk time[tw] OR 40-m run time[tw] OR figureof-eight run[tw] OR single-limb forward hop[tw] OR single limb forward hop[tw] OR stair hop[tw] OR shuttle run[tw] OR up/down hop[tw] OR hop up[tw] OR hopping up[tw] OR hop down[tw] OR hopping down[tw] OR triple crossover hop[tw] OR single-limb hurdle[tw] OR single limb hurdle[tw] OR single-limb 6-m hop[tw] OR single-limb 30-m hop[tw] OR figureof-eight hop[tw] OR figure of eight hop[tw] OR figure eight hop[tw] OR drop landing[tw] OR vertical jump[tw] OR "Walking Speed"[Mesh] OR "Gait"[Mesh] OR walking speed[tw] OR walking speeds[tw] OR walking gait[tw] OR gait speed[tw] OR gait speeds[tw] OR walking pace[tw] OR walking paces[tw] OR running gait[tw] OR running speed[tw] OR running speeds[tw] OR running pace[tw] OR running paces[tw] OR figure of 8 circumferential measure[tw] OR volumetric measure[tw] OR "Range of Motion, Articular"[Mesh] OR range of motion[tw] OR joint flexibility[tw] OR "Arthrometry, Articular"[Mesh] OR articular arthometry[tw] OR articular goniometry[tw] OR "Supination"[Mesh] OR supination[tw] OR supinations[tw] OR "Pronation"[Mesh] OR pronation[tw] OR pronations[tw] OR tibiopedal dorsiflexion[tw] OR weight-bearing lunge[tw] OR weight bearing lunge[tw] OR algometry[tw] OR "Pain Threshold"[Mesh] OR pain threshold[tw] OR pain thresholds[tw] OR pressurepain threshold[tw] OR pressurepain thresholds[tw] OR cutaneous sensation[tw] OR "Hypesthesia"[Mesh] OR hypesthesia[tw] OR "Hyperesthesia"[Mesh] OR hyperethesia[tw] OR joint position sense[tw] OR "Kinesthesis"[Mesh] OR kinesthesis[tw] OR kinesthesia[tw] OR kinesthesias[tw] OR kinesthetic[tw] OR movement sensation[tw] OR movement sensations[tw] OR isokinetic muscle strength[tw] OR isokinetic test[tw] OR isokinetic tests[tw] OR single-limb balance[tw] OR single limb balance[tw] OR Romberg test[tw] OR balance test[tw] OR balancing test[tw] OR Y balance[tiab] OR Balance Error Scoring System[tw] OR step-down test[tw] OR step down test[tw] OR single leg squat test[tw] OR functional movement screen[tw] OR functional movement screening[tw] OR functional movement screens[tw] OR joint accessory mobility[tw] OR joint play mobility[tw] OR anterior drawer[tw] OR talar tilt inversion[tw] OR talar tilt eversion[tw] OR talar rotation[tw] OR talofibular interval[tw] OR tibiofibular interval[tw] OR distal fibula interval[tw] OR Foot posture Index[tw] OR squeeze test[tiab] OR Cotton test[tiab] OR dorsiflexion maneuver[tw] OR dorsiflexion maneuvers[tw] OR dorsiflexion compression test[tw] OR crossed leg test[tw] OR heel thump test[tw] OR Kleiger dorsiflexion external rotation test[tiab] OR external rotation test[tw] OR Thompson test[tiab] OR function and prognostic score[tw] OR function and prognostic scores[tw] OR ankle function score[tw] OR ankle scoring system[tw] OR de Bie[tiab] OR multisegmented foot[tw] OR ankle-foot complex[tw] OR foot morphology[tw] OR intrinsic foot muscles[tw] OR ankle assessment[tw] OR ankle assessments[tw] OR foot assessment[tw] OR foot assessments[tw] OR feet assessment[tw] OR feet assessments[tw] OR biomechanical assessment[tw] OR biomechanical assessments[tw] OR foot root model[tw] OR ankle root model[tw])	241652

Table continues on page CPG66.

APPENDIX A

Search	Query	Items Found, n
#5	("Risk"[Mesh] OR "Risk Assessment"[Mesh] OR "Risk Factors"[Mesh] OR "Health Risk Behaviors"[Mesh] OR risk[tw] OR risks[tw] OR risk-benefit[tw] OR "Probability"[Mesh] OR probability[tw] OR probabilities[tw] OR likelihood[tw] OR propensity[tw] OR "Logistic Models"[Mesh] OR logistic model[tw] OR logistic models[tw] OR logistic modeling[tw] OR logistic regression[tw] OR logistic regressions[tw] OR "Protective Factors"[Mesh] OR protective factor[tw] OR protective factors[tw] OR "Bayes Theorem"[Mesh] OR Bayes theorem[tw] OR Bayesian[tw] OR "Causality"[Mesh] OR causality[tw] OR causalities[tw] OR causation[tw] OR causations[tw] OR cause[tw] OR causes[tw] OR enabling factor[tw] OR enabling factors[tw] OR reinforcing factor[tw] OR reinforcing factors[tw] OR predisposing factor[tw] OR predisposing factors[tw] OR predisposition[tw] OR "Precipitating Factors"[Mesh] OR precipitating factors[tw] OR precipitating factor[tw] OR predictor[tw] OR predictors[tw] OR odds ratio[tw] OR odds ratios[tw] OR predict[tw] OR prediction[tw] OR predictions[tw] OR predictabilities[tw] OR predictability[tw] OR predicted[tw] OR predictor[tw] OR predictors[tw] OR predictive[tw] OR etiology[tw] OR etiologies[tw] OR etiological[tw] OR etiologic[tw] OR aetiology[tw] OR origin[tw] OR origination[tw] OR originating[tw] OR interact[tw] OR interaction[tw] OR interactions[tw] OR interacting[tw])	8697169
#4	("Incidence"[Mesh] OR incidence[tw] OR incidences[tw] OR "Morbidity"[Mesh] OR morbidity[tw] OR morbidities[tw] OR "Epidemiology"[Mesh] OR epidemiology[tw] OR "epidemiology"[Subheading] OR "Prevalence"[Mesh] OR prevalence[tw] OR prevalent[tw] OR prevalencies[tw])	3328630
#3	("Physical Therapy Modalities"[Mesh] OR physical therapy[tw] OR physical therapies[tw] OR physiotherapy[tw] OR physiotherapies[tw] OR "Recovery of Function"[Mesh] OR recovery[tw] OR restoration[tw] OR reeducation[tw] OR "Rehabilitation"[Mesh] OR "rehabilitation"[Subheading] OR rehabilitation[tw] OR rehab[tw] OR "Early Ambulation"[Mesh] OR early ambulation[tw] OR accelerated ambulation[tw] OR early mobilization[tw] OR therapeutic modality[tw] OR therapeutic modalities[tw] OR "Exercise Therapy"[Mesh] OR exercise therapy[tw] OR therapeutic exercise[tw] OR therapeutic exercises[tw] OR stretching[tw] OR exercise movement[tw] OR strengthen[tw] OR strengthening[tw] OR "Resistance Training"[Mesh] OR resistance training[tw] OR strength training[tw] OR weight-bearing[tw] OR weight-lifting[tw] OR resistance methods[tw] OR training program[tw] OR "Biofeedback, Psychology"[Mesh] OR biofeedback[tw] OR psychophysiologic feedback[tw] OR neuromuscular electrical stimulation[tw] OR neuromuscular reeducation[tw] OR "Pain Management"[Mesh] OR "Pain Measurement"[Mesh] OR pain management[tw] OR pain measurement[tw] OR mobilization[tw] OR mobilizations[tw] OR "Musculoskeletal Manipulations"[Mesh] OR manipulation[tw] OR manipulations[tw] OR ultrasonography[tw] OR ultrasound[tw] OR acupuncture[tw] OR "Patient Education as Topic"[Mesh] OR patient education[tw] OR education of patients[tw] OR iontophoresis[tw] OR "Electric Stimulation"[Mesh] OR "Electric Stimulation Therapy"[Mesh] OR "Transcutaneous Electric Nerve Stimulation"[Mesh] OR electric stimulation[tw] OR nerve stimulation[tw] OR taping[tw] OR tape[tw] OR bracing[tw] OR brace[tw] OR braces[tw] OR orthoses[tw] OR immobilization[tw] OR immobilize[tw] OR orthotic[tw] OR orthotics[tw] OR thermal agent[tw] OR thermal agents[tw] OR diathermy[tw] OR "Range of Motion, Articular"[Mesh] OR range of motion[tw] OR joint flexibility[tw] OR joint movement[tw] OR manual therapy[tw] OR massage[tw] OR massages[tw] OR "Treatment Outcome"[Mesh] OR treatment outcome[tw] OR clinical effectiveness[tw] OR treatment effectiveness[tw] OR treatment efficacy[tw] OR patient outcome[tw] OR patient outcomes[tw])	3226165
#2	("Ankle Injuries"[Mesh] OR "Athletic Injuries"[Mesh] OR "Foot Injuries"[Mesh] OR injuries[tw] OR injury[tw] OR injured[tw] OR "Sprains and Strains"[Mesh] OR sprains[tw] OR sprain[tw] OR sprained[tw] OR strains[tw] OR strain[tw] OR strained[tw] OR swelling[tw] OR swollen[tw] OR swell[tw] OR "Joint Instability"[Mesh] OR instability[tw] OR instabilities[tw] OR unstable[tw] OR joint effusion[tw] oR "Proprioception"[Mesh] OR proprioception deficit[tw] OR proprioception deficits[tw] OR proprioception deficiency[tw] OR proprioception deficiencies[tw] OR "Postural Balance"[Mesh] OR balance[tw] OR unbalanced[tw] OR musculoskeletal equilibrium[tw] OR postural equilibrium[tw] OR hypermobility[tw] OR hypermobilities[tw] OR laxity[tw] OR laxities[tw] OR tear[tw] OR torn[tw] OR external rotation[tw] OR eversion[tw] OR inversion[tw] OR "Injury Severity Score"[Mesh] OR "Abbreviated Injury Scale"[Mesh])	2725758
#1	("Ankle"[Mesh] OR ankle[tw] OR ankles[tw] OR regio tarsalis[tw] OR talus[tw] OR tarsus[tw] OR "Metatarsus"[Mesh] OR metatarsus[tw] OR metatarsal[tw] OR "Ankle Joint"[Mesh] OR "Subtalar Joint"[Mesh] OR subtalar joint[tw] OR talocalcaneal joint[tw] OR talonavicular joint[tw] OR talocrural[tw] OR articulatio talocruralis[tw] OR "Tarsal Joints"[Mesh] OR tarsal joints[tw] OR tarsal joint[tw] OR midtarsal joint[tw] OR midtarsal joints[tw] OR intertarsal joint[tw] OR intertarsal joints[tw] OR intertarsal articulation[tw] OR articulationes intertarseae[tw]OR articulationes intertarsales[tw] OR "Lateral Ligament, Ankle"[Mesh] OR "Ligaments, Articular"[Mesh] OR "Collateral Ligaments"[Mesh] OR ankle lateral ligament[tw] OR ligamentum laterale articulationis talocruralis[tw] OR calcaneofibular[tw] OR tibiofibular[tw] OR tibiotalar[tw] OR tibionavicular[tw] OR tibiocalcaneal[tw] OR talofibular[tw] OR talonavicula[tw] OR calcaneocuboid[tw] OR bifurcate ligament*[tw] OR inferior transverse ligament*[tw] OR deltoid ligament*[tw] OR medial ligament*[tw] OR interosseous ligament*[tw] OR dorsal interossei[tw] OR plantar interossei[tw] OR "Tibial Nerve"[Mesh] OR tibial nerve[tw] OR peroneal nerve[tw] OR peroneus nerve[tw] OR saphenous nerve[tw] OR medial plantar nerve[tw] OR lateral plantar nerve[tw] OR fibular nerve[tw] OR fibularis tertius[tw] OR "Achilles Tendon"[Mesh] OR achilles tendon[tw] OR calcaneal[tw] OR calcaneus[tw] OR interosseous membrane[tw] OR interosseous membranes[tw] OR syndesmosis[tw] OR syndesmoses[tw] OR syndesmotic[tw] OR tibialis anterior[tw] OR fibularis longus[tw] OR fibularis brevis[tw] OR peroneus tertius[tw] OR peroneus longus[tw] OR peroneus brevis[tw] OR flexor hallucis longus[tw] OR flexor digitorum longus[tw] OR extensor digitorum longus[tw] OR tibialis posterior[tw] OR soleus[tw] OR peroneal[tw] OR gastrocnemius[tw] OR abductor halluces[tw] OR adductor halluces[tw] OR flexor hallucis brevis[tw] OR abductor digiti minimi[tw]OR flexor digiti minimi[tw] OR lumbricals[tw] OR quadratus plantae[tw] OR flexor digitorum brevis[tw] OR gluteus medius[tw] OR gluteus maximus[tw] OR gluteal[tw] OR hip abductor[tw] OR hip rotator[tw]) OR ("Foot"[Mesh] OR foot[tw] OR feet[tw] OR articulationes pedis[tw] OR "Foot Joints"[Mesh] OR "Metatarsophalangeal Joint"[Mesh] OR metatarsophalangeal[tw] OR "Heel"[Mesh] OR heel[tw] OR heels[tw] OR sinus tarsi[tw] OR sinus tarsus[tw] OR rearfoot[tw] OR midfoot[tw])	307276

