

# Impact of isometric exercise on pain management in acute and chronic sports injuries: A systematic review

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## Impact of isometric exercise on pain management in acute and chronic sports injuries: A systematic review

*Dampak latihan isometrik terhadap manajemen nyeri pada cedera olahraga akut dan kronis: Tinjauan sistematis*

Original Article/Review Article

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**Abstract.****Background**

Isometric exercises have become one of the most widely used exercise intervention methods in the rehabilitation process of sports injuries, particularly in pain management. The use of isometric exercises is growing due to their ability to provide analgesic effects while maintaining muscle strength during the injury recovery phase.

**Objectives**

This systematic review aims to analyze the effect, mechanism of action and effectiveness of isometric exercises in managing pain in acute and chronic sports injuries based on the latest scientific findings.

**Methods**

This study was organized based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, with article searches through the Scopus, ScienceDirect, Web of Science (WOS), and PubMed databases. A total of 8 articles were selected based on the inclusion criteria focusing on the use of isometric exercises in sports injury pain management.

**Results**

The results of the review showed that isometric exercises are able to provide short-term analgesic effects through the mechanisms of central pain modulation, increased pain threshold, and inhibition of nociceptive input. In addition, isometric exercises also play a role in maintaining muscle strength, preventing atrophy, and supporting the rehabilitation process without overloading the injured tissues. However, the effectiveness of isometric exercises is highly dependent on the dose, frequency, duration, injury site and individual response. Strong evidence supports its effectiveness in cases of tendinopathy, whereas in acute injuries such as muscle strains or ankle sprain it still requires further research.

**Conclusion**

This review confirms that isometric exercises have an important role in pain management and rehabilitation of sports injuries, especially in the early phase of recovery. Expectations for future research are the need for studies with more robust experimental designs, involving a more diverse population of athletes, measurement of more specific pain biomarker parameters, as well as long-term exploration of the effects of isometric exercise on the prevention of recurrent injuries and return to optimal sports performance.

**Keywords:** isometric exercise, pain management, acute, chronic.

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### INTRODUCTION

Isometric exercise has become an important topic that is increasingly researched globally in the context of pain management from sports injuries, both acute and chronic [1],[2]. It is seen as an effective non-pharmacological approach as it stimulates neuromuscular adaptation without aggravating the load of the damaged tissue [3]. In clinical practice, it is used as an early intervention strategy to help athletes control pain and maintain muscle strength despite injury [4]. In fact, isometric exercises are starting to become part of evidence-based rehabilitation protocols for various types of tendinopathies such as patellar and Achilles tendinopathies [3],[5].

The application of isometric exercises is considered important because it provides a number of physiological benefits for athletes who are injured. These exercises have been shown to reduce pain perception by central nervous system-based pain inhibition mechanisms [6], as well as maintaining muscle contraction function during the immobilization phase [7]. This analgesic effect also has the potential to facilitate the transition to more progressive weight training without causing flare-ups or aggravating tissue conditions [8]. In addition, recent studies have shown that isometric loading can reduce pain in individuals with chronic tendinopathy [9], which makes it an important option in the rehabilitation process.

Isometric exercises have also received attention in the context of rehabilitation of chronic or repetitive sports injuries. Some literature reveals that this exercise provides positive effects in restoring muscle strength and reducing recovery time in cases of injuries such as hamstring strain and shoulder impingement [3],[10]. In addition to the physical benefits, isometric training also provides psychological benefits because it can foster athletes' confidence to return to their activities gradually [11]. This shows that this exercise is not only localized to the injured tissue, but also contributes to the overall recovery of function [12].

Nevertheless, the implementation of isometric exercises in rehabilitation programs still faces a number of challenges. One of them is that there is no strong consensus regarding the optimal duration, intensity, and frequency of exercise to obtain the maximum analgesic effect [13],[8]. On the other hand, most of the protocols in use today are still based on studies that are limited to certain populations of athletes, such as football players or runners, so they cannot necessarily be generalized to all types of sports [5]. Differences in research methodology have also resulted in variations in results regarding the effectiveness of isometric training in managing pain [10]. This indicates the need for a systematic review that summarizes existing findings to provide a more comprehensive and contextualized picture.

