International Journal of
Disabilities Sports and Health Sciences
e-ISSN: 2645-9094

REVİEW ARTICLE

Effects of MET and Joint Mobilization on Pain Reduction and Shoulder Tightness in Athletes: A Systematic Review of Randomized Controlled Trials

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Abstract
Purpose: This study aims to evaluate the effects of muscle energy technique (MET) and shoulder joint mobilization on pain and shoulder stiffness in athletes. Materials and methods: A thorough search was done from April 2013 to April 2023 in the Cochrane Library, PubMed, PEDro, and Google Scholar. Data extraction required access to the whole texts of all research that might have been pertinent. Results: In total, 298 articles of RCT were discovered following the key phrase search. After removing duplicates, abstracts of the remaining 28 examining articles revealed that 18 did not match the requirements, leaving ten articles to be included. Conclusion: This study came to the conclusion that the muscle energy method and shoulder joint mobilization enhance range of motion (ROM) and lessen discomfort in athletes with tight shoulders.

Keywords
Muscle energy technique; Randomised control trial, Range of motion, Shoulder tightness; Shoulder joint mobilization.

INTRODUCTION

In athletes who execute a lot of repetitive overhead movements, shoulder issues are a prevalent musculoskeletal ailment with estimated lifetime frequency of 42%. In which 40–50% of patients report persisting symptoms after the period of 6–12 months and then 14% still receiving treatment after two years, shoulder issues are frequently ongoing and recurrent. Physiotherapists frequently employ mobilisation treatments to lessen pain and dysfunction in athletes with shoulder musculoskeletal problems. Maitland's approach is one method for mobilising the shoulder joint, which involves applying passive rhythmic oscillatory mobilisations anywhere within the range of motion of shoulder joint and grading them based on force, amplitude, direction, and duration (**Lluch et al., 2018**). There is not enough high-quality research on the muscle energy technique (MET) efficacy and its treatment method, although recent, developing studies support the technique's clinical application. According to Sherrington's theory of reciprocal inhibiting, hypertonic antagonists have the ability to reciprocally inhibit their agonist's muscles. Therefore, achieving normal muscle length and/or tone length should be the main priority when there are antagonist muscles that are short as well as tight (**Faqih et al., 2019**). The posterior shoulder provides plenty of force when throwing is in motion, particularly during the release and implementation phases. Athletes frequently display deficits in glenohumeral horizontal adduction and

Received: 18 August 2023 ; Revised ;20 December 2023 ; **Accepted:** 07 January 2023; **Published:** 25 January 2024

How to cite this article: Senthilkumar, R., Panda, S. and Kumar, V. (2024). Effects of MET And Joint Mobilization on Pain Reduction and Shoulder Tightness in Athletes: A Systematic Review of Randomized Controlled Trials. *Int J Disabil Sports Health Sci*;7(1):261-268. https://doi.org/10.33438/ijdshs.1331978

internal rotation associated with their throwing arm, as a result of this force generation. a reduction in the soft tissue's range of motion in the posterior shoulder, also known such as posterior shoulder stiffness, may be the cause of a restricted range of motion (**Yamauchi et al., 2016**). The shoulder internal rotators and the glenohumeral capsule are the typical glenohumeral external rotation limiters. To promote changes in the myofascial and enable the elongation of shortened components, using gradual and precise manual stresses, soft tissue mobilisation is accomplished. Because both Proprioceptive Nueromuscular Facilitation and soft tissue mobilisation techniques are frequently combined because they aim to alter myofascial length. It has been demonstrated that contract-relax PNF methods are beneficial in enhancing the Range of motion (**Moore et al., 2011**).

The humeral joint, posterior inferior glenohumeral ligament, teres minor, infraspinatus and teres major stiffness, and deltoid musculature are all impacted by shoulder tightness (ST) (**Oliver & Brambeck, 2016**). When throwing, the deceleration phase, eccentric resistive forces put stress on the muscles of the posterior aspect of shoulder capsule and Rotator cuff, resulting in tightness in the posterior shoulder (**Laudner & Stanek, 2006; Tyler et al., 2000**).

