



# The effect of strengthening exercise on the balance of athletes with chronic ankle instability: a literature review

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## ABSTRACT

**Background:** Repetitive ankle sprains can cause chronic ankle instability. More than 40% of athletes experience repeated ankle sprains and tend to be indifferent to these conditions, causing a decrease in ability when exercising or competing due to deficits in lower leg muscle strength, especially ankle propulsion, neuromuscular, proprioceptive, and postural control.

**Objective:** to determine the effect of strength exercise on athletes with chronic instability ankle conditions.

**Method:** the method used is a literature review or reviewing

**Keywords:** balance, chronic instability ankle, strength exercise.

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several articles that have been published.

**Results:** The seven journals discussed show that strength exercise can improve the balance of athletes with chronic stability ankle conditions, and there are also several combinations of using tools such as resistance bands and blood flow restriction cuffs that make strength exercise more effective in improving the balance of athletes with chronic stability ankle conditions.

**Conclusion:** There is an effect of strengthening exercises on the balance of athletes with chronic ankle instability.

## INTRODUCTION

Sports physiotherapy is one of the specialties of the physiotherapist profession. The role of sports physiotherapy, according to the International Federation of Sports Physiotherapy, includes education about good and correct sports activities, making exercise programs using sports principles in injury prevention, conducting examinations, diagnostics, plans, programs, evaluation and modification of physiotherapy in dealing with sports injuries, carrying out emergency injury management measures during the training and match process, and improving athlete performance through Education of specific exercises.

Sports injuries can occur during training sessions or matches. Some sports, such as football, basketball, volleyball, badminton, and tennis, have the highest risk of injury compared to other sports. Football sports have a percentage of 7,2 incidents per 1000 hours. The homotypical injury is an ankle injury, with a percentage of 36,12%.<sup>1</sup> Ankle sprains are the highest percentage of ankle injuries, 75% and 85% of which occur during ankle inversion movements.<sup>2</sup>

Repeated ankle sprains can cause chronic ankle instability. More than 40% of athletes experience recurrent ankle sprains and tend to be indifferent to the condition, causing a decrease in ability when exercising or competing due to deficits in lower leg muscle strength, especially ankle locomotion, neuromuscular disorders, and proprioceptive and

postural control.<sup>3</sup> This occurs due to increased weakness in the ankle caused by damage to muscle and nerve tissue in the ankle when ankle sprains occur repeatedly.<sup>4</sup> Repeated injuries to the ankle sprain four times ures more likely to experience Chronic Ankle Instability (CAI).<sup>5,6</sup> Chronic ankle instability is characterized by patients/athletes who are more than 12 months old being discharged from the initial LAS and display a tendency for recurrent ankle sprains, frequent episodes or perceptions of the ankle dropping, and persistent symptoms such as pain, swelling, limited movement, weakness and self-reported loss of function.<sup>2</sup>

Ankle stability is essential in some sports because the required movement speed is high when handling, kicking, heading, jumping, and making physical contact. Hence, it requires endurance or good ankle balance.<sup>2</sup> One component that maintains ankle stability when experiencing repeated ankle sprains is the peroneus longus muscle and anterior tibial, which are crucial in maintaining ankle stability when walking, running, and landing.<sup>7</sup> Dynamic joint stabilization is achieved by contracting the muscles surrounding the joint. During activities involving the lower limbs, such as running, chopping, and jumping, the athlete relies on muscle contraction, particularly eccentric control, to minimize forces between the ground and the ankle complex.<sup>3</sup>

Physiotherapists play a considerable role in the management of exercises that concern the components of motion and body functions related