This systematic review aims to review the scientific literature on the effect of isometric exercise on pain management in acute and chronic sports injuries. While some previous studies have shown the positive potential of this exercise, no comprehensive systematic review has thoroughly reviewed the evidence over a more recent time frame. Furthermore, the increasing interest in non-invasive exercise-based interventions in athlete rehabilitation makes this review relevant and important. As such, it is hoped that this review will provide evidence-based recommendations for exercise physiotherapy practice as well as inform the development of more standardized exercise protocols.

## METHOD

### Research Design.

This study used a systematic literature review approach based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The analytical framework in this study adopted the PICO (Population, Intervention, Comparison, Outcome) method commonly used in health and rehabilitation research. This strategy aimed to explore the scientific literature relevant to isometric exercise interventions in the management of pain from sports injuries, both acute and chronic. This study focused on articles that addressed the effects of isometric exercise on pain perception, clinical pain reduction, and the role of isometric exercise in sports injury rehabilitation programs.

### Search and Selection Strategy.

As shown in Figure 1 (PRISMA Diagram), the data sources used in this study included electronic databases such as Scopus, PubMed, ScienceDirect, and Web of Science (WOS). The keywords used in the search process included: "isometric exercise", "pain management", "sports injury", "acute injury", and "chronic injury". The use of Boolean operators such as AND and OR were applied to expand or narrow the article search.

The search process was conducted on articles published between 2018 and 2023, ensuring that the data analyzed was current. All articles obtained were exported and organized using Mendeley reference management software. The screening process was conducted in stages, starting with title and abstract selection, followed by full-text review of articles that met the initial criteria.

### Inclusion and Exclusion Criteria.

Articles included in this study had to meet the following inclusion criteria: (1) Articles were peer-reviewed scientific publications in journal form, (2) Articles were available in full-text, (3) Articles were in English, (4) Articles addressed isometric exercise interventions in the context of pain management due to sports injuries, (5) Articles were published between 2018 and 2023. Meanwhile, articles that were excluded from this study were characterized as follows: (1) Available only in abstract form, (2) Not relevant to the topic of sports injuries and isometric exercise, (3) Not available in open access or not fully accessible, (4) Studies are not Original Articles

Articles that passed all selection stages and met the inclusion criteria were used in this final systematic analysis. A PRISMA flowchart describing the article selection process is presented in Figure 1.

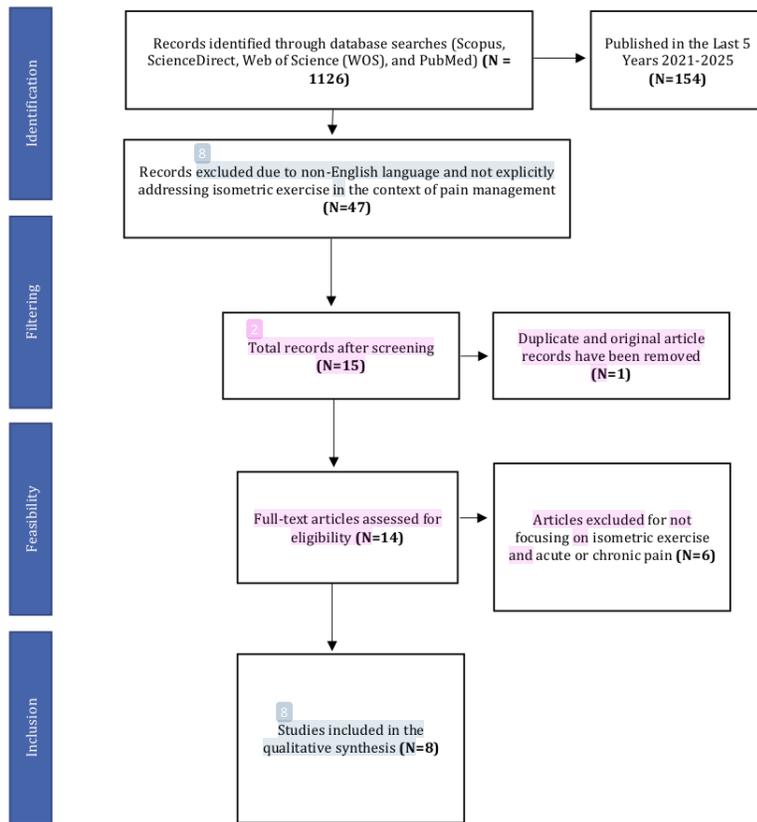


Figure 1. PRISMA Research Flowchart

## RESULTS AND DISCUSSION

### Results

Table 1 presents a summary of the methodological aspects of the analyzed studies, published between 2021 and 2025. The review showed that isometric exercises are consistently reported to have a positive effect in reducing pain intensity in both acute and chronic sports injuries. Some studies also indicate that it can increase pain tolerance and improve muscle and joint function in the injured area.