It is hypothesised that these significant forces and speeds at the back of the shoulder affect throwing athletes' Glenohumeral Joint Range of motion and cause posterior shoulder stiffness. The dominant arm of overhead athletes frequently has a higher glenohumeral joint external rotation ranges at 90 degree of abduction than the non-dominant arm. The overall motion arc, which is the sum of the maximal internal and external rotation range of motion at 90 degrees of abduction, frequently does not differ bilaterally, indicating a comparable decline in the shoulder joint internal rotation range of motion (**Moore et al., 2011**).

In particular, glenohumeral external rotation increases or improves and glenohumeral internal rotation and shoulder internal rotation emerge from demands exerted on the overhead athlete's shoulder as a result of repetitive, overhead rotation. In order to identify and track rotational anomalies and rotation and horizontal adduction range of motion in overhead athletes, as well as posterior ST are advised (**Chepeha et al., 2018**). Athletes' risk of injury is thought to be increased by posterior shoulder stiffness, which can change how the shoulder moves or how flexible the muscles are. There is evidence that aberrant shoulder biomechanics can be caused by posterior capsule tension (**Manske et al., 2010**).

The glenohumeral joint is subjected to large forces applied during the throwing action because of the high arm velocities and extended ranges of motion that take place. The overall arc of motion normally shifts in an equal manner as humeral retroversion increases, such that the gain in the exterior rotation is equivalent to the loss in interior rotation. However, decreased Glenohumeral internal rotation without a corresponding increases in external rotation, decreases horizontal adduction, and a higher risk of injury can all be caused by tightening of the soft tissues in the posterior shoulder (**Reed et al., 2018**).

Muscle energy techniques is a subset of soft tissue osteopathic manipulation techniques were first used to treat pain and improve musculoskeletal function. They involve isometric or isotonic contractions initiated by the patient that is precisely guided and regulated (**García-Peñalver et al., 2020; Rabbani & BV, 2021**). It is utilized to elongate a contracted muscle that is too short; strengthen a physiologically weak muscle; lessen pain; Tighten up the fascia; and Make joint restrictions work. A method by which the hypertonic muscle is tugged gently and without bouncing until it is just long enough to cause discomfort or until resistance to movement is first felt (**Burkhart et al., 2003; Fieisig et al., 1996**). While the patient gently contracts the afflicted muscle away from the barrier (the agonist is contracted) for 5–10 seconds, an effort is resisted with an exact equal counterforce. The procedure is carried out two to three times, beginning with this brand-new barrier. Because physiotherapists deal with problems like sports injuries (**Lluch et al., 2018; García-Peñalver et al., 2020**).

The objective of this study was to find the effects of MET and Shoulder joint mobilization in athletes with pain and ST.

MATERIALS AND METHODS

A: Eligibility Criteria

This analysis covered all randomized controlled trials (RCTs). Quasi-randomized controlled trials were excluded since the effects could have been biased using this methodology.

Studies were not rejected based on their status as publications. Only included health economic research that was done concurrently with studies was included in this comprehensive review's clinical component.

B: Systematic Search Strategy

All the Relevant articles were searched by using the keywords "Muscle energy techniques," "Shoulder Joint," and "Shoulder tightness," An extensive search was carried out in Google Scholar, Science Direct, Cochrane Library, PubMed, and PEDro.

