

REVIEW ARTICLE

 OPEN ACCESS

Received: 06.04.2023

Accepted: 20.06.2023

Published: 28.12.2023

**Citation:** Shiji E, Haridass S. Recent Advances in Exercise Intervention for Athletes with Ankle Injury. J Clin Biomed Sci 2023; 13(4): 102-107. <https://doi.org/10.58739/jcbs/v13i4.23.9>

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**Funding:** None

**Competing Interests:** None

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Published By Sri Devaraj Urs Academy of Higher Education, Kolar, Karnataka

**ISSN**

Print: 2231-4180

Electronic: 2319-2453



# Recent Advances in Exercise Intervention for Athletes with Ankle Injury

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## Abstract

Ankle sprain reported among 16%-40% of all sports-related injuries and most common frequent lower limb injury among athletes. It is particularly prevalent in soccer, American football, and basketball. The most commonly injured ligament is the lateral ligaments especially anterior talofibular ligament and quite a large percentage of patients report persistent symptoms and experience recurrent injuries. To prevent injuries and instability around ankle joint, various interventions evidenced are immobilization, cryotherapy, compression, elevation, analgesics, bracing, foot orthosis, exercises, electrophysical methods, and surgical interventions. Among these therapies physical exercises and splints are highly recommended across levels of rehabilitation. PubMed was used for literature search and articles on randomized control trial, systematic reviews and meta-analysis between 2017 to 2022 were included. Articles on advanced physiotherapy management for ankle injuries were included. Results from reviewing 6 RCT reported progressive exercises training significantly improved flexibility, strength, endurance, agility and balance in the ankle complex. Exercise techniques targeting the ligaments, muscle and structures around ankle joint based on the clinical presentation can lead to improved ankle joint performance in individuals diagnosed with ankle instability.

**Keywords:** Ankle injury; Ankle sprain; Exercise; Instability

## Introduction

Ankle sprain injury can occur both sides of the ankle, when the ankle is twisted or turned in awkward ways either lateral or medial side during any sports activities or ADL<sup>1,2</sup>. Prevalence and incidences of ankle sprain was reported higher in females compared to males (13.6 vs

6.94 per 1000 exposure). Also, higher incidence and prevalence was reported among children ((2.85 per 1000 exposure) than adolescents (1.94 per 1000 exposure), and higher in adolescents (1.94 per 1000 exposure) than adults (0.72 per 1000 exposure)<sup>3</sup>. During sports, the incidence of ankle injury is even higher, accounting for 16%-40% among the

causes of sports related trauma<sup>4</sup>. Almost 85% of ankle sprain occurs at the lateral ankle ligaments in which 65% involves (ATFL) anterior talofibular ligament, 20% involves both ATFL and calcaneofibular ligament (CFL) injury and remaining 15% involves medial ankle sprain<sup>5</sup>.

In ankle sprain one or more ligaments of the ankle are partially or completely torn<sup>6</sup>. Mechanical instability and neuromuscular impairment are the primary cause for chronic ankle instability (CAI)<sup>7</sup>. Lateral ankle sprain commonly occurs in sports involving higher lower limb momentum<sup>8</sup>. Ankle sprains are localized with pain at the site of the injury with clinical presentation of ligament laxity, muscular weakness, impaired joint proprioception, stability, inflammatory reaction, restricted joint movement mainly dorsiflexion at the ankle<sup>9,10</sup>.

The ATFL, CFL and posterior talofibular ligaments (PTFL) provides stability against ankle joint inversion<sup>11,12</sup>. ATFL is commonly injured in the lateral ligament complex with 85% prevalence. While CFL 35% cases and PTFL in 12 % cases during ankle sprain<sup>12,13</sup>. The deltoid ligament complex posterior tibiotalar (PTTL), tibiocalcaneal (TCL), tibionavicular (TNL) and anterior tibiotalar ligaments (ATTL) injured during vigorous pronation and supination of hindfoot. The common causes leading to ankle sprain are a fall with ankle twist, awkward landing on foot while running/jumping/ sports, excessive plantar or dorsi flexion of the foot, wearing improper footwear and use of High heels<sup>14–16</sup>.

The risk of ankle sprain includes history of ankle sprain, sports participation in amateurs, activities on uneven platforms, poor posture, balance and muscle weakness, improper shoes, carrying excessive weight, lack of warm up before the sports participation<sup>4,7</sup>. Clinical features of ankle sprain includes severe pain during standing or weight bearing, swelling, tenderness around the sprained ankle, limited mobility, strength and instability of the ankle joint<sup>4,17</sup>.