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to sports activities, so the role of physiotherapists, more specifically, is to analyze a movement and body function so that it can provide functional therapy and motion exercises. Physiotherapists prepare a special and separate portion of exercise medicine for each person according to their condition. There are two kinds of strengthening exercises, dynamic and static, with outer resistance. Active movement is carried out by the contraction of muscles that control the motor. Clear the mechanism of strengthening exercises during this time will lead to increased vasodilation and blood vessel metabolism, reducing pain and avoiding muscle spasms. Furthermore, muscle contraction will stimulate contractile tissue to generate tension in the muscle to generate force.<sup>8</sup> Also, many exercise methods in physiotherapy management aim to improve ankle stability, such as ankle balance, resistance bands, foot core, and plyometric exercises. One of the strengthening exercise aids is elastic bands. Elastic band is a flexible tool used for various flexible exercises.<sup>8</sup> Plyometric exercises, especially depth jumps, train the strength

of the body's muscles, including the muscles that support ankle stability, namely the soleus and gastrocnemius.<sup>8</sup> Ankle control exercises also help improve walking ability<sup>9</sup> At the ankle, there is proprioceptive, which has an important role in providing information about adjusting the position and movement of the ankle towards the upper limb as a balance control of the body.<sup>9,10,11,12</sup>

Exercises aimed at improving the stability of the ankle, in principle, strengthen the tissues around the ankle. Strengthening exercises can increase the strength of the ankle locomotion muscle and sensory proprioceptive in the ankle.<sup>13</sup> During exercise, the stimuli received by intrafusal and extrafusal fibers enrich sensory input to be sent and processed in the brain to determine how much muscle contraction can be exerted.<sup>14</sup> This provides the ability to maintain the anatomical position of the ankle, increase muscle tone, improve stretch reflexes that can prevent re-injury, and improve ankle stability.

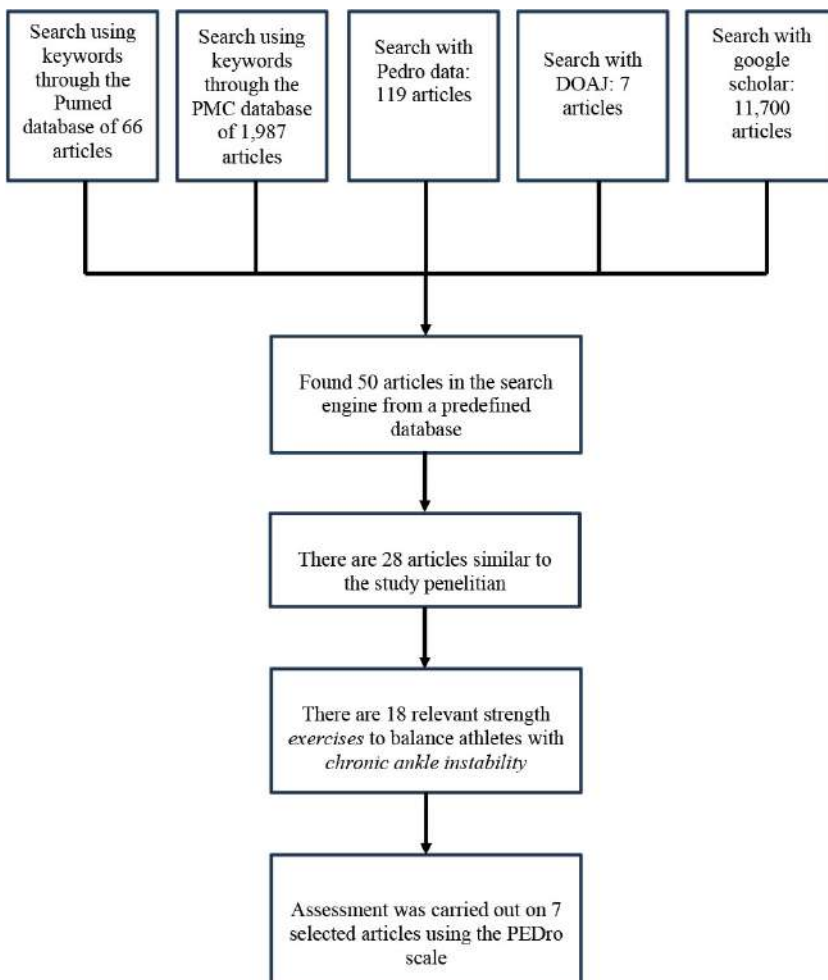
Strengthening exercises in chronic ankle instability conditions, such as quarter heel raising, can improve ankle balance by increasing the strength of the peroneus longus muscle.<sup>13</sup> Ankle strengthening exercises can also be performed using additional *kinesio* taping, which provides an inhibitory and facilitation effect on the ankle.<sup>15</sup>

Balance exercises in chronic ankle instability using bosu and resistance bands can improve ankle balance.<sup>16</sup>

**METHODS**

This study design is a literature review. A literature review is a research conducted by researchers by collecting several books, magazines, and articles related to research problems and objectives. This technique is carried out to reveal various theories relevant to the problem being faced/ researched as reference material in the discussion of research results. Article search strategies can be seen in Figure 1.