APPENDIX A

Embase Update

Updated Searches From June 26, 2018 to June 1, 2020

Search	Query	Items Found, n
#14	#1 AND #9 AND #12 AND #13 AND [embase]/lim	2702
#13	#3 OR #4 OR #5 OR (#6 AND #7) OR #8	20591088
#12	#10 OR #11	3453379
#11	#2 NOT (fracture NOT ('sprain'/exp OR sprains OR sprain OR sprained OR 'strain'/exp OR strains OR strains OR strain OR strained OR 'swelling'/exp OR swelling OR swollen OR swell OR 'instability'/exp OR instability OR instabilities OR unstable OR 'joint effusion'/exp OR 'joint effusion':ti,ab,de,tn OR 'proprioception deficit':ti,ab,de,tn OR 'proprioception deficits':ti,ab,de,tn OR 'proprioception deficiency':ti,ab,de,tn OR 'proprioception deficiencies':ti,ab,de,tn OR 'balance'/exp OR balance OR unbalanced OR 'musculoskeletal equilibrium'/exp OR 'musculoskeletal equilibrium':ti,ab,de,tn OR 'postural equilibrium'/exp OR 'postural equilibrium':ti,ab,de,tn OR 'hypermobility'/exp OR hypermobility OR hypermobilities OR laxity OR laxities OR 'tear'/exp OR tear OR torn OR 'external rotation'/exp OR 'external rotation':ti,ab,de,tn OR 'eversion'/exp OR 'inversion'/exp OR eversion OR inversion))	3338003
#10	#2 NOT (osteoarthritis NOT ('sprain'/exp OR sprains OR sprain OR sprained OR 'strain'/exp OR strains OR strains OR strain OR strained OR 'swelling'/exp OR swelling OR swollen OR swell OR 'instability'/exp OR instability OR instabilities OR unstable OR 'joint effusion'/exp OR 'joint effusion':ti,ab,de,tn OR 'proprioception deficit':ti,ab,de,tn OR 'proprioception deficits':ti,ab,de,tn OR 'proprioception deficiency':ti,ab,de,tn OR 'proprioception deficiencies':ti,ab,de,tn OR 'balance'/exp OR balance OR unbalanced OR 'musculoskeletal equilibrium'/exp OR 'musculoskeletal equilibrium':ti,ab,de,tn OR 'postural equilibrium'/exp OR 'postural equilibrium':ti,ab,de,tn OR 'hypermobility'/exp OR hypermobility OR hypermobilities OR laxity OR laxities OR 'tear'/exp OR tear OR torn OR 'external rotation'/exp OR 'external rotation':ti,ab,de,tn OR 'eversion'/exp OR 'inversion'/exp OR eversion OR inversion))	3441143
#9	(2018:py OR 2019:py OR 2020:py) NOT ([animals]/lim NOT[humans]/lim) NOT ('book'/it OR 'chapter'/it OR 'conference abstract'/it OR 'conference paper'/it OR 'conference review'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it OR 'press release'/it OR 'short survey'/it) AND[embase]/lim AND[english]/lim	1662347
#8	('diagnosis'/exp OR diagnosis OR diagnose OR diagnoses OR 'diagnostic'/exp OR diagnostic OR 'clinical decision-making'/exp OR 'clinical decision-making':ti,ab,de,tn OR 'clinical decision making'/exp OR 'clinical decision making':ti,ab,de,tn OR 'medical decision-making'/exp OR 'medical decision-making':ti,ab,de,tn OR 'medical decision making'/exp OR 'medical decision making':ti,ab,de,tn OR 'diagnostic imaging'/exp OR 'diagnostic imaging':ti,ab,de,tn OR 'medical imaging'/exp OR 'medical imaging':ti,ab,de,tn OR 'radiography'/exp OR radiography OR 'diagnostic x-ray':ti,ab,de,tn OR 'diagnostic x ray':ti,ab,de,tn OR 'diagnostic x-rays':ti,ab,de,tn OR 'magnetic resonance imaging'/exp OR 'magnetic resonance imaging':ti,ab,de,tn OR 'mri'/exp OR mri:ti,ab OR 'fmri'/exp OR fmri:ti,ab OR 'nmr imaging'/exp OR 'nmr imaging':ti,ab,de,tn OR 'mr tomography':ti,ab,de,tn OR 'ultrasonography'/exp OR ultrasonography OR 'ultrasound'/exp OR ultrasound OR ultrasounds OR 'ultrasonic'/exp OR ultrasonic OR 'electromyography'/exp OR electromyography OR electromyographies OR 'electromyogram'/exp OR electromyogram OR electromyograms OR 'electrophysiologic test':ti,ab,de,tn OR 'electrophysiologic tests':ti,ab,de,tn OR 'electrophysiologic testing':ti,ab,de,tn OR 'neural conduction'/exp OR 'neural conduction':ti,ab,de,tn OR 'neural conductions':ti,ab,de,tn OR 'nerve conduction'/exp OR 'nerve conduction':ti,ab,de,tn OR 'nerve conductions':ti,ab,de,tn OR 'actigraphy'/exp OR actigraphy)	9479270
#7	('sensitivity'/exp OR sensitivity OR 'specificity'/exp OR specificity OR 'evaluation indexes'/exp OR 'evaluation indexes':ti,ab,de,tn OR 'evaluation report'/exp OR 'evaluation report':ti,ab,de,tn OR 'evaluation reports':ti,ab,de,tn OR 'evaluation research'/exp OR 'evaluation research':ti,ab,de,tn OR 'use effectiveness'/exp OR 'use effectiveness':ti,ab,de,tn OR 'prepost tests':ti,ab,de,tn OR 'pre post tests'/exp OR 'pre post tests':ti,ab,de,tn OR 'prepost test':ti,ab,de,tn OR 'qualitative evaluation'/exp OR 'qualitative evaluation':ti,ab,de,tn OR 'qualitative evaluations':ti,ab,de,tn OR 'quantitative evaluation'/exp OR 'quantitative evaluation':ti,ab,de,tn OR 'quantitative evaluations':ti,ab,de,tn OR 'theoretical effectiveness'/exp OR 'theoretical effectiveness':ti,ab,de,tn OR 'critique'/exp OR critique OR critiques OR 'evaluation methodology'/exp OR 'evaluation methodology':ti,ab,de,tn OR 'evaluation methodologies':ti,ab,de,tn OR 'reproducibility'/exp OR reproducibility OR 'validity'/exp OR validity OR 'reliability'/exp OR reliability OR 'data accuracy'/exp OR 'data accuracy':ti,ab,de,tn OR 'data accuracies':ti,ab,de,tn OR 'data quality'/exp OR 'data quality':ti,ab,de,tn OR 'data qualities':ti,ab,de,tn OR 'precision'/exp OR precision OR 'responsiveness'/exp OR responsiveness OR 'consistency'/exp OR consistency OR consistencies OR consistent OR 'log-likelihood ratio':ti,ab,de,tn OR 'likelihood-ratio':ti,ab,de,tn OR 'likelihood ratio'/exp OR 'likelihood ratio':ti,ab,de,tn OR 'research design'/exp OR 'research design':ti,ab,de,tn OR 'research designs':ti,ab,de,tn OR 'research strategy':ti,ab,de,tn OR 'research strategies':ti,ab,de,tn OR 'research techniques':ti,ab,de,tn OR 'research technique':ti,ab,de,tn OR 'research methodology'/exp OR 'research methodology':ti,ab,de,tn OR 'research methodologies':ti,ab,de,tn OR 'experimental design'/exp OR 'experimental design':ti,ab,de,tn OR 'experimental designs')	8617240