Ankle sprains on lateral aspect commonly occur during speedy shift of body's center of mass on weight-bearing foot<sup>13</sup>. Excessive ankle Inversion and plantarflexion on the lateral side, affects ATFL, CFL and PTFL. Due to excessive eversion on the medial aspect of ankle, PTTL, TCL, TNL and ATTL are affected<sup>18,19</sup>. Complication includes recurrent ankle sprain due to lack of ligament resilience, joint instability, peroneal tendon injuries, arthritis, and functional performance deficit<sup>20,21</sup>. Research reported early return to sports before complete recovery or rehabilitation in ankle sprain resulted in poor recovery of ligaments properties. Reviews reported high chances of ankle sprain with excessive plantar flexion. Recurrence of ankle sprain can be limited by supervised rehab protocol, taping, bracing, customized shoes and by reducing the intensity of the activity.

Preventive parameters like proper warm up exercises before sports, cautiousness while walking or running on uneven surfaces, avoiding or minimizing high heeled shoes,

use of an ankle brace on weak or previously injured ankle and practicing or training sport with safety gears can reduce the occurrence of ankle sprain<sup>22,23</sup>.

## Problem Statement

Ankle sprain is a leading sports injury, and common across various age group due to prevailing life style and lack of awareness. In majority of the cases, the ligaments around the ankle expose to partial or complete tear resulting in ankle sprain and later it leads to CAI.

This condition not only affects the ligaments, but also affects the nearby connective tissues like muscle, tendons and its surrounding structures around the ankle joint; and more over leads to increased pain, reduced mobility, strength, balance, ankle instability and lower limb functional declines. Treatment planned based on the severity of ankle sprain. For acute condition initially, the treatment starts with RICE method (rest, icing, compression, elevation), ankle protections, graduated weight bearing and strengthening programs. The treatment for a chronic condition includes immobilization of ankle joint with orthosis and RICE method and further advanced physiotherapy techniques can help to recover the ligament properties.

This review intends to explore the recent advances in physiotherapy techniques reported in literature for the treatment of ankle sprain.

This study aims are to review evidence-based physiotherapy techniques reported in the literature and to analyse its applicability in improving the functional deficits associated in patients diagnosed with ankle sprain. The objective was to conduct synthesis of the available evidence on physiotherapy techniques for ankle ligament injury and to summarize the results of evidence and characteristics of the collected evidence.

## Methodology

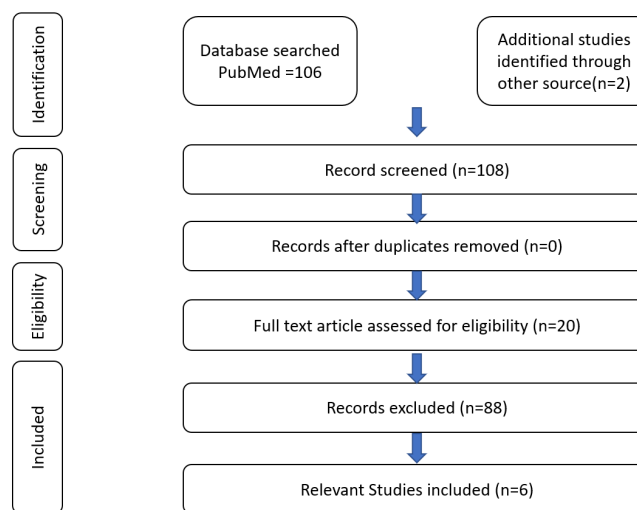
This narrative review included articles from PubMed between 2017 – 2022. Full text articles RCT, systematic reviews, Meta-analysis were included. Key terms used for literature search were Ankle sprain AND physiotherapy, ankle instability, exercises. Abstract and other languages articles were excluded. The quality of the study was analyzed using PEDro quality rating scale. The rating showed that all the studies were in fair and above of which 2 of the included studies were in excellent and one in good category rating (Table 1) .

The literature included for this study from PubMed was critically appraised as follows

1. Rafael sierra-Guzman et al<sup>24</sup> 2018, assessed the effectiveness of 6-weeks whole-body-vibration training technique on balance and body composition in 50 recreational athletes with self-reported chronic

**Table 1. PEDro detail for literature on exercise for ankle sprain**

Sl. No	PEDro Criterion	Sierra- guzman	Cruz- diaz	Huang p-y	Hall EA	Cain MS	Feland JB
1	Eligibility criteria	0	1	1	0	1	0
2	Random allocation	1	1	1	1	1	1
3	Concealed allocation	1	1	1	0	0	0
4	Baseline comparability	1	1	1	1	1	1
5	Blind subjects	0	0	0	0	0	0
6	Blind therapists	0	0	0	0	0	0
7	Blind assessors	0	1	0	0	0	0
8	Adequate follow-up	1	1	1	1	0	0
9	Intension- to- treat analysis	0	0	1	0	0	0
10	Between- group comparisons	1	1	1	1	1	1
11	Point estimates and variability	1	1	1	1	1	1
	TOTAL	6	8	8	5	5	4