The strategy of searching for articles or journals that match the inclusion and exclusion criteria is taken for further analysis. This Literature Review uses literature published in 2013-2022 which can be accessed in full text and scholarly (peer-reviewed journals). The technique used in this appraisal stage is the checklist technique on the PEDro scale. After reviewing the selected articles, PICO standards are checked. The goal is to determine whether the article is worthy of reference in the research. The PEDro scale is a tool used to measure the quality of a given physiotherapy intervention in randomized controlled trials (RCT) studies. There



**Figure 1.** Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram results

**Table 1. Found articles**

Authors (year)	Population
Minoonejad et al. (2019)	28 Student Basketball Athletes with Chronic Ankle Instability
Uzlasir et al., (2021)	Study sample population (n = 13) of athletes.
Cain et al. (2020)	43 High School Athletes with chronic ankle instability
Cruz Diaz (2015)	Study sample population (n = 35) of athletes.
Werasisirat & Yimlamai., (2022)	13 Student-Athletes.
Chang et al., (2021)	The 63 female athletes with chronic ankle instability in the dominant foot were divided into three study groups (all n = 21).
Hall et al.,(2015)	39 Athletes with chronic ankle instability

are 11 points measured in this scale, including 1) El, eligibility criteria; 2) Random allocation; 3) Concealed allocation; 4) Similarity in baseline (baseline comparability); 5) Blind subject; 6) Blind therapist; 7) Blind assessors; 8) At least one primary outcome > 85% adequate follow-up; 9) Intention-to-treat analysis; 10) Statistical comparison between groups (between-group comparison); and 11) Point estimates and variability. All subjects receive treatment according to the allocation of those subjects located.

## RESULTS

The result of this study was to see the effect of strength exercise on the balance of athletes with chronic ankle instability. This study used a literature review research method. This literature review was conducted to determine the effect of strength exercise on the balance of athletes with chronic ankle instability with literature collection techniques.

The articles selected from this literature review research base. Most of them discuss various kinds of strength training used to improve balance with chronic ankle instability conditions where the respondents are athletes, as seen in Table 1. Several journals found the effect of increasing balance in athletes with chronic instability ankle conditions. Strength exercises can maximize the performance of the agonist and antagonist muscles in the ankle if done regularly with standard SOP exercises that are applied. The selected exercise is simple and can be done at home after the athlete has received therapy services. Furthermore, after reviewing the selected articles, the PICO standard was checked. The aim is to determine whether the articles used are worthy of reference in the research.

Table 2 shows the PICO of the seven selected articles. Research conducted by Minoonejad et al. (2019) of 14 control groups given a 6-week Hop program intervention can improve the balance of athletes with chronic ankle instability. Balance

training can also be combined with stroboscopic interventions, research conducted by Uzlasir et al. (2021) obtained the same results, which can improve balance and motor control of athletes with chronic ankle instability, with a control group of 13 respondents. Forty-three high school athletes in North Carolina with the same problem were given Resistance band training and biomechanical ankle exercise 3 times per week for four weeks, which were divided into four groups, namely Resistance band group, Ankle Biomechanical Group, Combination Group, Control Group. Research conducted by Cain et al. (2020) found an improvement for each group, and none was superior to the others. Strength training with seven modified exercises every two weeks significantly improves the balance of athletes conducted by 35 respondents in the control group Cruz Diaz (2015). Werasisirat & Yimlamai (2022), with the addition of a blood flow restriction, must be accompanied by strength training three times a week carried out for four weeks in the control group, obtained more effective results in increasing ankle muscle strength and functional ability of the ankle compared to the group that only received strength training alone. The therapy program carried out in the research of Chang et al. (2021) vibration using AIBI power and a balance ball significantly improves athletes' balance, with 63 respondents divided into these three groups. In 39 athletes studied by Hall et al. (2015) with chronic ankle instability. The group was given resistance band training, and the PNF group, carried out three times a week for six weeks, significantly improved the ankle strength and balance of these athletes.