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APPENDIX A

Search	Query	Items Found, n
#6	('cumberland ankle instability tool'/exp OR 'cumberland ankle instability tool':ti,ab,de,tn OR 'chronic ankle instability scale':ti,ab,de,tn OR 'ankle joint functional assessment tool':ti,ab,de,tn OR 'foot function index'/exp OR 'foot function index':ti,ab,de,tn OR 'foot and ankle outcome score':ti,ab,de,tn OR 'karlsson ankle function score':ti,ab,de,tn OR 'karlsson score':ti,ab,de,tn OR 'kaikkonen scale':ti,ab,de,tn OR 'kaikkonen score':ti,ab,de,tn OR 'ottawa ankle rules'/exp OR 'ottawa ankle rules':ti,ab,de,tn OR 'buffalo modification':ti,ab,de,tn OR 'foot and ankle ability measure'/exp OR 'foot and ankle ability measure':ti,ab,de,tn OR 'foot ability measure':ti,ab,de,tn OR 'ankle ability measure':ti,ab,de,tn OR 'foot and ankle disability index'/exp OR 'foot and ankle disability index':ti,ab,de,tn OR 'lower extremity function scale'/exp OR 'lower extremity function scale':ti,ab,de,tn OR 'lower extremity functional scale':ti,ab,de,tn OR 'ankle instability scale':ti,ab,de,tn OR 'sports ankle rating system':ti,ab,de,tn OR 'ankle joint function assessment':ti,ab,de,tn OR 'ankle instability index':ti,ab,de,tn OR 'ankle instability instrument':ti,ab,de,tn OR 'identification of functional ankle instability':ti,ab,de,tn OR 'tampa scale of kinesiophobia'/exp OR 'tampa scale of kinesiophobia':ti,ab,de,tn OR 'sway index':ti,ab,de,tn OR 'functional reach test'/exp OR 'functional reach test':ti,ab,de,tn OR 'patient reported outcome measurement information system'/exp OR 'patient reported outcome measurement information system':ti,ab,de,tn OR 'short form health survey':ti,ab,de,tn OR 'short-form health survey':ti,ab,de,tn OR 'Short Form 36'/exp OR 'Short Form 12'/exp OR 'Short Form 20'/exp OR 'Short Form 8'/exp OR 'short form health survey':ti,ab,de,tn OR 'short-form health survey':ti,ab,de,tn OR 'Visual Analogue Scale':ti,ab,de,tn OR 'health utilities index'/exp OR 'health utilities index':ti,ab,de,tn OR HUI:ti,ab OR HUI-III:ti,ab OR HUI-3:ti,ab OR HUI3:ti,ab OR HUI-II:ti,ab OR HUI-2:ti,ab OR HUI2:ti,ab OR HUI-I:ti,ab OR HUI-1:ti,ab OR HUI1:ti,ab OR 'european quality of life 5 dimensions'/exp OR 'European Quality of life 5 Dimensions':ti,ab,de,tn OR EuroQol*:ti,ab OR EQ-5D:ti,ab OR EQ5D*:ti,ab OR EQ 5D:ti,ab OR EORTC:ti,ab OR Rosser:ti,ab OR SF36:ti,ab OR SF-36:ti,ab OR 'SF 36':ti,ab OR 'short form 36':ti,ab OR 'shortform 36':ti,ab OR shortform36:ti,ab OR '36 item short form':ti,ab OR '36-item short form':ti,ab OR SF20:ti,ab OR SF-20:ti,ab OR 'SF 20':ti,ab OR 'short form 20':ti,ab OR 'shortform 20':ti,ab OR shortform20:ti,ab OR '20 item short form':ti,ab OR '20-item short form':ti,ab OR SF12:ti,ab OR SF-12:ti,ab OR 'SF 12':ti,ab OR 'short form 12':ti,ab OR 'shortform 12':ti,ab OR shortform12:ti,ab OR '12 item short form':ti,ab OR '12-item short form':ti,ab OR SF8:ti,ab OR SF-8:ti,ab OR 'SF 8':ti,ab OR 'short form 8':ti,ab OR 'shortform 8':ti,ab OR shortform8:ti,ab OR '8 item short form':ti,ab OR '8-item short form':ti,ab OR SF6:ti,ab OR SF-6:ti,ab OR 'SF 6':ti,ab OR 'short form 6':ti,ab OR 'shortform 6':ti,ab OR shortform6:ti,ab OR '6 item short form':ti,ab OR '6-item short form':ti,ab OR 'QoL Questionnaire':ti,ab,de,tn OR QLQ:ti,ab OR 'health questionnaire':ti,ab,de,tn OR 'godin leisure time':ti,ab,de,tn OR 'numeric pain scale'/exp OR 'numeric pain scale':ti,ab,de,tn OR 'lateral hopping for distance':ti,ab,de,tn OR '6-m crossover hop':ti,ab,de,tn OR 'side hop':ti,ab,de,tn OR 'hopping course':ti,ab,de,tn OR 'square hop':ti,ab,de,tn OR 'cross hop':ti,ab,de,tn OR 'hop test':ti,ab,de,tn OR 'hopping test':ti,ab,de,tn OR '40-m walk time':ti,ab,de,tn OR '40-m run time':ti,ab,de,tn OR 'figureof-eight run':ti,ab,de,tn OR 'single-limb forward hop':ti,ab,de,tn OR 'single limb forward hop':ti,ab,de,tn OR 'stair hop':ti,ab,de,tn OR 'shuttle run':ti,ab,de,tn OR 'up/down hop':ti,ab,de,tn OR 'hop up':ti,ab,de,tn OR 'hopping up':ti,ab,de,tn OR 'hop down':ti,ab,de,tn OR 'hopping down':ti,ab,de,tn OR 'triple crossover hop':ti,ab,de,tn OR 'single-limb hurdle':ti,ab,de,tn OR 'single limb hurdle':ti,ab,de,tn OR 'single-limb 6-m hop':ti,ab,de,tn OR 'single-limb 30-m hop':ti,ab,de,tn OR 'figureof-eight hop':ti,ab,de,tn OR 'figure of eight hop':ti,ab,de,tn OR 'figure eight hop':ti,ab,de,tn OR 'drop landing':ti,ab,de,tn OR 'vertical jump'/exp OR 'vertical jump':ti,ab,de,tn OR 'walking speed'/exp OR 'walking speed':ti,ab,de,tn OR 'walking speeds':ti,ab,de,tn OR 'walking gait':ti,ab,de,tn OR 'gait speed'/exp OR 'gait speed':ti,ab,de,tn OR 'gait speeds':ti,ab,de,tn OR 'walking pace':ti,ab,de,tn OR 'walking paces':ti,ab,de,tn OR 'running gait':ti,ab,de,tn OR 'running speed'/exp OR 'running speed':ti,ab,de,tn OR 'running speeds':ti,ab,de,tn OR 'running pace':ti,ab,de,tn OR 'running paces':ti,ab,de,tn OR 'figure of 8 circumferential measure':ti,ab,de,tn OR 'volumetric measure':ti,ab,de,tn OR 'range of motion'/exp OR 'range of motion':ti,ab,de,tn OR 'joint flexibility'/exp OR 'joint flexibility':ti,ab,de,tn OR 'articular arthometry':ti,ab,de,tn OR 'articular goniometry':ti,ab,de,tn OR 'supination'/exp OR supination OR supinations OR 'pronation'/exp OR pronation OR pronations OR 'tibiopedal dorsiflexion':ti,ab,de,tn OR 'weight-bearing lunge':ti,ab,de,tn OR 'weight bearing lunge':ti,ab,de,tn OR 'algometry'/exp OR algometry OR 'pain threshold'/exp OR 'pain threshold':ti,ab,de,tn OR 'pain thresholds':ti,ab,de,tn OR 'pressurepain threshold'/exp OR 'pressurepain threshold':ti,ab,de,tn OR 'pressurepain thresholds':ti,ab,de,tn OR 'cutaneous sensation'/exp OR 'cutaneous sensation':ti,ab,de,tn OR 'hypesthesia'/exp OR hypesthesia OR hyperethesia OR 'joint position sense'/exp OR 'joint position sense':ti,ab,de,tn OR 'kinesthesis'/exp OR kinesthesis OR 'kinesthesia'/exp OR kinesthesia OR kinesthesias OR kinesthetic OR 'movement sensation':ti,ab,de,tn OR 'movement sensations':ti,ab,de,tn OR 'isokinetic muscle strength':ti,ab,de,tn OR 'isokinetic test':ti,ab,de,tn OR 'isokinetic tests':ti,ab,de,tn OR 'single-limb balance':ti,ab,de,tn OR 'single limb balance':ti,ab,de,tn OR 'romberg test'/exp OR 'romberg test':ti,ab,de,tn OR 'balance test'/exp OR 'balance test':ti,ab,de,tn OR 'balancing test':ti,ab,de,tn OR 'y balance':ti,ab,de,tn OR 'balance error scoring system'/exp OR 'balance error scoring system':ti,ab,de,tn OR 'step-down test':ti,ab,de,tn OR 'step down test'/exp OR 'step down test':ti,ab,de,tn OR 'single leg squat test':ti,ab,de,tn OR 'functional movement screen'/exp OR 'functional movement screen':ti,ab,de,tn OR 'functional movement screening':ti,ab,de,tn OR 'functional movement screens':ti,ab,de,tn OR 'joint accessory mobility':ti,ab,de,tn OR 'joint play mobility':ti,ab,de,tn OR 'anterior drawer':ti,ab,de,tn OR 'talar tilt inversion':ti,ab,de,tn OR 'talar tilt eversion':ti,ab,de,tn OR 'talar rotation':ti,ab,de,tn OR 'talofibular interval':ti,ab,de,tn OR 'tibiofibular interval':ti,ab,de,tn OR 'distal fibula interval':ti,ab,de,tn OR 'foot posture index'/exp OR 'foot posture index':ti,ab,de,tn OR 'squeeze test'/exp OR 'squeeze test':ti,ab,de,tn OR 'cotton test':ti,ab,de,tn OR 'dorsiflexion maneuver':ti,ab,de,tn OR 'dorsiflexion maneuvers':ti,ab,de,tn OR 'dorsiflexion compression test':ti,ab,de,tn OR 'crossed leg test':ti,ab,de,tn OR 'heel thump test':ti,ab,de,tn OR 'kleiger dorsiflexion external rotation test':ti,ab,de,tn OR 'external rotation test':ti,ab,de,tn OR 'thompson test':ti,ab,de,tn OR 'function and prognostic score':ti,ab,de,tn OR 'function and prognostic scores':ti,ab,de,tn OR 'ankle function score':ti,ab,de,tn OR 'ankle scoring system':ti,ab,de,tn OR 'multisegmented foot':ti,ab,de,tn OR 'ankle-foot complex':ti,ab,de,tn OR 'foot morphology':ti,ab,de,tn OR 'intrinsic foot muscles':ti,ab,de,tn OR 'ankle assessment':ti,ab,de,tn OR 'ankle assessments':ti,ab,de,tn OR 'foot assessment':ti,ab,de,tn OR 'foot assessments':ti,ab,de,tn OR 'feet assessment':ti,ab,de,tn OR 'feet assessments':ti,ab,de,tn OR 'biomechanical assessment':ti,ab,de,tn OR 'biomechanical assessments':ti,ab,de,tn OR 'foot root model':ti,ab,de,tn OR 'ankle root model')	258518

Table continues on page CPG69.

