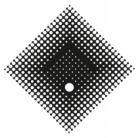
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Muscle energy technique for non-specific low-back pain

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Muscle energy technique for non-specific low-back pain (Review)

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[Intervention Review]

Muscle energy technique for non-specific low-back pain

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ABSTRACT

Background

Low-back pain (LBP) is responsible for considerable personal suffering due to pain and reduced function, as well as the societal burden due to costs of health care and lost work productivity. For the vast majority of people with LBP, no specific anatomical cause can be reliably identified. For these people with non-specific LBP there are numerous treatment options, few of which have been shown to be effective in reducing pain and disability. The muscle energy technique (MET) is a treatment technique used predominantly by osteopaths, physiotherapists and chiropractors which involves alternating periods of resisted muscle contractions and assisted stretching. To date it is unclear whether MET is effective in reducing pain and improving function in people with LBP.

Objectives

To examine the effectiveness of MET in the treatment of people with non-specific LBP compared with control interventions, with particular emphasis on subjective pain and disability outcomes.

Search methods

CENTRAL, MEDLINE, EMBASE, five other databases and two trials registers were searched from inception to May and June 2014 together with reference checking and citation searching of relevant systematic reviews.

Selection criteria

Randomised controlled trials assessing the effect of MET on pain or disability in patients with non-specific LBP were included.

Data collection and analysis

Two authors independently assessed the risk of bias and extracted the data. Meta-analysis was performed where clinical homogeneity was sufficient. The quality of the evidence for each comparison was assessed with the GRADE approach.

Main results

There were 12 randomised controlled trials with 14 comparisons included in the review, with a total sample of 500 participants across all comparisons. Included studies were typically very small (n = 20 to 72), all except one were assessed as being at high risk of bias, and all reported short-term outcomes. For the purposes of pooling, studies were divided into seven clinically homogenous comparisons according to the patient population (acute or chronic LBP) and the nature of the control intervention. Most of the comparisons (five out of seven) included only one study, one comparison had two studies, and one comparison included seven studies.

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The meta-analyses provided low-quality evidence that MET provided no additional benefit when added to other therapies on the outcomes of chronic pain and disability in the short-term (weighted mean difference (WMD) for pain 0.00, 95% CI -2.97 to 2.98 on a 100-point scale; standardised mean difference (SMD) for disability -0.18, 95% CI -0.43 to 0.08, 7 studies, 232 participants). There was low-quality evidence that MET produced no clinically relevant differences in pain compared to sham MET (mean difference (MD) 14.20, 95% CI -10.14 to 38.54, 1 study, 20 participants). For the comparison of MET to other conservative therapies for acute non-specific LBP, there was very low-quality evidence of no clinically relevant difference for the outcomes of pain (MD -10.72, 95% CI -32.57 to 11.13, 2 studies, 88 participants) and functional status (MD 0.87, 95% CI -6.31 to 8.05, 1 study, 60 participants). For the comparison of MET to other conservative therapies for chronic non-specific LBP, there was low-quality evidence of no clinically relevant difference for the outcomes of pain (MD -9.70, 95% CI -20.20 to 0.80, 1 study, 30 participants) and functional status (MD -4.10, 95% CI -9.53 to 1.33, 1 study, 30 participants). There was low-quality evidence of no clinically relevant difference for the addition of MET to other interventions for acute non-specific LBP for the outcome of pain (MD -3, 95% CI -11.37 to 5.37, 1 study, 40 participants) and low-quality evidence of an effect in favour of MET for functional status (MD -17.6, 95% CI -27.05 to -8.15, 1 study, 40 participants). For chronic non-specific LBP, there was low-quality evidence of an effect in favour of MET for the addition of MET to other interventions for the outcomes of pain (MD -34.1, 95% CI -38.43 to -29.77, 1 study, 30 participants) and functional status (MD -22, 95% CI -27.41 to -16.59, 1 study, 30 participants). Lastly, there was low-quality evidence of no difference for the addition of MET to another manual intervention compared to the same intervention with other conservative therapies for the outcomes of pain (MD 5.20, 95% CI -3.03 to 13.43, 1 study, 20 participants) and functional status (MD 6.0, 95% CI -0.49 to 12.49, 1 study, 20 participants).

No study reported on our other primary outcome of general well-being. Seven studies reported that no adverse events were observed, whereas the other five studies did not report any information on adverse events.

Authors' conclusions

The quality of research related to testing the effectiveness of MET is poor. Studies are generally small and at high risk of bias due to methodological deficiencies. Studies conducted to date generally provide low-quality evidence that MET is not effective for patients with LBP. There is not sufficient evidence to reliably determine whether MET is likely to be effective in practice. Large, methodologically-sound studies are necessary to investigate this question.

PLAIN LANGUAGE SUMMARY

Muscle energy technique (MET) for non-specific low-back pain

This review investigated the 'muscle energy technique' (MET) as a treatment for non-specific low-back pain (low-back pain that cannot be linked to a specific cause).