**Fig 1.** steps in selection of article

ankle instability. This randomized control clinical trial (RCT), incorporated unilateral balance exercise training on a Excel pro vibration platform and on BOSU balance trainer 3 times per week for six weeks with vibration and non-vibrational platforms. The result was evaluated through star excursion balance test and the Biodex balance system (SEBT). This study found significant improvement in balance parameters with vibration and non-vibration training, however vibration group reported better outcomes with Biodex balancing system.

- David Cruz Diaz et al<sup>25</sup>, 2020, conducted a RCT on the effects of ankle joint self-mobilization over cross fit training in 75 recreational athletes with CIA. Self-mobilization plus cross fit training for one group and

cross fit training-alone for another group for twice per week for a period of 12 weeks was given. Cross fit exercises focused on strength, endurance, agility, functional mobility and ankle joint self-mobilization with a resistance band, kettlebell dorsiflexion, band pull. Weight-bearing lunge test for dorsiflexion ROM, Cumberland ankle instability instrument for perceived rate of activity difficulty, star excursion test for dynamic balance control, subjective sense of instability, and dynamic postural control were measured. The study reported cross fit training and ankle joint self-mobilization were effective in enhancing ankle dorsiflexion ROM, postural control, stability in individuals with chronic ankle instability.

3. Pi-yin Huang et al<sup>26</sup>, 2021 investigated the effect of combined balance and plyometric training on unstable ankle's joint position sense and neuromuscular activity through a RCT. Thirty amateur athletes with functional ankle instability were divided into: controlled, plyometric, and plyometric combined with balance training groups. Exercises included simple squat jump progressed to challenging jump and hops, integrated with balance exercise training and a balanced squat or lunge for 3 times a week for six weeks of exercise intervention thrice a week was given. Pre and post training, the outcome measures on ankle joint position sensation, integrated electromyography, and balance adjustment time during medial single leg drop landing tasks were measured. The study showed increased ankle joint position awareness and plantar flexor muscle activation during single limb drop and landing with plyometric exercises. The medial single limb drop and land time to stability was shortened with the plyometric training. However, both exercises reported to minimize ankle joint position sense error and enhance neuromuscular control.
4. Ben anguish et al<sup>27</sup>, 2018, in a RCT studied the effects of a progressive hop-to stabilization balance program to a single limb balance program on self-reported function, dynamic postural control, and kinesthetic sensation in athletes with CIA. 18 participants divided into 2 groups received progressive hop to stabilization (PHS) balance program and single limb balance (SLB) program for 3 times per week over a 4-week period with approximately 30 minutes session. PHS exercises consisted of single limb hop to stabilization and reach, unanticipated hop to stabilization using a 9-marker grid and single limb stance activities with eyes open and closed and on compromising surface. SLB training consisted of single limb stance for 60 sec with 2 rep, single limb stance with tossing / kicking a ball against resistance in four direction. Five kicks in each direction for 3 times and step down on a 6-inch step. The foot and ankle ability measured activities of daily life subscales were used for the pre and post-test measurements of ankle joint functional. This study reported that athletes with chronic ankle instability benefitted from a 4-week progressive hop-stabilization balance and a single-limb balance exercises, with large to moderate effect sizes. Further progressive hop-to-stabilization balance training and single-limb balance training improved postural control and lower limb functions.
5. Feland JB et al<sup>28</sup>, 2020, in a RCT analyzed effect of full body vibration training with static stretching on ankle dorsiflexion ROM in 39 recreational athletes with CAI. The study reported that static stretching causing musculotendinous influence on the gastrocnemius alone may not be powerful enough to overcome the arthrokinematics restrictions in recurrent ankle instability. The mechanical effects of vibration at the arthrokinematics point of limitation reported improved dorsiflexion mobility in patients with CAI. Hence exercises focusing on improving joint mechanics along with muscle kinetics would be beneficial in patients with CAI.
6. Emily A Hall et al<sup>29</sup>, conducted study in 2018. This RCT assessed the effect of balance-strength-training program on balance, strength and functional performance in CAI. Baseline measurements of eccentric and concentric isokinetic strength of ankle movements, balance errors, Side-hop functional performance and dynamic balance with star excursion test were completed by participants. 50 eligible participants were randomized into control group, balance training and strength training group. One group received progressive balance exercises as per McKeon protocol which focused on challenging balance exercise and strategy development. Exercises were hop to stabilization with reach/box drill, one limb-stance activities with eyes opened and closed. Progressive resistance exercises using band and PNF exercises of Hall protocol targeting ankle joint muscles were given. Control group received static bicycle training with moderate resistance. After Six weeks of intervention, balance exercises and strength training methods showed increased strength, stability, and functional activity performance. Exercises focusing on dynamic stabilization, perturbation, eccentric contractions, Hop-to-stabilization exercises were recommended as part of rehabilitation protocols in CAI.