APPENDIX A

Search	Query	Items Found, n
#5	('risk'/exp OR risk OR risks OR 'risk benefit':ti,ab,de,tn OR 'probability'/exp OR probability OR probabilities OR likelihood OR propensity OR 'logistic model'/exp OR 'logistic model':ti,ab,de,tn OR 'logistic models':ti,ab,de,tn OR 'logistic modeling':ti,ab,de,tn OR 'logistic regression'/exp OR 'logistic regression':ti,ab,de,tn OR 'logistic regressions':ti,ab,de,tn OR 'protective factor':ti,ab,de,tn OR 'protective factors'/exp OR 'protective factors':ti,ab,de,tn OR 'bayes theorem'/exp OR 'bayes theorem':ti,ab,de,tn OR bayesian OR 'causality'/exp OR causality OR causalities OR causation OR causations OR cause OR causes OR 'enabling factor':ti,ab,de,tn OR 'enabling factors':ti,ab,de,tn OR 'reinforcing factor':ti,ab,de,tn OR 'reinforcing factors':ti,ab,de,tn OR 'predisposing factor'/exp OR 'predisposing factor':ti,ab,de,tn OR 'predisposing factors':ti,ab,de,tn OR 'predisposition'/exp OR predisposition OR 'precipitating factors'/exp OR 'precipitating factors':ti,ab,de,tn OR 'precipitating factor':ti,ab,de,tn OR 'odds ratio'/exp OR 'odds ratio':ti,ab,de,tn OR 'odds ratios':ti,ab,de,tn OR predict OR 'prediction'/exp OR prediction OR predictions OR predictabilities OR 'predictability'/exp OR predictability OR predicted OR predictor OR 'predictors'/exp OR predictors OR predictive OR 'etiology'/de OR etiology OR etiologies OR etiological OR etiologic OR aetiology OR 'origin'/exp OR origin OR origination OR originating OR interact OR interaction OR interactions OR interacting)	13175574
#4	('incidence'/exp OR incidence OR incidences OR morbidity OR morbidities OR 'epidemiology'/exp OR epidemiology OR 'prevalence'/exp OR prevalence OR prevalent OR prevalencies)	5330831
#3	('physical therapy'/exp OR 'physical therapy':ti,ab,de,tn OR 'physical therapies':ti,ab,de,tn OR 'physiotherapy'/exp OR physiotherapy OR physiotherapies OR 'recovery'/exp OR recovery OR restoration OR reeducation OR 'rehabilitation'/exp OR rehabilitation OR rehab OR 'early ambulation'/exp OR 'early ambulation':ti,ab,de,tn OR 'accelerated ambulation':ti,ab,de,tn OR 'early mobilization'/exp OR 'early mobilization':ti,ab,de,tn OR 'exercise therapy'/exp OR 'exercise therapy':ti,ab,de,tn OR 'therapeutic exercise'/exp OR 'therapeutic exercise':ti,ab,de,tn OR 'therapeutic exercises':ti,ab,de,tn OR 'therapeutic modality':ti,ab,de,tn OR 'therapeutic modalities':ti,ab,de,tn OR 'stretching'/exp OR stretching OR 'exercise movement':ti,ab,de,tn OR strengthen OR strengthening OR 'resistance training'/exp OR 'resistance training':ti,ab,de,tn OR 'strength training'/exp OR 'strength training':ti,ab,de,tn OR 'weight bearing'/exp OR weight-bearing OR 'weight lifting'/exp OR weight-lifting OR 'resistance methods':ti,ab,de,tn OR 'training program'/exp OR 'training program':ti,ab,de,tn OR 'biofeedback'/exp OR biofeedback OR 'psychophysiologic feedback':ti,ab,de,tn OR 'neuromuscular electrical stimulation'/exp OR 'neuromuscular electrical stimulation':ti,ab,de,tn OR 'neuromuscular reeducation':ti,ab,de,tn OR 'pain management'/exp OR 'pain management':ti,ab,de,tn OR 'pain measurement'/exp OR 'pain measurement':ti,ab,de,tn OR 'mobilization'/exp OR mobilization OR mobilizations OR 'manipulation'/exp OR manipulation OR manipulations OR 'ultrasonography'/exp OR ultrasonography OR ultrasound OR 'acupuncture'/exp OR acupuncture OR 'patient education'/exp OR 'patient education':ti,ab,de,tn OR 'education of patients':ti,ab,de,tn OR 'iontophoresis'/exp OR iontophoresis OR 'electric stimulation'/exp OR 'electric stimulation':ti,ab,de,tn OR 'nerve stimulation'/exp OR 'nerve stimulation':ti,ab,de,tn OR 'tape'/exp OR taping OR tape OR 'bracing'/exp OR 'brace'/exp OR bracing OR brace OR braces OR orthoses OR 'immobilization'/exp OR immobilization OR immobilize OR 'orthotics'/exp OR orthotic OR orthotics OR 'thermal agent':ti,ab,de,tn OR 'thermal agents':ti,ab,de,tn OR 'diathermy'/exp OR diathermy OR 'range of motion'/exp OR 'range of motion':ti,ab,de,tn OR 'joint flexibility'/exp OR 'joint flexibility':ti,ab,de,tn OR 'joint movement'/exp OR 'joint movement':ti,ab,de,tn OR 'manual therapy'/exp OR 'manual therapy':ti,ab,de,tn OR 'massage'/exp OR massage OR massages OR 'treatment outcome'/exp OR 'treatment outcome':ti,ab,de,tn OR 'clinical effectiveness'/exp OR 'clinical effectiveness':ti,ab,de,tn OR 'treatment effectiveness':ti,ab,de,tn OR 'treatment efficacy':ti,ab,de,tn OR 'patient outcome'/exp OR 'patient outcome':ti,ab,de,tn OR 'patient outcomes')	5266135
#2	('injury'/de OR injuries OR injury OR injured OR 'sprain'/exp OR sprains OR sprain OR sprained OR 'strain'/exp OR strains OR strains OR strain OR strained OR 'swelling'/exp OR swelling OR swollen OR swell OR 'instability'/exp OR instability OR instabilities OR unstable OR 'joint effusion'/exp OR 'joint effusion':ti,ab,de,tn OR 'proprioception deficit':ti,ab,de,tn OR 'proprioception deficits':ti,ab,de,tn OR 'proprioception deficiency':ti,ab,de,tn OR 'proprioception deficiencies':ti,ab,de,tn OR 'balance'/exp OR balance OR unbalanced OR 'musculoskeletal equilibrium'/exp OR 'musculoskeletal equilibrium':ti,ab,de,tn OR 'postural equilibrium'/exp OR 'postural equilibrium':ti,ab,de,tn OR 'hypermobility'/exp OR hypermobility OR hypermobilities OR laxity OR laxities OR 'tear'/exp OR tear OR torn OR 'external rotation'/exp OR 'external rotation':ti,ab,de,tn OR 'eversion'/exp OR 'inversion'/exp OR eversion OR inversion)	3456282

Table continues on page CPG70.

APPENDIX A

Search	Query	Items Found, n
#1	('ankle'/exp OR ankle OR ankles OR 'regio tarsalis':ti,ab,de,tn OR 'tarsus'/exp OR talus OR tarsus OR 'metatarsus'/exp OR metatarsus OR metatarsal OR 'subtalar joint'/exp OR 'subtalar joint':ti,ab,de,tn OR 'talonavicular joint'/exp OR 'talocalcaneal joint'/exp OR 'talocalcaneal joint':ti,ab,de,tn OR talocrural OR 'articulatio talocruralis':ti,ab,de,tn OR 'tarsal joint'/exp OR 'tarsal joints':ti,ab,de,tn OR 'tarsal joint':ti,ab,de,tn OR 'midtarsal joint'/exp OR 'midtarsal joint':ti,ab,de,tn OR 'midtarsal joints':ti,ab,de,tn OR 'intertarsal joint'/exp OR 'intertarsal joint':ti,ab,de,tn OR 'intertarsal joints':ti,ab,de,tn OR 'intertarsal articulation'/exp OR 'intertarsal articulation':ti,ab,de,tn OR 'articulationes intertarseae':ti,ab,de,tn OR 'articulationes intertarsales':ti,ab,de,tn OR 'ligamentum laterale articulationis talocruralis':ti,ab,de,tn OR calcaneofibular OR tibiofibular OR tibiotalar OR tibionavicular OR tibiocalcaneal OR talofibular OR talonavicula OR calcaneocuboid OR 'ankle lateral ligament'/exp OR 'ankle lateral ligament':ti,ab,de,tn OR 'bifurcate ligament*':ti,ab,de,tn OR 'inferior transverse ligament*':ti,ab,de,tn OR 'deltoid ligament*':ti,ab,de,tn OR 'medial ligament*':ti,ab,de,tn OR 'interosseous ligament*':ti,ab,de,tn OR 'peroneus nerve'/exp OR 'tibial nerve'/exp OR 'tibial nerve':ti,ab,de,tn OR 'peroneal nerve':ti,ab,de,tn OR 'peroneus nerve':ti,ab,de,tn OR 'saphenous nerve'/exp OR 'saphenous nerve':ti,ab,de,tn OR 'medial plantar nerve'/exp OR 'medial plantar nerve':ti,ab,de,tn OR 'lateral plantar nerve'/exp OR 'lateral plantar nerve':ti,ab,de,tn OR 'fibular nerve'/exp OR 'fibular nerve':ti,ab,de,tn OR 'fibularis tertius':ti,ab,de,tn OR 'achilles tendon'/exp OR 'achilles tendon':ti,ab,de,tn OR calcaneal OR calcaneus OR 'interosseous membrane'/exp OR 'interosseous membrane':ti,ab,de,tn OR 'interosseous membranes':ti,ab,de,tn OR 'dorsal interossei':ti,ab,de,tn OR 'plantar interossei':ti,ab,de,tn OR syndesmosis OR syndesmoses OR syndesmotic OR 'tibialis anterior':ti,ab,de,tn OR 'fibularis longus':ti,ab,de,tn OR 'fibularis brevis':ti,ab,de,tn OR 'peroneus tertius':ti,ab,de,tn OR 'peroneus longus'/exp OR 'peroneus longus':ti,ab,de,tn OR 'peroneus brevis'/exp OR 'peroneus brevis':ti,ab,de,tn OR 'flexor hallucis longus'/exp OR 'flexor hallucis longus':ti,ab,de,tn OR 'flexor digitorum longus'/exp OR 'flexor digitorum longus':ti,ab,de,tn OR 'extensor digitorum longus':ti,ab,de,tn OR 'tibialis posterior':ti,ab,de,tn OR 'soleus'/exp OR soleus OR peroneal OR 'gastrocnemius'/exp OR gastrocnemius OR 'abductor hallucis'/exp OR 'abductor hallucis':ti,ab,de,tn OR 'adductor hallucis':ti,ab,de,tn OR 'flexor hallucis brevis'/exp OR 'flexor hallucis brevis':ti,ab,de,tn OR 'abductor digiti minimi'/exp OR 'abductor digiti minimi':ti,ab,de,tn OR 'flexor digiti minimi':ti,ab,de,tn OR 'lumbricals':ti,ab,de,tn OR 'quadratus plantae':ti,ab,de,tn OR 'flexor digitorum brevis':ti,ab,de,tn OR 'gluteus muscle'/exp OR 'gluteus medius':ti,ab,de,tn OR 'gluteus maximus':ti,ab,de,tn OR 'gluteal':ti,ab,de,tn OR 'hip abductor':ti,ab,de,tn OR 'hip rotator' OR 'foot'/exp foot OR feet OR 'foot muscle'/exp OR 'flexor digitorum brevis'/exp OR 'flexor digitorum brevis muscle'/exp OR 'plantaris muscle'/exp OR 'plantaris muscle':ti,ab,de,tn OR 'articulationes pedis':ti,ab,de,tn OR metatarsophalangeal OR 'heel'/exp OR heel OR heels OR 'sinus tarsi':ti,ab,de,tn OR 'sinus tarsus':ti,ab,de,tn OR 'rearfoot'/exp OR rearfoot OR 'midfoot'/exp OR midfoot)	133956