MET is a form of manual or 'hands-on' therapy used by osteopathic physicians, chiropractors, and physical therapists. In this type of therapy, a patient contracts muscles by pushing against resistance provided by the therapist. The therapist then assists the patient in stretching, strengthening and relaxing those muscles. The goal is to help restore normal muscle and joint mobility.

Review question: is MET a safe and effective treatment for people with non-specific low-back pain?

Researchers from The Cochrane Collaboration looked for randomised controlled trials (a type of clinical study) that compared MET to other treatment approaches.

These comparison treatment approaches included no treatment, sham MET treatment, exercise, other manual therapies, ultrasound, electro-therapies, heat therapy and any combination of these approaches. This review included patients with back pain of any duration, from acute (less than six weeks duration) to chronic (greater than 12 weeks duration).

The people in these studies ranged in age from 18 to 65 years and had pain ranging in severity from mild to substantial. They usually had about five sessions of MET, or the comparison treatment(s), over a period of about 10 days.

The review authors aimed to determine if MET helped to relieve pain or increase a person's ability to do normal activities of daily living, or both.

Background

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Low-back pain (LBP) is a common symptom from adolescence into old age. About 50% of the general population experiences back pain over the course of a year and up to 80% of people report LBP over the course of their lifetimes.

The vast majority of people have acute (short-term) back pain and recover within a few weeks, with or without treatment.

Longer lasting LBP, subacute (for 6 to 12 weeks) and chronic (> 12 weeks) pain, generally has less favourable outcomes. A small proportion of people with acute LBP go on to have chronic disabling LBP, which can interfere with every aspect of normal living, cause significant pain and suffering, and create huge costs in terms of medical care, work disability, and workers' compensation claims.

There are many therapies claimed to be useful for the treatment of LBP. Most of these treatments have not been well investigated or have been found to have modest effects in terms of pain relief and improving disability. For many people with LBP, however, even modestly effective treatments can help in coping with symptoms and returning to normal living. It is therefore useful to explore the effectiveness of treatments that may assist people with LBP, particularly those treatments such as MET which are non-invasive and are likely to be safe and inexpensive.

Study characteristics

The Cochrane Collaboration researchers looked for studies (randomised controlled trials) published through to May and June 2014. They included studies where MET was delivered by osteopathic physicians, chiropractors, or physical therapists.

Twelve randomised controlled trials were found that included a total of 500 patients. All patients in these studies had 'non-specific LBP', meaning that there was no identifiable cause for their back symptoms.

After looking at the evidence, The Cochrane Collaboration review authors included four types of comparison treatments, each divided into acute and chronic pain:

•MET plus any intervention versus that same intervention alone;

•MET versus no treatment;

•MET versus sham MET;

•MET versus all other therapies.

Key results

The review authors could not find adequate evidence to make any definitive judgements about the safety or effectiveness of MET. Studies were generally too small and had a high risk of bias, producing unreliable answers about this therapy.

There is a need for larger, high-quality studies to determine the effectiveness and safety of MET.

At present there is no convincing evidence that MET is effective as a stand-alone therapy or improves the effectiveness as an accompaniment to other therapies.

Quality of the evidence

The quality of the evidence was poor. The available studies were small and reported only short term outcomes. Most studies were determined to have a high risk of bias because of the way they were designed and conducted.

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SUMMARY OF FINDINGS FOR THE MAIN COMPARISON *[Explanation]*

MET plus any intervention compared to other therapies plus that intervention for chronic non-specific LBP

Patient or population: patients with non-specific low-back pain (LBP)
Settings: mostly physiotherapy departments
Intervention: MET plus any intervention
Comparison: other therapies plus that intervention, chronic back pain (BP)

Outcomes	Assumed risk	Comparative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	other therapies plus that intervention, chronic BP	MET plus any intervention			
Pain A 0 to 100 visual or numerical scale, where 0 equals no pain at all and 100 is the worst pain imaginable Follow-up: post-treatment	The mean pain ranged from **3.3 to 53.6** points across control groups	The mean change in pain in the intervention groups was **0.00** (2.97 lower to 2.98 higher)	232 (7 studies)	⊕⊕◯◯ **low**[1,2]	This difference is not statistically significant and not likely to be clinically relevant
Functional status Oswestry; 100-point scale where 0 equals no disability and 100 is seriously disabled Follow-up: post-treatment	The mean functional status ranged from **5.7 to 42.5** across control groups	The mean change in functional status in the intervention groups was **0.18 standard deviations lower** (0.43 lower to 0.08 higher)	232 (7 studies)	⊕⊕◯◯ **low**[1,2]	This difference is not statistically significant and not likely to be clinically relevant
General well-being	Not reported	Not estimable	-	No evidence	-
Adverse events	Not reported	Not estimable	-	No evidence	-

CI: confidence interval

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] High risk of bias in included studies
[2] Sample size <400

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BACKGROUND

Clinical guidelines for low-back pain (LBP), developed by the National Institute for Health and Clinical Excellence (NICE 2009), define non-specific LBP as "tension, soreness and/or stiffness in the lower back region for which it is not possible to identify a specific cause of the pain". The aetiology of LBP is poorly understood and authors and researchers have offered different opinions on the cause of this complaint. Deyo and Weinstein (Deyo 2001) estimate that 85% of patients with isolated LBP cannot be given a precise patho-anatomical diagnosis. In a literature review, Vuori 2001 stated that 85% of the cases of LBP are unspecific and functional. Nachemson 1994 claimed that 97% of the lumbar spine problems are classified as 'unspecific'.