C: Study Selection

Reviewer searched for eligibility and considered titles, abstracts, and full texts. Article inclusion was decided upon by general agreement. Following the key phrase search, a total of 298 RCT articles were discovered. After duplicates were eliminated, the abstracts of the 150 remaining articles were analyzed, and it was discovered that 28 of them did not match the eligibility requirements, leaving ten papers that may be included (**Chepeha et al., 2018; E et al., 2018; Faqih et al., 2019; Godges, Mattson-Bell, Thorpe, & Shah, 2003; Henricus M Vermeulen, 2006; Manske et al., 2010; McClure et al., 2007; Moore et al., 2011; Reed et al., 2018; Yamauchi et al., 2016**)The studies included were conducted in Australia, Spain, China, Canada and France. (Table 1)

D: Quality Assessment of the Individual Studies

Using the Pedro Scores helps to find the 'good' to 'excellent' inter-rater reliability for randomised controlled trials of physiotherapy therapies, and 'excellent' inter-rater reliability for trials of pharmaceutical interventions. It has been demonstrated that consensus ratings produced by teams of two or three raters improve the inter-rater reliability for both the overall Pedro scale items. The Pedro score has both a scale and a total both have been demonstrated to have construct validity and supporting data demonstrating the overall Pedro score's ability to discriminate between superior and inferior trials. In this study, the three reviewers evaluated the study's quality and included (Table 2). The assessment revealed that two were deemed to be high-quality research articles, six were deemed to be moderate-quality articles and two were deemed to be low-quality articles

E: Participant's Characteristics

Table 1 displays the attributes of the ten included research. A randomized controlled design was used in each study. The largest sample was Henricus M Vermeule's hundred boys, (Henricus M Vermeulen, 2006 whereas Stephanie D. Moore et al. had sixty-one participants (**Moore et al., 2011**). The smallest was Joseph J. Godges et al., which is twenty participants (**Faqih et al., 2019**). Five trials had fewer than 25 participants, and sample sizes ranged from 10 to 100. All studies included people of both sexes.

RESULTS

A. Outcome Measures

In most of the studies, the Numerical pain rating scale, Visual Analogue Scale, DASH, Goniometer, Basic inclinometer, digital inclinometer, and Bubble Inclinometer was used as outcome measure to improve pain and Range of motion.

Range of Motion

For Range of motion, the following outcome was used in the studies.

Goniometer was used in these studies in four studies a study conducted by Lluch et al., 2018 concluded that there was no improvement in ROM and the p-value is not significant, which a p-value was 0.96 (**E Lluch et al., 2018**). A study was conducted by Faqih et al., 2019 and they concluded by stating that there is a significant improvement between the group's p-value was <0.002 respectively (**Faqih et al., 2019**). Another study conducted by Chepeha et al., 2018 came to a conclusion by stating that there was a significant improvement in ROM for athletes, which is p<0.001 (**Chepeha et al., 2018**). And another study by Henrisu M Vermeulen et.al., concluded the study by has no significant improvement in increasing the ROM in which the p-value was 0.85 respectively (**Henricus M Vermeulen, 2006**.)

Inclinometer was used in a study conducted by Godges et al., 2003 they concluded that there is no improvement in the ROM of athletes, in which the p-value is 0.009 (**Godges et al., 2003**).

The digital inclinometer was used in two studies in which research was done by Moore et al., 2011 they concluded that there was no increase in ROM in players with a p-value was 0.20 (**Moore et al., 2011**)and also Reed et al., 2018

conducted research and concluded by resulting significant improvement in ROM and p-value was 0.91 respectively (**Reed et al., 2018**).

Bubble inclinometer: This outcome was used in two studies that research was done by Robert C. Manske et.al, concluded that there was no noticeable distinction observed between groups, and the p-value is 0.044, (**McClure et al., 2007**). And another study by Manske et al., 2010 concluded that there was a noticeable distinction between groups in which the p-value is 0.02 respectively (**Manske et al., 2010**).

Shear wave elastography (SWE) was an ultrasonic method to check muscle tightness which is done in a study conducted which shows improvement in ROM in which the p-value was 0.04 respectively (**Yamauchi et al., 2016**).