Isometric exercises are known to stimulate neuromuscular pathways that play a role in pain inhibition through a central descending inhibition mechanism. This is particularly evident in studies on conditions such as patellar tendinopathy, Achilles tendinopathy and shoulder injuries. In addition, several studies have shown that short duration isometric interventions (approximately 45 seconds, 5 sets) can significantly reduce pain in less than 1 week [13],[3].

The article identification process is shown in Figure 1 (PRISMA Diagram). A total of 1,126 articles were identified through the Scopus, PubMed, Web of Science, and ScienceDirect database searches. After an initial screening process based on title and abstract, 47 articles were screened for full-text review.

Subsequently, 8 articles met the inclusion criteria and were included in the further review. The following is a summary of articles relevant to this study.

**Table 1. Summary of the Effect of Isometric Exercise on Acute and Chronic Pain**

Author	Characteristics of the sample	Method	Conclusion
(Rich, Cook, Hahne, Rio, Ford, 2021)	20 participants with proximal hamstring tendinopathy (PHT), recruited from local communities and sports clubs.	Randomized controlled trial (RCT) with cross-over design. Each participant underwent 1 isotonic and 1 isometric hamstring training session, with strength and pain measurements before, immediately after, 45 minutes after, and 24 hours after the intervention.	This study is a protocol study that aims to compare the effectiveness of isometric and isotonic exercises on pain and strength in PHT. The final results of this study provide evidence of the benefits of isometric exercise for pain management and strength improvement in PHT.
(Bradford, Rio, Murphy, Wells, Khondoker, Clarke, Chan, Chester, 2021)	11 participants with mid-portion Achilles tendinopathy, recruited from NHS community physiotherapy services and local running clubs.	Randomized cross-over pilot study. Participants performed isometric calf muscle (plantarflexion) exercises in two positions: knee full extension and 80° flexion. Pain measurements were taken before and after exercise using the Numeric Pain Rating Scale (NPRS).	Isometric plantarflexion exercise provides an immediate pain reduction of approximately 50% during a functional load test in Achilles tendinopathy. There was no significant difference between the knee extension and flexion positions, but both were effective and well tolerated.
(Kangeswari, Murali, Arulappan, 2021)	200 patients with Knee Osteoarthritis (ROA) Grade I, II, and III (100 intervention group, 100 control group) in two hospitals in India.	Quasi-experimental pretest-posttest control group design. The intervention group underwent an isometric exercise program and counseling for 12 weeks, with pain assessment using the WOMAC questionnaire on days 15, 30, 60, and 90.	Isometric exercise and counseling for 12 weeks significantly decreased pain, reduced stiffness, and improved physical function in KOA patients compared to the control group.
(Toyoshima, Akagi, & Nabeshima, 2021)	82 patients with acute lateral ankle sprain, divided into intervention group (given isometric exercise + EMS during immobilization) and control group (only immobilization with short-leg cast).	Experimental study. Measuring the relationship between ankle ROM at cast removal and return to play (RTP) time. Comparison of total ROM and RTP time between intervention and control groups.	Isometric exercise and EMS during immobilization significantly increased ROM and reduced ankle pain and accelerated return-to-play time (RTP) compared to the control group.
(Sadeghi, Rostami, Ameri, Moghaddam, Moghaddam, Zeraatchi, 2022)	24 patients with cervical osteoarthritis and neck pain (22 women and 2 men; mean age 46.7 years), were divided into 2 groups: neck isometric exercise (n=12) and conservative management without exercise (n=12).	Randomized controlled trial (RCT). Pain and disability levels were measured using the Neck Disability Index (NDI) and Neck Pain and Disability Scale (NPAD) before and after the 4-week intervention.	Isometric exercise significantly reduced the level of pain and disability in cervical spondylosis patients compared to the control group without exercise.
(Pérez, Pérez, Ramírez, Trujillo, Cabrera, Romero, Reina, Pérez,	47 healthy participants, divided into 2 groups: isometric exercise (n=23) and isotonic	Parallel experimental trial. Measurements included pain pressure threshold (PPT) at medial gastrocnemius, lateral gastrocnemius, Achilles tendon,	Isometric exercise was only able to significantly improve PPT in the plantar aponeurosis area. Meanwhile, isotonic exercise showed significant clinical changes in 2PD and MVC-PF. No