CINAHL Update

Updated Searches From June 26, 2018 to June 1, 2020

Search	Query	Items Found, n
#10	#1 AND #2 AND #9 AND [Published Date: 20180601-20201231, Publication Types: Case Study, Clinical Trial, Journal Article, Meta Analysis, Meta Synthesis, Nursing Diagnoses, Nursing Interventions, Practice Acts, Practice Guidelines, Protocol, Questionnaire/Scale, Randomized Controlled Trial, Research, Research Instrument, Review, Standards, Statistics, Systematic Review]	2855
#9	#3 OR #4 OR #5 OR (#6 AND #7) OR #8	3215476
#8	(MH "Diagnosis" OR MH "Diagnosis, Computer Assisted" OR MH "Diagnosis, Delayed" OR MH "Diagnosis, Differential" OR MH "Early Diagnosis" OR MM "Diagnosis, Musculoskeletal" OR MH "Diagnostic Imaging" OR diagnosis OR diagnose OR diagnoses OR diagnostic OR "clinical decision-making" OR "clinical decision making" OR "medical decision-making" OR "medical decision making" OR "diagnostic imaging" OR "medical imaging" OR MH "Magnetic Resonance Imaging" OR MH "Ultrasonography" OR MH "Tomography, X-Ray" OR MH "Radiography" OR radiography OR "diagnostic x-ray" OR "diagnostic x ray" OR "diagnostic x-rays" OR "magnetic resonance imaging" OR MRI OR fMRI OR "NMR imaging" OR "MR tomography" OR ultrasonography OR ultrasound OR ultrasounds OR ultrasonic OR MH "Electromyography" OR electromyography OR electromyographies OR electromyogram OR electromyograms OR "electrophysiologic test" OR "electrophysiologic tests" OR "electrophysiologic testing" OR "neural conduction" OR "neural conductions" OR "nerve conduction" OR "nerve conductions" OR MH "Actigraphy" OR actigraphy OR MH "Physical Therapy Assessment")	1317355
#7	(MH "Sensitivity and Specificity" OR sensitivity OR specificity OR MH "Evaluation Research" OR "evaluation indexes" OR "evaluation report" OR "evaluation reports" OR "evaluation research" OR use-effectiveness OR "use effectiveness" OR "prepost tests" OR "pre post tests" OR "prepost test" OR "qualitative evaluation" OR "qualitative evaluations" OR "quantitative evaluation" OR "quantitative evaluations" OR "theoretical effectiveness" OR critique OR critiques OR "evaluation methodology" OR "evaluation methodologies" OR MH "Reproducibility of Results" OR reproducibility OR MH "Validity+" OR validity OR MH "Reliability" OR reliability OR MH "Reliability and Validity" OR "data accuracy" OR "data accuracies" OR "data quality" OR "data qualities" OR MH "Precision" OR precision OR responsiveness OR consistency OR consistencies OR consistent OR "log-likelihood ratio" OR "likelihood-ratio" OR "likelihood ratio" OR MH "Study Design" OR "research design" OR "research designs" OR "research strategy" OR "research strategies" OR "research techniques" OR "research technique" OR MH "Research Methodology" OR "research methodology" OR "research methodologies" OR "experimental design" OR "experimental designs")	828261

Table continues on page CPG71.

APPENDIX A

Search	Query	Items Found, n
#6	(ZQ "cumberland ankle instability tool" OR ZQ "cumberland ankle instability tool (cait)" OR "Cumberland ankle instability tool" OR ZQ "chronic ankle instability scale (cais)" OR "Chronic Ankle Instability Scale" OR ZQ "sports ankle rating system" OR "Sports Ankle Rating System" OR ZQ "ankle joint functional assessment tool" OR "Ankle Joint Functional Assessment Tool" OR ZQ "foot function index" OR ZQ "foot function index (ffi)" OR "Foot Function Index" OR ZQ "foot and ankle outcome score" OR ZQ "foot and ankle outcome score (faos)" OR ZQ "foot and ankle outcome scores (faos)" OR "Foot and Ankle Outcome Score" OR ZQ "karlsson score" OR "Karlsson Ankle Function Score" OR "Karlsson Score" OR ZQ "kaikkonen scale" OR "Kaikkonen scale" OR "Kaikkonen score" OR ZQ "ottawa ankle rules" OR ZQ "ottawa ankle rules (oar)" OR "Ottawa ankle rules" OR "Buffalo modification" OR ZQ "foot and ankle ability measure (faam)" OR "foot and ankle ability measure" OR "foot ability measure" OR "ankle ability measure" OR ZQ "foot and ankle disability index (fadi)" OR "foot and ankle disability index" OR ZQ "lower extremity functional scale (lefs)" OR "lower extremity functional scale" OR "ankle instability scale" OR "sports ankle rating system" OR ZQ "ankle joint functional assessment tool (ajfat)" OR "ankle joint function assessment" OR ZQ "ankle instability index" OR "ankle instability index" OR ZQ "ankle instability instrument" OR "ankle instability instrument" OR "identification of functional ankle instability" OR ZQ "tampa scale for kinesiophobia (tsk)" OR "Tampa scale of kinesiophobia" OR "sway index" OR ZQ "functional reach test" OR ZQ "functional reach test (frt)" OR "functional reach test" OR ZQ "patient reported outcomes measurement information system (promis)" OR "Patient Reported Outcome Measurement Information System" OR MH "Short Form-36 Health Survey (SF-36)" OR ZQ "short form health survey (sf-36)" OR ZQ "short form health survey" OR "short form health survey" OR "short-form health survey" OR ZQ "visual analogue scale" OR ZQ "visual analogue scale (vas)" OR "Visual Analogue Scale" OR ZQ "health utilities index (hui)" OR "health utilities index" OR "European Quality of life 5 Dimensions" OR EuroQol OR "short form 36" OR "shortform 36" OR shortform36 OR "36 item short form" OR "36-item short form" OR "short form 20" OR "shortform 20" OR shortform20 OR "20 item short form" OR "20-item short form" OR "short form 12" OR "shortform 12" OR shortform12 OR "12 item short form" OR "12-item short form" OR "short form 8" OR "shortform 8" OR shortform8 OR "8 item short form" OR "8-item short form" OR "short form 6" OR "shortform 6" OR shortform6 OR "6 item short form" OR "6-item short form" OR "QoL Questionnaire" OR "health questionnaire" OR ZQ "godin leisure time exercise questionnaire" OR ZQ "godin leisure time exercise questionnaire (glteq)" OR "Godin leisure time" OR ZQ "numeric pain scale" OR "Numeric Pain Scale" OR ZQ "hop test" OR "lateral hopping for distance" OR "6-m crossover hop" OR "side hop" OR "hopping course" OR "square hop" OR "cross hop" OR "hop test" OR "hopping test" OR "40-m walk time" OR "40-m run time" OR "figureof-eight run" OR "single-limb forward hop" OR "single limb forward hop" OR "stair hop" OR "shuttle run" OR "up/down hop" OR "hop up" OR "hopping up" OR "hop down" OR "hopping down" OR "triple crossover hop" OR "single-limb hurdle" OR "single limb hurdle" OR "single-limb 6-m hop" OR "single-limb 30-m hop" OR "figureof-eight hop" OR "figure of eight hop" OR "figure eight hop" OR "drop landing" OR "vertical jump" OR "walking speed" OR "walking speeds" OR "walking gait" OR "gait speed" OR "gait speeds" OR "walking pace" OR "walking paces" OR "running gait" OR "running speed" OR "running speeds" OR "running pace" OR "running paces" OR "figure of 8 circumferential measure" OR "volumetric measure" OR MH "Range of Motion" OR "range of motion" OR "joint flexibility" OR "articular arthometry" OR "articular goniometry" OR MH "Supination" OR supination OR supinations OR MH "Pronation" OR pronation OR pronations OR "tibiopedal dorsiflexion" OR "weight-bearing lunge" OR "weight bearing lunge" OR MH "Algometry" OR algometry OR MH "Pain Threshold" OR "pain threshold" OR "pain thresholds" OR "pressurepain threshold" OR "pressurepain thresholds" OR "cutaneous sensation" OR MH "Hypesthesia" OR hypesthesia OR hyperethesia OR "joint position sense" OR MH "Kinesthesis" OR kinesthesis OR kinesthesia OR kinesthesias OR kinesthetic OR "movement sensation" OR "movement sensations" OR "isokinetic muscle strength" OR "isokinetic test" OR "isokinetic tests" OR "single-limb balance" OR "single limb balance" OR ZQ "romberg test" OR ZQ "romberg's test" OR "Romberg test" OR ZQ "balance test" OR "balance test" OR "balancing test" OR ZQ "y balance test" OR "Y balance" OR ZQ "balance error scoring system (bess)" OR "Balance Error Scoring System" OR ZQ "step-down test"OR "step-down test" OR "step down test" OR "single leg squat test" OR ZQ "functional movement screen" OR ZQ "functional movement screen (fms)" OR "functional movement screen" OR "functional movement screening" OR "functional movement screens" OR "joint accessory mobility" OR "joint play mobility" OR ZQ "anterior drawer test" OR "anterior drawer" OR "talar tilt inversion" OR "talar tilt eversion" OR "talar rotation" OR "talofibular interval" OR "tibiofibular interval" OR "distal fibula interval" OR ZQ "foot posture index" OR ZQ "foot posture index (fpi)"OR "foot posture index" OR "squeeze test" OR "Cotton test" OR "dorsiflexion maneuver" OR "dorsiflexion maneuvers" OR "dorsiflexion compression test" OR "crossed leg test" OR "heel thump test" OR "Kleiger dorsiflexion external rotation test" OR "external rotation test" OR ZQ "thompson test" OR "Thompson test" OR "function and prognostic score" OR "function and prognostic scores" OR ZQ "ankle function score" OR "ankle function score" OR "ankle scoring system" OR "multisegmented foot" OR "ankle-foot complex" OR "foot morphology" OR "intrinsic foot muscles" OR "ankle assessment" OR "ankle assessments" OR "foot assessment" OR "foot assessments" OR "feet assessment" OR "feet assessments" OR "biomechanical assessment" OR "biomechanical assessments" OR "foot root model" OR "ankle root model")	103455
#5	(MH "Risk Assessment" OR MH "Risk Factors" OR risk OR risks OR risk-benefit OR MH "Probability" OR probability OR probabilities OR likelihood OR propensity OR MH "Multiple Logistic Regression" OR "logistic model" OR "logistic models" OR "logistic modeling" OR "logistic regression" OR "logistic regressions" OR "protective factor" OR "protective factors" OR "Bayes theorem" OR Bayesian OR MH "Causal Attribution" OR causality OR causalities OR causation OR causations OR cause OR causes OR "enabling factor" OR "enabling factors" OR "reinforcing factor" OR "reinforcing factors" OR "predisposing factor" OR "predisposing factors" OR predisposition OR "precipitating factors" OR "precipitating factor" OR predictor OR predictors OR MH "Odds Ratio" OR "odds ratio" OR "odds ratios" OR predict OR prediction OR predictions OR predictabilities OR predictability OR predicted OR predictor OR predictors OR predictive OR etiology OR etiologies OR etiological OR etiologic OR aetiology OR origin OR origination OR originating OR MH "Interaction (Research)" OR interact OR interaction OR interactions OR interacting)	2001260
#4	(MH "Incidence OR incidence OR incidences OR MH "Morbidity" OR morbidity OR morbidities OR MH "Epidemiology" OR epidemiology OR MH "Prevalence" OR prevalence OR prevalent OR prevalencies)	258799

Table continues on page CPG72.