Disabilities of the Arm Shoulder and Head (DASH) was used for the assessment of the shoulder, disabilities of the arm, and hand for the shoulder disability. It was used in two studies in which a study was conducted by (**Yamauchi et al., 2016**) they found that there was no observable difference between the group in which p values was <0.01 respectively (**Lluch et al., 2018**). And a study by Faqih et al., 2019 shows a noteable difference between groups in which the p-value is <0.001 respectively (**Faqih et al., 2019**).

there was no

Pain

Visual analog scale (VAS) was used only in one research which was done by Faqih et al., 2019 this study showed that there was no improvement in pain among players in which the p values was 0.013 respectively (**Faqih et al., 2019**).

Numerical Pain Rating Scale (NPRS) was used to assess the pain of the players, which was used in three studies. Research conducted by Yamauchi et al., 2016 their result shows that there was a observable improvement between groups the p-value was < 0.05 respectively (**Yamauchi et al., 2016**). A study conducted by Chepeha et al., 2018 concluded that the study shows a significant improvement in pain in which p-value was >0.002 respectively (**Chepeha et al., 2018**). And another research conducted by Henricus M Vermeulen et al., concluded that there was no difference between groups in which the p-value was 0.85 respectively (**Henricus M Vermeulen, 2006**).

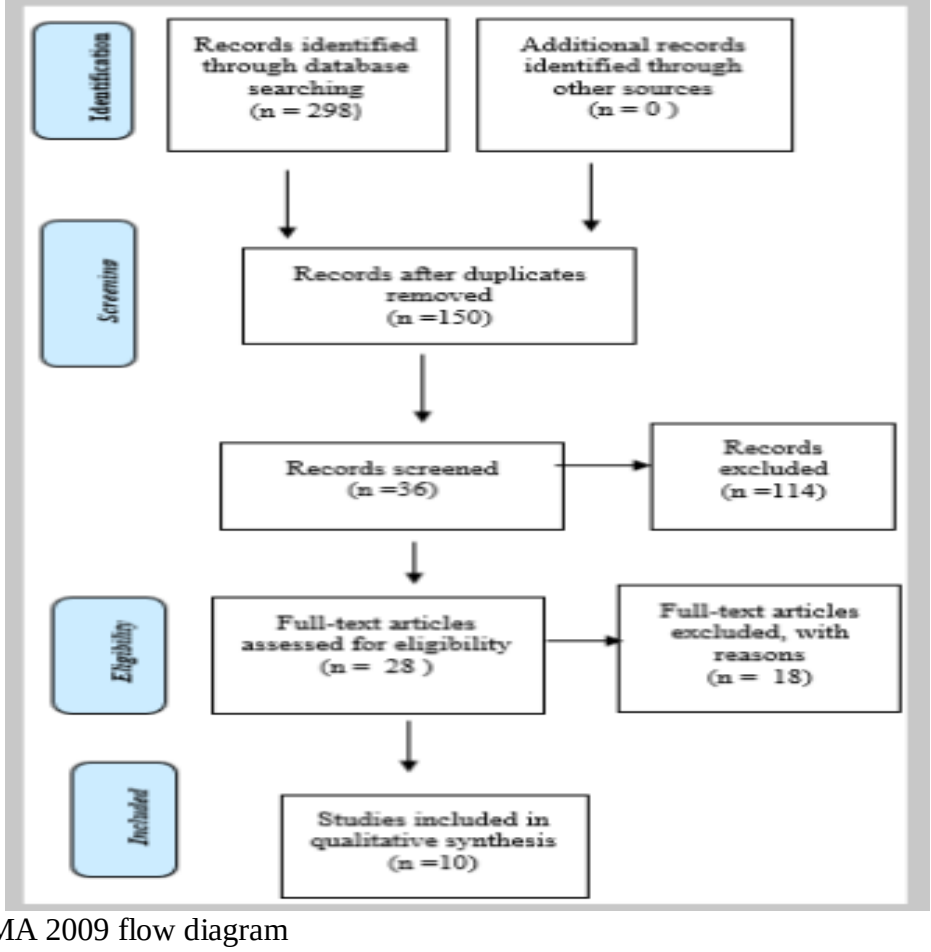

Figure 1. PRISMA 2009 flow diagram

Table 1. Characterıstıcs of this study

Author	No. Patients	Country	Population	Study Design	Age (years)	Outcome Measures	Intervention	Conclusion
Lluch E et al.(2018)	31	Spain	Over head athletes	Randomized Controlled Trial	>18	Gonıometer, Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire	Shoulder joint mobilization, Manual contact, no- contact intervention.	There were no discernible changes between the treatment conditions for any of the investigated variables.
Faqih et al.(2019)	30	Hong Kong	Athletes with post-surgical shoulder stiffness	Randomized Controlled Trial	>18	Visual analog scale, Gonıometer	MET	After the immobilisation was removed, providing MET resulted in an increase in ROM and functionality.
Yamauchi et al. (2016)	24	Japan	Base ball athletes	Randomized Controlled Trial	<25	The Numeric Pain Rating Scale (NPRS), shear wave elastography (SWE)	Modified Crossarm Stretching (MCS), Modified Sleeper Stretching (MSS)	These technique shows a significant improvement in players to prevent shoulder tightness.
Godges et al. (2003)	20	Los Angeles, CA.	Over head athletes	Randomized Controlled Trial	>23	Inclınometer	Soft tissue mobilization (STM), Proprioceptive neuromuscular facilitation (PNF).	There was a significant effects on improving the ROM during single intervention in patients with ST.