## Discussion

This review studied the recent advances in physiotherapy management for ankle sprain. The common symptoms of ankle sprain in acute cases include tenderness over the tip of lateral malleolus or medial malleolus, inability to weight bear immediately after the injury<sup>5</sup>. In case of chronic ankle sprain severe pain with ankle joint instability resulting in deficit of functional performance and reduced ankle range of motion are reported<sup>5,15</sup>. The literature reviewed reported that the ankle sprain is common in both men and women aged 17 years to 35 years. We observed that chronic joint instability was commonly reported in amateur and recreational players. Further lack of supervised sport training can lead to structural and functional rearrangements. Physiotherapy interventions reported in quality research targeted training of structures enhancing stability, mobility and functional components involving the ankle complex. To achieve these parameters, cause of clinical symptom with evidence based therapeutic techniques and protocols

through robust research methods are warranted. With these objectives the reviewed literatures reported combination of exercises ranging from stretching, strengthening and balance exercises during the initial setting phase and progressively advancing to plyometric and agility exercises for sports specific training. The summary of evidenced exercises are as follows. The conservative approach of RICE is a standard method used for any soft tissue injury and also in ankle sprain condition. With the reduction of pain, swelling and the inflammation symptoms, the exercise regimen reported in the literature includes multicomponent exercises like static stretching, strengthening and mobilization, balance exercises, and advance exercises like unilateral balance training with vibration, self-mobilization and cross-fit training, whole body vibration and progressive hop-to-stabilization balance program.

Progressive strengthening exercises with self-mobilization improved dorsiflexion & plantarflexion ROM, dynamic postural control and decreased perceived ankle instability. The recommended training protocol was twice/thrice per week for 6-12 weeks, with 3 sets x 10 repetitions.

Unilateral balance training with Static stretching for calf muscles reported ROM improvements, increased blood flow, changes in the viscoelastic characteristics of muscles and better relaxation of sensory afferents. Protocol of 3-5 seconds hold for 10-15 repetition with duration of 3 times per week for a total of 4 week<sup>28</sup>.

Single limb balance exercise including kicking / ball toss, single limb-hop to stabilization with reach 3 times a week for 4 week reported significant improvement in joint position sense, balance and ankle activities of ADL<sup>27</sup>. The physiological changes reported were enhanced muscle spindle activity and excitability of motoneurons, decreased reaction time of the ankle-stabilizing muscles and motor-unit recruitment thresholds<sup>27</sup>.

Cross fit training with a warm up period for 21 repetitions × 3 sets, a training phase including band pull, ankle joint mobilization with a resistance band, and kettlebell dorsiflexion for 10 repetitions with 3 sets twice a week for

a total of 12 weeks reported improved plantar flexion and dorsiflexion followed by cool down period<sup>2</sup>.

Advanced training protocol included Unilateral balance training program on vibration platform like biodex balance system, progressive Unilateral balance training with vibration on BOSU balance trainer incorporating 1-leg stance, crossed-legged sway, runner's pose, catching and throwing a volleyball against the wall reported significant improvement in balance parameters and stability in antero-posterior and medial-lateral index<sup>24</sup>

## Conclusion

6 articles related to the recent advances for improving functional activities of ankle sprain were selected and reviewed. Self-mobilization and cross fit protocol shown to have significant effectiveness in treating ankle sprain, followed by single limb balance and progressive hop-to-stabilization balance program. It can be concluded that based on the clinical presentations, structures involved and severity of structures damaged, client specific evidence-based physiotherapy interventions needs to be planned. Treating the pain and inflammatory response with RICE and protective gears are basic & standard methods of practice. To further enhance movements, strength and endurance of the structures around ankle complex, stretching and strengthening exercises with self-mobilization techniques are reported to have significant functional outcomes. Followed by balance and functional training with unilateral limb balance program with vibration, cross fit training, hop-to-stabilization exercise training supported with good quality RCTs can be implemented in the clinical practice with causation of ethic and geographical variations to prevent ankle injuries and instability in the athletes requiring excellent strength, endurance and flexibility in ankle and related functions. Further good quality RCTs in Indian population might be helpful for the implementation of such protocols in our context. As well as systematic reviews on protocols are indicated for getting gold standard evidence for decision-making.

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