APPENDIX A

Search	Query	Items Found, n
#3	(MH "Physical Therapy" " OR "physical therapy" OR "physical therapies" OR physiotherapy OR physiotherapies OR MH "Recovery" OR MH "Recovery, Exercise" OR recovery OR restoration OR reeducation OR MH "Rehabilitation" OR rehabilitation OR rehab OR MH "Early Ambulation" OR "early ambulation" OR "accelerated ambulation" OR "early mobilization" OR MH "Therapeutic Exercise OR "exercise therapy" OR "therapeutic exercise" OR "therapeutic exercises" OR "therapeutic modality" OR "therapeutic modalities" OR stretching OR "exercise movement" OR MH "Gait Training" OR strengthen OR strengthening OR MH "Resistance Training" OR MH "Muscle Strengthening" OR "resistance training" OR "strength training" OR weight-bearing OR weight-lifting OR "resistance methods" OR "training program" OR MH "Biofeedback" OR biofeedback OR "psychophysiologic feedback" OR "neuromuscular electrical stimulation" OR "neuromuscular reeducation" OR MH "Pain Management" OR MH "Pain Measurement" OR "pain management" OR "pain measurement" OR MH "Joint Mobilization" OR mobilization OR mobilizations OR manipulation OR manipulations OR MH "Ultrasonography" OR ultrasonography OR ultrasound OR MH "Acupuncture" OR acupuncture OR MH "Patient Education"OR "patient education" OR "education of patients" OR MH "Iontophoresis" OR iontophoresis OR MH "Electrotherapy" OR "electric stimulation" OR "nerve stimulation" OR MH "Taping and Strapping" OR taping OR tape OR MH "Orthoses" OR orthoses OR bracing OR brace OR braces OR immobilization OR immobilize OR orthotic OR orthotics OR "thermal agent" OR "thermal agents" OR diathermy OR "range of motion" OR "joint flexibility" OR "joint movement" OR MH "Manual Therapy" OR "manual therapy" OR MH "Massage" OR massage OR massages OR MH "Treatment Outcomes" OR "treatment outcome" OR "clinical effectiveness" OR "treatment effectiveness" OR "treatment efficacy"OR MH "Outcomes (Health Care)"OR "patient outcome" OR "patient outcomes")	889646
#2	(MH "Wounds and Injuries" OR MH "Athletic Injuries+" OR MH "Leg Injuries" OR MH "Ligament Injuries" OR MH "Ankle Injuries+" OR MH "Foot Injuries+" OR MH "Tendon Injuries+"OR injuries OR injury OR injured OR MH "Ankle Sprain, Syndesmosis" OR MH "Sprains and Strains+" OR MH "Calf Strain" OR sprains OR sprain OR sprained OR strains OR strain OR strained OR swelling OR swollen OR swell MH "Joint Instability+" OR instability OR instabilities OR unstable OR "joint effusion" OR "proprioception deficit" OR "proprioception deficits" OR "proprioception deficiency" OR "proprioception deficiencies" OR MH "Balance, Postural" OR balance OR unbalanced OR "musculoskeletal equilibrium" OR "postural equilibrium" OR hypermobility OR hypermobilities OR laxity OR laxities OR MH "Tears and Lacerations+" OR tear OR torn OR "external rotation" OR MH "Eversion" OR MH "Inversion" OR eversion OR inversion)	530619
#1	(MH "Ankle"OR ankle OR ankles OR regio tarsalis OR MH "Talus" OR talus OR tarsus OR metatarsus OR metatarsal OR MH "Ankle Joint" OR "subtalar joint" OR "talocalcaneal joint" OR talocrural OR "articulatio talocruralis" OR "tarsal joints" OR "tarsal joint" OR "midtarsal joint" OR "midtarsal joints" OR "intertarsal joint" OR "intertarsal joints" OR "intertarsal articulation" OR "articulationes intertarseae" OR "articulationes intertarsales" OR "ligamentum laterale articulationis talocruralis" OR calcaneofibular OR tibiofibular OR tibiotalar OR tibionavicular OR tibiocalcaneal OR talofibular OR talonavicula OR calcaneocuboid OR MH "Lateral Ligament, Ankle" OR "ankle lateral ligament" OR "bifurcate* ligament*" OR "inferior transverse ligament*" OR "deltoid ligament*" OR "medial ligament*" OR "interosseous ligament*" OR MH "Tibial Nerve" OR "tibial nerve" OR MH "Peroneal Nerve" OR "peroneal nerve" OR "saphenous nerve" OR "medial plantar nerve" OR "lateral plantar nerve" OR "fibular nerve" OR "fibularis tertius" OR MH "Achilles Tendon" OR "achilles tendon" OR calcaneal OR calcaneus OR "interosseous membrane" OR "interosseous membranes" OR "dorsal interossei" OR "plantar interossei" OR syndesmosis OR syndesmoses OR syndesmotic OR "tibialis anterior" OR "fibularis longus" OR "fibularis brevis" OR "peroneus tertius" OR "peroneus longus" OR "peroneus brevis" OR "flexor hallucis longus" OR "flexor digitorum longus" OR "extensor digitorum longus" OR "tibialis posterior" OR MH "Soleus Muscles" OR soleus OR peroneal OR MH "Gastrocnemius Muscle" OR gastrocnemius OR "abductor hallucis" OR "adductor hallucis" OR "flexor hallucis brevis" OR "abductor digiti minimi" OR "flexor digiti minimi" OR "lumbricals" OR "quadratus plantae" OR "flexor digitorum brevis" OR MH "Gluteal Muscles" OR "gluteus medius" OR "gluteus maximus" OR "gluteal" OR "hip abductor" OR "hip rotator") OR (foot OR MH "Foot" OR feet OR "articulationes pedis" OR metatarsophalangeal OR MH "Heel" OR heel OR heels OR "sinus tarsi" OR "sinus tarsus" OR rearfoot OR midfoot)	94360

Cochrane Library Update

Updated Searches From June 26, 2018 to June 1, 2020

Search	Query	Items Found, n
#10	#1 AND #2 AND #9 AND Cochrane Library publication date from Jun 2018 to Dec 2020	2318
#9	#3 OR #4 OR #5 OR (#6 AND #7) OR #8	869066
#8	(diagnosis OR diagnose OR diagnoses OR diagnostic OR "clinical decision-making" OR "clinical decision making" OR "medical decision-making" OR "medical decision making" OR "diagnostic imaging" OR "medical imaging" OR radiography OR "diagnostic x-ray" OR "diagnostic x ray" OR "diagnostic x-rays" OR "magnetic resonance imaging" OR MRI OR fMRI OR "NMR imaging" OR "MR tomography" OR ultrasonography OR ultrasound OR ultrasounds OR ultrasonic OR electromyography OR electromyographies OR electromyogram OR electromyograms OR "electrophysiologic test" OR "electrophysiologic tests" OR "electrophysiologic testing" OR "neural conduction" OR "neural conductions" OR "nerve conduction" OR "nerve conductions" OR actigraphy)	249235
#7	(sensitivity OR specificity OR "evaluation indexes" OR "evaluation report" OR "evaluation reports" OR "evaluation research" OR use-effectiveness OR "use effectiveness" OR "prepost tests" OR "pre post tests" OR "prepost test" OR "qualitative evaluation" OR "qualitative evaluations" OR "quantitative evaluation" OR "quantitative evaluations" OR "theoretical effectiveness" OR critique OR critiques OR "evaluation methodology" OR "evaluation methodologies" OR reproducibility OR validity OR reliability OR "data accuracy" OR "data accuracies" OR "data quality" OR "data qualities" OR precision OR responsiveness OR consistency OR consistencies OR consistent OR "log-likelihood ratio" OR "likelihood-ratio" OR "likelihood ratio" OR "research design" OR "research designs" OR "research strategy" OR "research strategies" OR "research techniques" OR "research technique" OR "research methodology" OR "research methodologies" OR "experimental design" OR "experimental designs")	152431

Table continues on page CPG73.