Moore et al. (2011)	61	USA	Baseball players	Randomized Controlled Trial	>23	Dıgıtal ınclınometer	MET	Single application of MET improves the ROM of shoulder joint in athletes.
Chepeha et al. (2018)	37	Canada	Volley ball players	Randomized Controlled Trial	>20	The numeric pain rating scale (nprs), Gonıometer	Sleeper stretch	There is a improvement in ROM and helps in management of posterior ST.
McClure et al. (2007)	54	USA	Athletes with ST	Randomized Controlled Trial	>18	Bubble ınclnometer	MET	There is increase in internal rotation ROM.
Vermeule et al, (2006)	100	Vlieland	Athletes with ST	Randomized Controlled Trial	>23	The Numeric Pain Rating Scale (NPRS), gonıometer	MET	There is improvement in ROM of shoulder joint after the intervention period of 12 months
Manske et al, (2010)	39	USA	College level athletes	Randomized Controlled Trial	>18	Bubble ınclnometer	Stretching, Shoulder joint mobilization	Internal rotation ROM was improved in both the groups after 4 weeks of intervention period.
Reed, et al. (2018)		USA	Baseball and softball athletes	Randomized Controlled Trial	>20	Dıgıtal ınclınometer	MET, joint mobilization.	There is a improvement in MET and no significant improvement in joint mobilization after the intervention period.

Table 2. PEDro scoring of the study

Study	Eligibility criteria	Randomly allocated	Allocation concealed	Baseline compara bility	Blind subject	Blind therapists	Blind assessors	Adequate follow up	Intention to treat analysis	Between group comparison	Point estimates and variability	Total
Lluch E et al.(2018)	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	8
Faqih et al.(2019)	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	6
Yamauchi et al.(2016)	Yes	Yes	No	Yes	Yes	No	No	Yes	No	Yes	Yes	5
Godges et al. (2003)	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	No	5
Moore et al.(2011)	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	6
Chepeha et al. (2018)	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	6

McClure et al. (2007)	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	6
Vermeule et al, (2006)	Y es	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	8
Manske et.al, (2010)	Yes	Yes	No	Yes	Yes	No	No	No	No	Yes	Yes	6
Reed, et al. (2018)	Yes	Yes	No	Yes	Yes	No	No	Yes	No	No	Yes	6

DISCUSSION

All overhead players demonstrate posterior shoulder stiffness on the dominant side of the arm, which is accompanied by a deficit in internal rotation (**Reinold et al., 2008; Wilk et al., 2011**). Previous study consistently demonstrates that throwing sportsmen, in particular, are predisposed to shoulder stiffness, and shoulder injuries are so likely due to ongoing microtrauma at the shoulder during the subsequent phase, capsule (**Burkhart et al., 2003**). This study's objective is to rule out the possibility that shoulder joint mobilization and MET can reduce pain and improve the range of motion in athletes with ST.