Villafañe, Carnero, Josué, 2022)	exercise (n=24) on the ankle plantar flexor muscles.	and plantar aponeurosis, two-point discrimination (2PD), and maximum voluntary contraction of plantar flexion (MVC-PF) before and after the intervention.	significant differences were found between the isometric and isotonic groups in other variables.
(Brynzak, Putrov, Olena, Kostenko, Myroshnichenko, 2023)	Beach soccer players in Ukraine	Pedagogical experimental study with literature analysis, observation, survey of players, coaches, and medical personnel, and experimental test of the application of isometric exercises in the annual training program.	Isometric training significantly (p<0.05) improved physical fitness and was effective in injury prevention and pain reduction in beach soccer players. The isometric training method applied in an annual cycle proved effective in preventing injuries according to the characteristics and demands of beach soccer.
(Rajkumar, Logeswaran, Suryaraj, Raveen, Kannan, Sujinraj, Balaji, 2024)	30 male soccer players (aged 18-23 years) with knee ACL injuries in Coimbatore, Tamil Nadu, India. Divided into 2 groups: Isometric Strength Exercise Group (n=15) and Control Group (n=15).	An experiment with a treatment and control group design. The treatment group underwent isometric exercise, while the control group underwent cryotreatment. Measurements were made on active and passive ROM using Kinovea software, with a t-dependent test (p<0.05).	Isometric exercise significantly (p<0.05) improved active and passive knee range of motion (ROM) in soccer players with ACL injuries, compared to the control group. Isometric exercises effectively support knee rehabilitation and deserve wider application.

## Discussion

The results of this systematic review suggest that isometric exercises have an important role in pain management in various sports injury conditions, both acute and chronic. This finding is in line with the study [15], which reported that isometric exercise in patellar tendinopathy was able to provide significant pain reduction in the short term, even within five minutes after the intervention. This analgesic response is believed to be related to the activation of descending pain inhibitory pathways, thus providing a rapid pain modulating effect. In addition, the role of isometric exercise in reducing pain is also related to a decrease in muscle protective motor activity, which often exacerbates pain conditions in sports injuries [6]. Thus, isometric exercises can be used as part of an early rehabilitation strategy, especially in athletes who have significant pain but still need muscle activation to maintain function.

The mechanism of pain reduction through isometric exercise is also supported by research [19], which found that isometric contractions increase the pressure pain threshold and improve neuromuscular control. These effects are particularly relevant in the context of tendon injuries, such as Achilles or patellar tendinopathy, where isometric exercise not only provides an analgesic effect, but also aids the adaptation process of the tendon tissue. However, the analgesic effect of isometric training is not always consistent across all injury types or populations. For example, a study [3] showed that in rotator cuff tendinopathy, isometric exercise did not result in significant pain reduction compared to isotonic exercise. This suggests that the effectiveness of isometric exercises in reducing pain is highly dependent on the injury site, tissue characteristics, and the dose and design of the exercise program applied.

In addition, the benefits of isometric exercise in pain management are also strongly related to the specific parameters of the exercise, such as intensity, duration of contraction, number of repetitions, and joint position while performing the exercise. recommends 70% isometric maximal contraction for 45 seconds with 5 sets as an effective protocol for patellar tendinopathy. However, research [15] suggests that variations in these parameters may affect the outcome of the intervention, where contractions of shorter duration or lower intensity may not produce the same analgesic effect. Therefore, personalization of isometric exercise programs is necessary for optimal intervention results, according to the individual characteristics and pain tolerance of the injured patient or athlete.

In the context of chronic injuries, such as tendinopathies, isometric exercises serve not only as a pain management modality, but also as the first step in the load progression process towards dynamic exercises. Isometric exercises allow activation of muscles and tendons without adding excessive motion load, making them suitable for use in the early phases of rehabilitation [19]. Furthermore, once the pain is under control, exercises can be progressed to isotonic, eccentric, and plyometric, depending on the

functional needs of the patient. This shows that isometric exercises have a strategic transitional role in the sports injury rehabilitation continuum.