APPENDIX A

Search	Query	Items Found, n
#6	("Cumberland ankle instability tool" OR "Chronic Ankle Instability Scale" OR "Sports Ankle Rating System" OR "Ankle Joint Functional Assessment Tool" OR "Foot Function Index" OR "Foot and Ankle Outcome Score" OR "Karlsson Ankle Function Score" OR "Karlsson Score" OR "Kaikkonen scale" OR "Kaikkonen score" OR "Ottawa ankle rules" OR "Buffalo modification" OR "foot and ankle ability measure" OR "foot ability measure" OR "ankle ability measure" OR "foot and ankle disability index" OR "lower extremity functional scale" OR "ankle instability scale" OR "sports ankle rating system" OR "ankle joint function assessment" OR "ankle instability index" OR "ankle instability instrument" OR "identification of functional ankle instability" OR "Tampa scale of kinesiophobia" OR "sway index" OR "functional reach test" OR "Patient Reported Outcome Measurement Information System" OR "short form health survey" OR "short-form health survey" OR "Visual Analogue Scale" OR "health utilities index" OR "European Quality of life 5 Dimensions" OR EuroQol OR "short form 36" OR "shortform 36" OR shortform36 OR "36 item short form" OR "36-item short form" OR "short form 20" OR "shortform 20" OR shortform20 OR "20 item short form" OR "20-item short form" OR "short form 12" OR "shortform 12" OR shortform12 OR "12 item short form" OR "12-item short form" OR "short form 8" OR "shortform 8" OR shortform8 OR "8 item short form" OR "8-item short form" OR "short form 6" OR "shortform 6" OR shortform6 OR "6 item short form" OR "6-item short form" OR "QoL Questionnaire" OR "health questionnaire" OR "Godin leisure time" OR "Numeric Pain Scale" OR "lateral hopping for distance" OR "6-m crossover hop" OR "side hop" OR "hopping course" OR "square hop" OR "cross hop" OR "hop test" OR "hopping test" OR "40-m walk time" OR "40-m run time" OR "figureof-eight run" OR "single-limb forward hop" OR "single limb forward hop" OR "stair hop" OR "shuttle run" OR "up down hop" OR "hop up" OR "hopping up" OR "hop down" OR "hopping down" OR "triple crossover hop" OR "single-limb hurdle" OR "single limb hurdle" OR "single-limb 6-m hop" OR "single-limb 30-m hop" OR "figureof-eight hop" OR "figure of eight hop" OR "figure eight hop" OR "drop landing" OR "vertical jump" OR "walking speed" OR "walking speeds" OR "walking gait" OR "gait speed" OR "gait speeds" OR "walking pace" OR "walking paces" OR "running gait" OR "running speed" OR "running speeds" OR "running pace" OR "running paces" OR "figure of 8 circumferential measure" OR "volumetric measure" OR "range of motion" OR "joint flexibility" OR "articular arthometry" OR "articular goniometry" OR supination OR supinations OR pronation OR pronations OR "tibiopedal dorsiflexion" OR "weight-bearing lunge" OR "weight bearing lunge" OR algometry OR "pain threshold" OR "pain thresholds" OR "pressurepain threshold" OR "pressurepain thresholds" OR "cutaneous sensation" OR hypesthesia OR hyperethesia OR "joint position sense" OR kinesthesis OR kinesthesia OR kinesthesias OR kinesthetic OR "movement sensation" OR "movement sensations" OR "isokinetic muscle strength" OR "isokinetic test" OR "isokinetic tests" OR "single-limb balance" OR "single limb balance" OR "Romberg test" OR "balance test" OR "balancing test" OR "Y balance" OR "Balance Error Scoring System" OR "step-down test" OR "step down test" OR "single leg squat test" OR "functional movement screen" OR "functional movement screening" OR "functional movement screens" OR "joint accessory mobility" OR "joint play mobility" OR "anterior drawer" OR "talar tilt inversion" OR "talar tilt eversion" OR "talar rotation" OR "talofibular interval" OR "tibiofibular interval" OR "distal fibula interval" OR "foot posture index" OR "squeeze test" OR "Cotton test" OR "dorsiflexion maneuver" OR "dorsiflexion maneuvers" OR "dorsiflexion compression test" OR "crossed leg test" OR "heel thump test" OR "Kleiger dorsiflexion external rotation test" OR "external rotation test" OR "Thompson test" OR "function and prognostic score" OR "function and prognostic scores" OR "ankle function score" OR "ankle scoring system" OR "multisegmented foot" OR "ankle-foot complex" OR "foot morphology" OR "intrinsic foot muscles" OR "ankle assessment" OR "ankle assessments" OR "foot assessment" OR "foot assessments" OR "feet assessment" OR "feet assessments" OR "biomechanical assessment" OR "biomechanical assessments" OR "foot root model" OR "ankle root model")	78741
#5	(risk OR risks OR risk-benefit OR probability OR probabilities OR likelihood OR propensity OR "logistic model" OR "logistic models" OR "logistic modeling" OR "logistic regression" OR "logistic regressions" OR "protective factor" OR "protective factors" OR "Bayes theorem" OR Bayesian OR causality OR causalities OR causation OR causations OR cause OR causes OR "enabling factor" OR "enabling factors" OR "reinforcing factor" OR "reinforcing factors" OR "predisposing factor" OR "predisposing factors" OR predisposition OR "precipitating factors" OR "precipitating factor" OR predictor OR predictors OR "odds ratio" OR "odds ratios" OR predict OR prediction OR predictions OR predictabilities OR predictability OR predicted OR predictor OR predictors OR predictive OR etiology OR etiologies OR etiological OR etiologic OR aetiology OR origin OR origination OR originating OR interact OR interaction OR interactions OR interacting)	462091
#4	(incidence OR incidences OR morbidity OR morbidities OR epidemiology OR prevalence OR prevalent OR prevalencies)	220299
#3	("physical therapy" OR "physical therapies" OR physiotherapy OR physiotherapies OR recovery OR restoration OR reeducation OR rehabilitation OR rehab OR "early ambulation" OR "accelerated ambulation" OR "early mobilization" OR "exercise therapy" OR "therapeutic exercise" OR "therapeutic exercises" OR "therapeutic modality" OR "therapeutic modalities" OR stretching OR "exercise movement" OR strengthen OR strengthening OR "resistance training" OR "strength training" OR weight-bearing OR weight-lifting OR "resistance methods" OR "training program" OR biofeedback OR "psychophysiologic feedback" OR "neuromuscular electrical stimulation" OR "neuromuscular reeducation" OR "pain management" OR "pain measurement" OR mobilization OR mobilizations OR manipulation OR manipulations OR ultrasonography OR ultrasound OR acupuncture OR "patient education" OR "education of patients" OR iontophoresis OR "electric stimulation" OR "nerve stimulation" OR taping OR tape OR bracing OR brace OR braces OR immobilization OR immobilize OR orthotic OR orthotics OR "thermal agent" OR "thermal agents" OR diathermy OR "range of motion" OR "joint flexibility" OR "joint movement" OR "manual therapy" OR massage OR massages OR "treatment outcome" OR "clinical effectiveness" OR "treatment effectiveness" OR "treatment efficacy" OR "patient outcome" OR "patient outcomes")	402118
#2	(injuries OR injury OR injured OR sprains OR sprain OR sprained OR strains OR strain OR strained OR swelling OR swollen OR swell OR instability OR instabilities OR unstable OR "joint effusion" OR "proprioception deficit" OR "proprioception deficits" OR "proprioception deficiency" OR "proprioception deficiencies" OR balance OR unbalanced OR "musculoskeletal equilibrium" OR "postural equilibrium" OR hypermobility OR hypermobilities OR laxity OR laxities OR tear OR torn OR "external rotation" OR eversion OR inversion)	118796

Table continues on page CPG74.

APPENDIX A

Search	Query	Items Found, n
#1	(ankle OR ankles OR regio tarsalis OR talar OR tarsus OR metatarsus OR metatarsal OR "subtalar joint" OR "talocalcaneal joint" OR talocrural OR "articulatio talocruralis" OR "tarsal joints" OR "tarsal joint" OR "midtarsal joint" OR "midtarsal joints" OR "intertarsal joint" OR "intertarsal joints" OR "intertarsal articulation" OR "articulationes intertarseae" OR "articulationes intertarsales" OR "ligamentum laterale articulationis talocruralis" OR calcaneofibular OR tibiofibular OR tibiotalar OR tibionavicular OR tibiocalcaneal OR talofibular OR talonavicula OR calcaneocuboid OR "bifurcate* ligament*" OR "inferior transverse ligament*" OR "deltoid ligament*" OR "medial ligament*" OR "interosseous ligament*" OR "tibial nerve" OR "peroneal nerve" OR "saphenous nerve" OR "medial plantar nerve" OR "lateral plantar nerve" OR "fibular nerve" OR "fibularis tertius" OR "achilles tendon" OR calcaneal OR calcaneus OR "interosseous membrane" OR "interosseous membranes" OR "dorsal interossei" OR "plantar interossei" OR syndesmosis OR syndesmoses OR syndesmotic OR "tibialis anterior" OR "fibularis longus" OR "fibularis brevis" OR "peroneus tertius" OR "peroneus longus" OR "peroneus brevis" OR "flexor hallucis longus" OR "flexor digitorum longus" OR "extensor digitorum longus" OR "tibialis posterior" OR soleus OR peroneal OR gastrocnemius OR "abductor hallucis" OR "adductor hallucis" OR "flexor hallucis brevis" OR "abductor digiti minimi" OR "flexor digiti minimi" OR "lumbricals" OR "quadratus plantae" OR "flexor digitorum brevis" OR "gluteus medius" OR "gluteus maximus" OR "gluteal" OR "hip abductor" OR "hip rotator") OR (foot OR feet OR "articulationes pedis" OR metatarsophalangeal OR heel OR heels OR "sinus tarsi" OR "sinus tarsus" OR rearfoot OR midfoot)	27650

PEDro Advanced Search Update

Updated Searches From June 26, 2018 to June 1, 2020

Search	Query	Items Found, n
#15	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14	...
#14	Abstract & Title: diagnos* Body Part: Foot OR Ankle Published Since: 2018	34
#13	Abstract & Title: inversion Body Part: Foot OR Ankle Published Since: 2018	15
#12	Abstract & Title: eversion Body Part: Foot OR Ankle Published Since: 2018	13
#11	Abstract & Title: external rotation Body Part: Foot OR Ankle Published Since: 2018	2
#10	Abstract & Title: tear Body Part: Foot OR Ankle Published Since: 2018	2
#9	Abstract & Title: equilibrium Body Part: Foot OR Ankle Published Since: 2018	3
#8	Abstract & Title: balance Body Part: Foot OR Ankle Published Since: 2018	129
#7	Abstract & Title: proprioception Body Part: Foot OR Ankle Published Since: 2018	10
#6	Abstract & Title: swell* Body Part: Foot OR Ankle Published Since: 2018	5
#5	Abstract & Title: injury Body Part: Foot OR Ankle Published Since: 2018	47
#4	Abstract & Title: strain* Body Part: Foot OR Ankle Published Since: 2018	1
#3	Abstract & Title: sprain* Body Part: Foot OR Ankle Published Since: 2018	29

Table continues on page CPG75.

APPENDIX A

Search	Query	Items Found, n
#2	Abstract & Title: unstable Body Part: Foot OR Ankle Published Since: 2018	7
#1	Abstract & Title: instability Body Part: Foot OR Ankle Published Since: 2018	38

APPENDIX B

SEARCH RESULTS

Database/ Platform	Original Date	Original Results, n	2020 Update	2020 Update Results, n
PubMed National Library of Medicine	June 26, 2018	13753	June 1, 2020	4826
Embase Elsevier	June 26, 2018	7327	June 1, 2020	1204
CINAHL EBSCO	June 26, 2018	1616	June 1, 2020	987
Cochrane Library Wiley	June 26, 2018	808	June 1, 2020	1028
PEDro University of Sydney	June 26, 2018	182	June 1, 2020	131

APPENDIX C

ARTICLE INCLUSION AND EXCLUSION CRITERIA

Articles published in English from 2013 to June 1, 2020 in peer-reviewed journals that include studies of the following types: systematic reviews, meta-analyses, experimental and quasi-experimental, cohort, case series (10 or more participants), and cross-sectional studies were included.

Meeting abstracts, press releases, theses, nonsystematic review articles, case reports (fewer than 10 participants), and articles that could not be retrieved in English were excluded.