In a related study, Stephanie et al. compared two muscle energy techniques (MET) for the Glenohumeral joint horizontal abductors and external rotators in order to increase the range of motion (ROM) of the glenohumeral joint (GHJ) in baseball players who were asymptomatic (**Handelberg et al., 1998**). Another study discovered that just a single application of a muscle energy technique (MET) to the Glenohumeral Joint Horizontal Abductors in asymptomatic collegiate athletes led to an immediate improvement in both the GlenoHumeral Joint Horizontal Adduction and Internal Rotation Range of Motion (**Bailey et al., 2015**). According to Taishi Yamauchi et al.'s study, multiple immediate results of AP glenohumeral joint mobilisation with manual touch and no-contact therapy were compared to the `pain and function-related end assessments. For all of the variables evaluated, there were no appreciable differences between the treatment conditions. However, after using the mobilisation technique, the self-reported shoulder pain immediately subsided (**Lluch et al., 2018**).

Using overhead reach athletes with shoulder disorders, Maddox L. Reed et al. conducted a study to see if soft tissue mobilisation and proprioceptive neuromuscular facilitation procedures were effective in improving glenohumeral external rotation right away. They found that the range of motion increased following the intervention session (**Godges et al., 2003**). According to research by Stephanie d. Moore et al., overhead throwers have significantly less glenohumeral joint internal rotation ranges of motion in their affected arm than in their non-affected arm. The posterior muscle tightening, posterior-inferior capsule tightness, and osseous adaptation have all been linked to the reduction in the throwing arm's internal rotation range of motion (**Moore et al., 2011**).

According to research by Robert C. Manske et al., they had an observable difference between the groups in each athlete's dominant and nondominant shoulders' Internal Rotation and Horizontal Adduction Range of motion, respectively. These values are advantageous because they account for the athlete's "normal" level of internal rotation and horizontal adduction range of motion by comparing both shoulders and show the proportionate Range of motion loss that results from recurrent overhead shoulder motion on the dominant shoulder (**Chepeha et al., 2018**).

Limıtation

The limitations of this research study include being confined to the English language, which excludes other languages from the analysis and could restrict the generalizability of the findings. Additionally, the study's inclusion of only randomized controlled trials (RCTs) may restrict the range of study designs considered, reducing the ability to draw broader conclusions beyond the context of RCTs. Furthermore, the absence of a meta-analysis in this research study potentially overlooks the advantages of synthesizing and analyzing data from multiple studies.

Recommendation And Future Scope

- There was no follow-up in all 10 studies after the intervention period. Proper follow-up

after the research is recommended for further knowledge.

- Intervention periods are very less, they can increase the duration of the intervention and sample size.

Conclusion

Out of the ten articles Pedro scored, two were deemed to be high-quality research articles (eight out of ten), six were deemed to be moderate-quality articles (six out of ten), and two were deemed to be low-quality articles (five out of ten). Pedro gave each article a score out of ten, with a score out of ten representing the highest quality. The muscle energy technique was an immediate pain-relieving and flexibility-improving option for athletes who suffer from tightness in the posterior aspect of the shoulder. For players or patients experiencing shoulder pain or tightness, the review offered in this paper includes useful information that was especially important for the planning and implementation of therapies. The methods discussed here have been demonstrated to be successful in enhancing ROM and lowering pain. It could be a part of the daily routine.

Conflict of Interest

No conflict of interest is declared by the authors. In addition, no financial support was received.

Author Contributions

Author Contributions Study Design: SP, RS; Data Collection: SP, RS, VK; Data Interpretation: SP, RS, VK; Manuscript Preparation: RS; Final review and editing: SP, RS, VK; Literature Search, SP, RS. All authors have read and agreed to the published version of the manuscript.

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