However, the effectiveness of isometric exercise in acute injuries is still a matter of debate. In conditions such as acute muscle strains or ankle sprain, evidence regarding the use of isometric exercise as an analgesic strategy is limited. Most studies focus on chronic tendon injuries, whereas there are relatively fewer studies on the effects of isometrics on acute muscle or ligament injuries. However, the theory of decreased neuromuscular inhibition and protection against muscle atrophy provides a rationale that low-dose isometric exercise can be used cautiously in the sub-acute phase, after the acute inflammatory phase has subsided [15]. This strategy needs to be studied further to ascertain its safety and effectiveness in injuries other than tendinopathies.

On the other hand, isometric training also contributes to the long-term improvement of muscle function and strength, which is very important to restore the athlete's performance after injury. It can slowly increase tendon stiffness, strengthen collagen tissue structure, and improve muscle-tendon force transmission [21]. This adaptation is very important, especially in tendons that have degenerated due to overuse injury. In addition, isometric exercises are also able to maintain neuromuscular integrity in conditions of immobilization or decreased activity due to injury, thus accelerating the process of returning to sports activities [17].

However, the implementation of isometric exercises in rehabilitation programs must also consider potential limitations and risks. One important issue is the short-term analgesia effect of isometric exercise, which needs to be combined with other exercise strategies for long-term results. In addition, the variability in individual response to isometric exercise suggests the need for periodic evaluation to adjust the exercise dose, especially in patients with pain hypersensitivity or certain psychological conditions. Therefore, the role of a physiotherapist or strength & conditioning coach in monitoring isometric programs is crucial.

Another important factor in the effectiveness of isometric exercise is patient or athlete education. Knowledge of the purpose, mechanism of action, and benefits of isometric exercises can increase compliance and motivation during the rehabilitation program [15]. In addition, mental strengthening and reduction of fear avoidance beliefs through isometric exercise is also one of the positive aspects, especially in patients who experience fear of motion due to pain [2]. Thus, isometric exercises not only function physically, but also have a positive psychological impact in the recovery process of sports injuries.

Overall, the findings from this systematic review support that isometric exercise is an effective and flexible intervention in pain management in sports injuries, especially in chronic tendinopathic conditions. The use of isometric exercises as an initial, transitional and integrative modality in the rehabilitation continuum suggests that this intervention is worth considering in standard physiotherapy and sports rehabilitation practice. However, the differences in results between studies point to the need for personalization of evidence-based interventions, taking into account injury characteristics, exercise dose, and individual patient factors.

Considering the findings and limitations of the study, a practical recommendation is to use isometric exercises with parameters that have been shown to be effective (70% MVIC contraction, 30-45 seconds duration, 4-5 sets) for chronic tendinopathic conditions. For acute injuries, isometric exercises can be carefully considered in the sub-acute phase with close monitoring. Future research needs to focus on exploring the effects of isometrics on other types of injuries, such as muscle strains, ligaments, and joint conditions, as well as further analysis of the neuromuscular and biopsychosocial mechanisms in response to isometric exercise. An integrative, adaptive and individualized rehabilitation approach is key in optimizing the use of isometric exercise for pain management in sports injuries.

## CONCLUSION

Isometric exercises have an important and strategic role in pain management in various sports injury conditions, both acute and chronic, especially in cases of tendinopathy. The main mechanisms underlying the effectiveness of isometric exercises in reducing pain involve activation of central pain inhibition pathways, increased pain threshold, reduced nociceptor sensitivity, as well as modulation of reflex neuromuscular inhibition. In addition to producing significant short-term analgesic effects, isometric exercises are also able to maintain local muscle strength, prevent muscle atrophy during immobilization or activity restriction phases, and prepare tissues for more dynamic stages of rehabilitation. However, the effectiveness of isometric exercises is greatly influenced by several

important factors such as dose, duration, frequency, number of contractions, injury location, tissue characteristics, and the patient's individual response to the exercise. The strongest scientific evidence supports the use of isometric exercises in patellar, achilles, and rotator cuff tendinopathies, while its application in acute injuries such as muscle strains or ankle sprain still shows mixed results and requires further research for more definitive recommendations. Thus, isometric exercise can be recommended as an integral part of a sports injury rehabilitation program, especially in the early phase for pain control, provided that its application should be evidence-based practice, individually tailored, using standardized exercise protocols, and progressively integrated towards dynamic and functional exercises according to the needs of the patient and the characteristics of the injury.

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#### AUTHOR CONTRIBUTION STATEMENT

The writing of this article involved roles in devising the research concept and design, reviewing and analyzing relevant literature, and drafting the overall manuscript

#### CONFLICT OF INTEREST AND FUNDING

There is no conflict of interest

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