Table 3 shows the analyzes of seven articles using the PEDro scale. The seven articles reviewed discussed the effect of different types of strength training on ankle drive muscle strength changes in athletes with chronic ankle instability.

## DISCUSSION

Chronic ankle instability is a condition characterized by recurrent ankle sprains. It usually occurs while walking or doing other activities, but can also occur while standing. Many athletes experience chronic ankle instability. Patients with chronic ankle instability often complain of repeatedly spraining their ankles, especially on uneven surfaces or during exercise, persistent discomfort and swelling, pain, and weak or unstable ankles. Appropriate rehabilitation is needed to strengthen the muscles around the ankle and retrain the tissues in the ankle that affect balance as for the interventions discussed in the seven pieces of literature that

**Table 2. PICO Analysis**

Title	Population	Intervention	Comparison	Outcome
Hop Stabilization Training Improves Neuromuscular Control in Collegiate Basketball Players with Chronic Ankle Instability: A Randomized Controlled Trial (2019)	Student Basketball Athletes	Provision of intervention Hop Program 6 weeks	Student Basketball Athletes were given a 14-participant Hop Program and a 14-participant control group.	The Hop Stabilization Training intervention can improve the balance of athletes with chronic ankle instability.
The Effects Of Stroboscopic Balance Training on Cortical Activities in Athletes with Chronic Ankle Instability (2021)	The 39 athletes comprised 12 football athletes, 11 volleyball athletes, six basketball athletes, six handball athletes, and 4 track and field athletes.	Stroboscopic, balance training for six weeks	Balance training group with stroboscopic 13 participants, balance training group without stroboscopic 13 participants, control group 13 participants	Stroboscopic intervention and balance training can improve athletes' balance and motor control with chronic ankle instability.
Four-Week Ankle-Rehabilitation Programs in Adolescent Athletes With Chronic Ankle Instability (2020)	43 High School Athletes with chronic ankle instability in North Carolina	Resistance band exercise, biomechanical ankle exercise 3 times per week for four weeks	Resistance band group, Ankle Biomechanical Group, Combination Group, Control Group	Evaluation using time-in-balance tests, foot-lift tests, Star Excursion Balance Tests (medial, posteromedial, and posterolateral directions), and test hops, there was an improvement for each group, and none was superior to the others
Effects of 6 Weeks of Balance Training on Chronic Ankle Instability in Athletes: A Randomized Controlled Trial (2015)	The 70 athletes in Spain were divided into treatment and control groups.	Seven kinds of Strength exercises modify the type of exercise every two weeks.	The treatment group of 35 participants and the control group of 35 participants	Strength Exercise based on multi-station balance showed significant results in improving the balance of athletes with chronic ankle instability
Effect of supervised Rehabilitation combined with blood flow restriction training in athletes with chronic ankle Instability: a randomized placebo-controlled Trial (2022)	13 Student Athletes with chronic ankle instability	Strength exercise (leg squat, heel raise, double & single leg on bosu) and addition of Blood Flow Restriction Cuff three times a week for four weeks	Strength Exercise Group 8 participants, Strength Exercise + Blood Flow Restriction Cuff Group 8 participants	The program conducted for four weeks showed that strength exercise plus blood flow restriction cuff is more effective than strength exercise in increasing ankle muscle strength and functional ankle ability
Effects of Whole-Body Vibration and Balance Training on Female Athletes with Chronic Ankle Instability (2021)	63 female athletes with chronic ankle instability in the dominant foot, and divided into three groups (each group consists of 21 participants)	The therapy program is carried out three times a week for six weeks, using a Vibration platform such as (AIBI Power Shaper, AIBI Fitness, Singapore), and using a balance ball (BOSU Balance Trainer, Fitness Quest, Ashland, OH, USA)	Vibration Platform Group 21 participants, Balance Ball Group 21 participants, Control Group 21 participants	The Vibration Platform and Balance Ball groups have significant changes to improve the balance of athletes with chronic ankle instability. Both are equally effective for improving the balance of athletes with chronic ankle instability.
Strength-Training Protocols to Improve Deficits in Participants With Chronic Ankle Instability: A Randomized Controlled Trial (2015)	39 athletes with chronic ankle instability, 17 men (44%), 22 women (56%)	Resistance band and Proprioceptive Neuromuscular Facilitation, three times weekly for six weeks	Resistance band Group 13 participants, PNF Group 13 participants, Control Group 13 participants	The resistance band and PNF groups significantly improved the ankle strength and balance of athletes with chronic ankle instability on the Y-Balance Test.