Inclusion Criteria

We included articles reporting on

- The functional anatomy of the ankle-foot complex (to include the distal tibiofibular, talocrural, subtalar, talonavicular, calcaneocuboid, and tarsometatarsal joints; extrinsic and intrinsic foot muscles) relevant to lateral ankle sprains and chronic ankle instability

OR

- Tests and measures for differential diagnosis of lateral ankle sprains and chronic ankle instability within the scope of physical therapist practice, including but not limited to symptoms, functions, activity and participation such as patient-reported outcome measures and examination techniques of joint structure and function, neurophysiologic and sensorimotor function, balance, gait, psychosocial contributors, and occupation and sports-specific activity

OR

  - Measurement properties of instruments and tests specific to measuring lateral ankle sprains and chronic ankle instability outcomes, including but not limited to symptoms, functions, and activity and participation such as the Identification of Functional Ankle Instability, Cumberland Ankle Instability Tool, and Ankle Instability Instrument

OR

- Measurement properties of instruments that are not specific to lateral ankle sprains and chronic ankle instability but are specific to pain, general health, physical activity, psychosocial function, or lower extremity function, used in the assessment of individuals with lateral ankle sprains and chronic ankle instability. This included but was not limited to the following: the Patient-Reported Outcomes Measurement Information System, Tampa Scale of Kinesiophobia, Lower Extremity Functional Scale, Foot and Ankle Outcome Score, Foot and Ankle Ability Measure activities of daily living subscale, Foot and Ankle Ability Measure sports subscale, Ankle Joint Functional Assessment Tool, Star Excursion Balance Test/Y Balance Test, single-leg squat, step-down test, STAR, lateral hopping, balance, weight-bearing dorsiflexion range of motion, Foot Function Index, and Foot Posture Index

OR

- Primarily adults (13 years old or older)
  - Studies reporting on persons younger than 13 years old when the proportion in the sample was small (less than 5%) or when separate data were available for adults

AND

Lateral ankle sprains and chronic ankle instability, including the following topics:

- Risk of lateral ankle sprains and chronic ankle instability, including but not limited to sex, body mass index, prior injury, and ability to step down following injury
- Diagnostic characteristics of lateral ankle sprains and chronic ankle instability, including but not limited to pain location, duration, and quality, and related body system impairments and activity limitations
- Preventative and rehabilitation interventions within the scope of practice of physical therapists, to include therapeutic electrophysical agents (including but not limited to cryotherapy, diathermy, electrotherapy, low-level laser therapy, ultrasound, and dry needling), manual therapy, orthotic devices and bracing, taping, therapeutic exercise, neuromuscular re-education, and sport-specific training
- Engagement of the multidisciplinary team and referral

We included all outcomes.

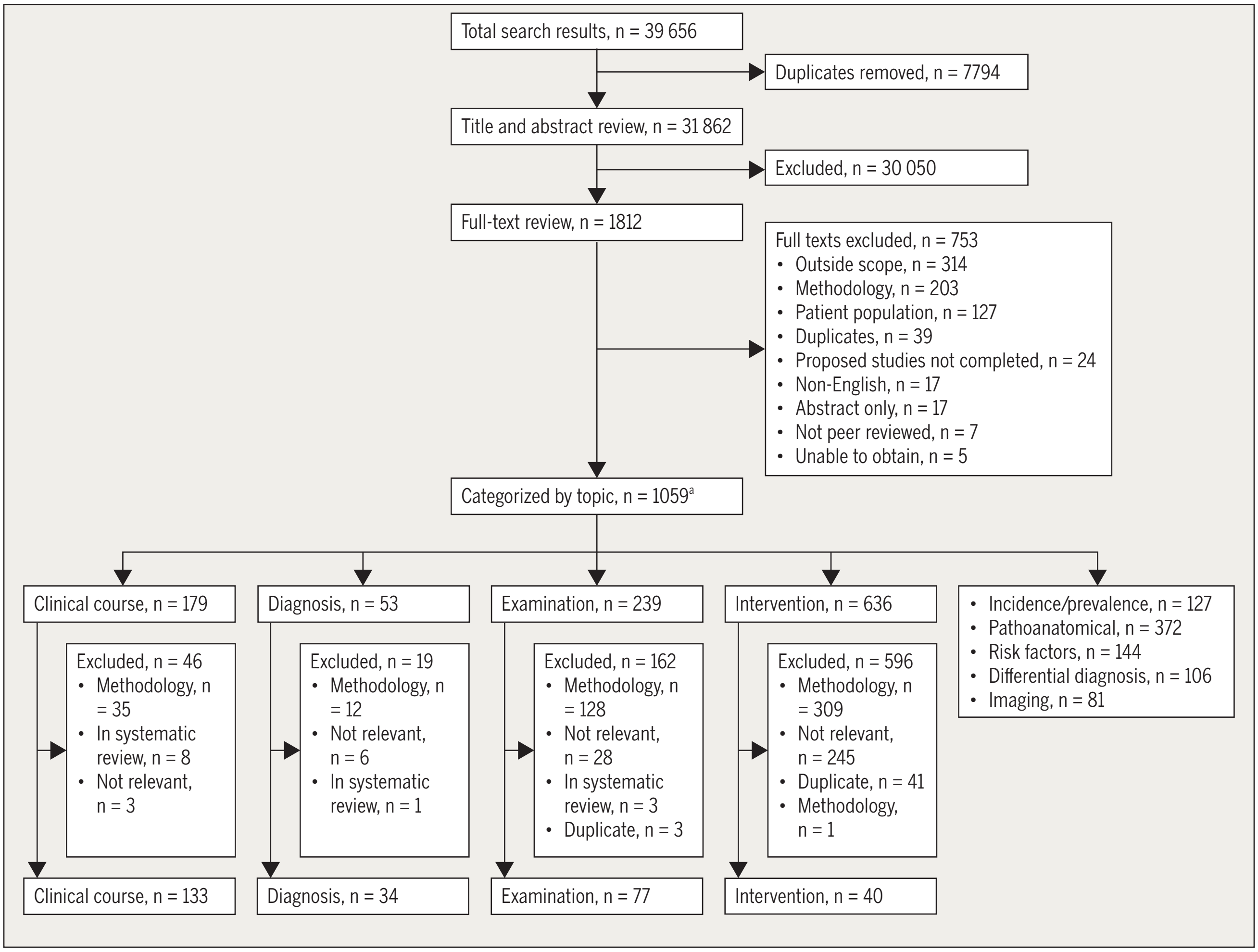
Exclusion Criteria

We excluded articles reporting on

- Animal studies
- Primarily infants and children (younger than 13 years old)
- Symptoms, body system impairments, activity limitations, and participation restrictions related primarily to conditions other than lateral ankle sprains and chronic ankle instability
  - Tumors
  - Metabolic or vascular diseases, such as
    - Gout
    - Diabetes
    - Lupus
    - Rheumatoid arthritis
    - Psoriatic arthritis
  - Posterior heel pain related to calcaneal tendinopathy
  - Medial ankle pain related to posterior tibial tendinopathy
- Topics outside the scope of physical therapist practice
  - Systemic processes (autoimmune, rheumatology)

APPENDIX D

PRISMA FLOW CHART OF ARTICLES (2013-2020)



[a]*Articles could be placed into multiple categories.*

APPENDIX E

LEVELS OF EVIDENCE TABLE[a]

Level	Intervention/Prevention	Pathoanatomic/Risk/Clinical Course/Prognosis/Differential Diagnosis	Diagnosis/Diagnostic Accuracy	Prevalence of Condition/Disorder	Exam/Outcomes
I	Systematic review of high-quality RCTs High-quality RCT[b]	Systematic review of prospective cohort studies High-quality prospective cohort study[c]	Systematic review of high-quality diagnostic studies High-quality diagnostic study[d] with validation	Systematic review, high-quality cross-sectional studies High-quality cross-sectional study[e]	Systematic review of prospective cohort studies High-quality prospective cohort study
II	Systematic review of high-quality cohort studies High-quality cohort study[c] Outcomes study or ecological study Lower-quality RCT[f]	Systematic review of retrospective cohort study Lower-quality prospective cohort study High-quality retrospective cohort study Consecutive cohort Outcomes study or ecological study	Systematic review of exploratory diagnostic studies or consecutive cohort studies High-quality exploratory diagnostic studies Consecutive retrospective cohort	Systematic review of studies that allows relevant estimate Lower-quality cross-sectional study	Systematic review of lower-quality prospective cohort studies Lower-quality prospective cohort study
III	Systematic reviews of case-control studies High-quality case-control study Lower-quality cohort study	Lower-quality retrospective cohort study High-quality cross-sectional study Case-control study	Lower-quality exploratory diagnostic studies Nonconsecutive retrospective cohort	Local nonrandom study	High-quality cross-sectional study
IV	Case series	Case series	Case-control study		Lower-quality cross-sectional study
V	Expert opinion	Expert opinion	Expert opinion	Expert opinion	Expert opinion

Abbreviation: RCT, randomized clinical trial.

[a]*Adapted from the Centre for Evidence-Based Medicine 2009 levels of evidence (https://www.cebm.ox.ac.uk/resources/levels-of-evidence/oxford-centre-for-evidence-based-medicine-levels-of-evidence-march-2009). See also* **APPENDIX F.**

[b]*High quality includes RCTs with greater than 80% follow-up, blinding, and appropriate randomization procedures.*

[c]*High-quality cohort study includes greater than 80% follow-up.*

[d]*High-quality diagnostic study includes consistently applied reference standard and blinding.*

[e]*High-quality prevalence study is a cross-sectional study that uses a local and current random sample or censuses.*

[f]*Weaker diagnostic criteria and reference standards, improper randomization, no blinding, and less than 80% follow-up may add bias and threats to validity.*

APPENDIX F

PROCEDURES FOR ASSIGNING LEVELS OF EVIDENCE

- Level of evidence is assigned based on the study design using the Levels of Evidence table (**APPENDIX E**), assuming high quality (eg, for intervention, randomized clinical trial starts at level I)
- Study quality is assessed using the critical appraisal tool, and the study is assigned 1 of 4 overall quality ratings based on the critical appraisal results
- Level of evidence assignment is adjusted based on the overall quality rating:
  - High quality (high confidence in the estimate/results): study remains at assigned level of evidence (eg, if the randomized clinical trial is rated high quality, its final assignment is level I). High quality should include:
    - Randomized clinical trial with greater than 80% follow-up, blinding, and appropriate randomization procedures
    - Cohort study includes greater than 80% follow-up
    - Diagnostic study includes consistently applied reference standard and blinding
    - Prevalence study is a cross-sectional study that uses a local and current random sample or censuses
  - Acceptable quality (the study does not meet requirements for high quality and weaknesses limit the confidence in the accuracy of the estimate): downgrade 1 level
    - Based on critical appraisal results
  - Low quality: the study has significant limitations that substantially limit confidence in the estimate: downgrade 2 levels
    - Based on critical appraisal results
  - Unacceptable quality: serious limitations—exclude from consideration in the guideline
    - Based on critical appraisal results

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