**Table 3. Pedro Analysis**

Title	Hop Stabilization Training Improves Neuromuscular Control in Collegiate Basketball Players with Chronic Ankle Instability: A Randomized Controlled Trial (2019)	The Effects Of Stroboscopic Balance Training on Cortical Activities in Athletes with Chronic Ankle Instability (2021)	Four-Week Ankle-Rehabilitation Programs in Adolescent Athletes With Chronic Ankle Instability (2020)	Effects of 6 Weeks of Balance Training on Chronic Ankle Instability in Athletes: A Randomized Controlled Trial	Effect of supervised Rehabilitation combined with blood flow restriction training in athletes with chronic ankle instability: a randomized placebo-controlled Trial (2022)	Effects of Whole-Body Vibration and Balance Training on Female Athletes with Chronic Ankle Instability (2021)	Strength-Training Protocols to Improve Deficits in Participants With Chronic Ankle Instability: A Randomized Controlled Trial (2015)
Eligibility Criteria	X	X	✓	X	✓	✓	✓
Random Allocation	✓	✓	✓	✓	✓	✓	✓
Concealed Allocation	✓	✓	✓	✓	X	X	X
Baseline Comparability	✓	✓	✓	✓	✓	✓	✓
Blind Subjects	X	X	X	X	X	X	X
Blind Therapists	X	X	X	X	X	X	X
Blind Assessors	✓	X	✓	✓	X	X	X
Adequate Followup	✓	✓	✓	✓	✓	✓	✓
Intention n-to treat Analysis.	✓	✓	X	X	X	X	✓
Between Group Comparison	✓	✓	✓	✓	✓	✓	✓
Point Estimates and Variability	✓	✓	✓	✓	✓	✓	✓
Score	8/10	7/10	7/10	7/10	5/10	5/10	6/10

have been presented, namely the hop exercise program, which has six types of hopping exercise movements: square shape hops, zigzag pattern hops, forward and backward hops, and side-to-side hops. The stroboscopic muscle strength training program gives six balance exercises: single leg hop to stabilization, hop to stabilization and reach unanticipated jump to stabilization, and single leg balance with eyes open and closed. For activities on the vibration platform and balance ball, double leg stance, one leg stance, and tandem stance are given. For practices using resistance bands, use resistance heavy (light blue), super heavy (dark blue), and ultra heavy (purple).

Of the seven articles reviewed, many studies are conducted in other countries, especially on the problem of strength exercise to improve the balance of athletes with chronic ankle instability. There is an intervention in the selected article, namely strength exercise. Strength exercise has many variations to increase the strength of the ankle drive muscle, which is responsible for maintaining ankle balance. The key to the balance and strength of athletes to perform sports and competition activities such as football, basketball, volleyball, martial arts, and other sports require muscular ankle muscle strength.

The next stage that will be carried out is the article analysis stage using PEDro. The goal was to see the quality of articles with a randomized control trial (RCT) study design. The results of the PEDro scale can make it easier for researchers to quickly assess whether the articles used have a high or low risk of bias, which can affect the research results. There are 11 points on the PEDro scale: 1) Eligibility criteria; 2) Random allocation; 3) Concealed allocation; 4) Similarity in baseline (baseline comparability); 5) Blind subject; 6) Blind therapist; 7) Blind assessors; 8) At least one primary outcome > 85% adequate follow-up; 9) Intention-to-treat analysis; 10) Statistical comparison between groups (between-group comparison); and 11) Point estimates and variability. If the point is listed in the article, it is given a value of 1; if it is not, it is given a value of 0. Eligibility criteria are not counted on the total score, so the overall score is ten from the sum. One of the articles studied discusses the effect of the Hop Training program on the strength of the peroneus longus muscle and anterior tibial muscle by intervening three times a week for six weeks. The article explained that 14 respondents of alter basketball students in the experimental group showed neuromuscular activation through the sensitivity of the muscle spindle and Golgi tendon organs that can increase ankle muscle tension and strength due to repeated displacement

of concentric and eccentric contractions to increase ankle stability.<sup>17</sup>

The effect of strength exercise can be seen not only in the success rate through how much intervention is given to the patient but also see the patient's condition to do an exercise to support the success of an intervention. Most patients have the power to contract and can move parts of the body fully against gravity.<sup>13</sup> The difference in the effect of strength exercise compared to stroboscopic, it turns out that there is no significant difference between strength exercise and stroboscopic on the effect of improving ankle balance through activation and deactivation of cortical nerve.<sup>18</sup>

Seven journals selected for review as a literature review in this study discuss strength exercises that can not only affect changes in the anterior peroneus longus and tibialis muscles as ankle stabilizers. Strength training can affect balance in athletes with chronic ankle instability. This suggests that strength exercise interventions can affect muscle strength and balance changes in athletes with chronic ankle instability.<sup>19</sup> Therefore, with systematic and standard procedures, strength exercises can train the peroneus longus muscle, anterior tibial, and ankle proprioception in athletes with chronic ankle instability conditions.

Seven articles reviewed discuss strength exercises that can be a single exercise to increase the strength of the peroneus longus and anterior tibial muscles in athletes with chronic ankle instability. The results showed a significant influence between strength exercise on changes, especially in the peroneus longus muscle and the anterior tibialis. This exercise is given periodically by measuring using pretest and post-test activities to determine the effect of giving strength exercises.<sup>20</sup> Strength exercises can also be used as the primary exercise modality to accompany the exercise to maximize the exercise of strengthening the peroneus longus and anterior tibial muscles.<sup>21</sup> Balance assessment is also carried out using measuring instruments with high validity such as SEBT, hop test, Y-Balance Test, HUBER balance device, joint position sense test, and Electromyography (EMG).<sup>22,23</sup> Strength exercise is an essential consideration during ankle rehabilitation.<sup>24</sup> In this article, strength training is more effective at increasing changes in athletes with chronic ankle instability by adding interventions or tools such as resistance bands, blood flow restriction cuff cuffs, and strength exercises using stroboscopic.<sup>18,20</sup> based on the biopsychosocial model, the concepts of self-organization and perceptual-action cycles derived from dynamic systems theory and patient-specific neural signatures, are used to illustrate this linkage.<sup>24</sup>

Up to 85% of all injuries respond to conservative treatment like strength exercise; however, up to 20% will continue to be unstable, which is a severe grade of CAI, prompting surgical intervention.<sup>26</sup>

This study still has some limitations, but it is hoped that improvements can be made in future research. The limitation of this study is the difficulty of finding research articles conducted in Indonesia. Many articles are still being researched in other countries so that the population can remain the same. In addition, researchers need help finding articles discussing strength exercises to increase the strength of the peroneus longus muscle and anterior tibial. Some articles discuss the effect of strength exercise on parts of the peroneus longus and anterior tibial muscles in detail.

## CONCLUSION

Based on the results of the analysis of seven articles that have been selected show that strength exercise can be an effective exercise to improve the balance of athletes with chronic ankle instability conditions. Strength exercises can be used as a single exercise intervention or companion exercise. The condition of athletes who are suitable for strength exercise intervention is the condition of athletes who have the strength to contract and can move body parts fully against gravity. One of the factors that can support the success of strength exercise is to increase the strength of the peroneus longus muscle, anterior tibial, and activation of the neuromuscular system in the ankle is carried out periodically with the correct SOP.

## ETHICAL CLEARANCE

The author states no potential conflict of interest concerning this article's research, authorship, or publication.

## CONFLICT OF INTEREST

This study has no conflicts of interest.

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## AUTHOR CONTRIBUTIONS

NGA conceived the study design and data collection and drafted the manuscript; WW collected and revised the data.

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