A systematic review of observational studies (van Tulder 1997) stated that no firm evidence for the presence or absence of a causal relationship between radiographic findings and non-specific LBP could be found. Bogduk 2009 argues that plain radiographs, magnetic resonance imaging (MRI) scans or computed tomography (CT) scans are unable to reveal the cause of somatic pain in the majority of cases and that they carry the risk of erroneously positive interpretations. A purely biomechanical explanatory model for the development of LBP does not seem to be broad enough (Hestbaek 2003). Gilkey 2010 stated that back pain is multifactorial and different chains of causation make it very difficult to isolate risk factors. The recurrence rate of LBP is high. Studies state that 47% to 84% of individuals who have an episode of LBP will suffer a recurrence within one year (Stanton 2008). To this day, it is not possible to predict reliably who will develop back pain and what the reasons for that development are.

In clinical practice, non-specific LBP which is present for less than six weeks is classified as 'acute'. With a recovery rate of close to 90% within six to eight weeks, acute back pain has a great tendency to be self-limiting (Burton 2006; Waddell 2004). When back pain persists between six weeks and three months it is described as 'subacute', and longer than three months as 'chronic' (van Tulder 2006). Other authors (Cedraschi 1999; Dionne 2008) point out that patients with LBP typically suffer from changing, intermittent episodes of varying duration, and the 'acute-subacute-chronic' classification is inadequate in classifying this episodic and intermittent condition.

Economic consequences of back pain are enormous. The small percentage of patients with chronic or episodic LBP account for a large fraction of the healthcare expenditure on the condition. Various factors have been shown to be correlated with, or predictive of, chronic LBP including the characteristics of the initial episode, pain, psychosocial issues and occupation (Neubauer 2006). In addition to the economic impact of LBP on the individual and society, there is a further personal impact on the individual. Researchers have reported changes in social behaviour, retreat from activities of daily living and reduced quality of life in people who suffer from back pain (Croft 1994).

Description of the intervention

Muscle energy technique (MET) is a commonly used treatment technique in osteopathy (Fryer 2009; Fryer 2010b; Johnson 2003; Orrock 2009) and manual therapy (Boyling 2005; Chaitow 2006). It was developed 50 years ago by Fred Mitchell Sr and was then refined and partially modified by his son Fred Mitchell Jr (Mitchell 1999; Mitchell 2001a; Mitchell 2001b). MET uses the voluntary contraction of the patient's muscle in a precisely controlled direction against an externally applied counter-force, which is applied by the operator.

It is suggested that MET can be used to:

- lengthen a shortened muscle;
- mobilise an articulation with restricted mobility;
- strengthen a physiologically weakened muscle;
- reduce localised edema and passive congestion.

Several factors are theoretically of importance for the successful use of MET. These include exact diagnosis, precise positioning of the joint or tightened muscle by the therapist, active and appropriately regulated muscle contraction by the patient against a defined resistance of the therapist, accurate control of the modification in range of movement and, if necessary, repositioning of the joint at a new point of movement restriction (Greenman 2003; Mitchell 2001a).

Over the years, MET has undergone considerable modification. The classical concept focuses on an osteo-kinematic diagnosis and sees the tightened muscle in the context of a joint dysfunction (Mitchell 2001a), while newer approaches emphasise the application of MET in muscle tightness, reduced muscle extensibility, and pain from myofascial trigger points (Chaitow 2006). Authors of MET texts have described many techniques for treating lumbar spinal joint dysfunction and lumbar, pelvic and lower extremity muscle dysfunction for the purpose of treating patients with mechanical non-specific LBP (Chaitow 2006; Greenman 2003; Mitchell 2001a).

How the intervention might work

The physiological mechanisms underlying the therapeutic effects of MET are unclear and may involve a variety of neurological and biomechanical mechanisms, including hypoalgesia, altered proprioception, motor programming and control, and changes in tissue fluid (Fryer 2010a). Lasting biomechanical changes to muscle property following MET have not been demonstrated, and changes to muscle extensibility and spinal range of motion may be related to mechanisms promoting hypoalgesia and an increase in stretch tolerance. Clinical studies suggest MET and related post-isometric techniques reduce pain and discomfort when applied to the spine (Wilson 2003) or muscles (Ballantyne 2003; Magnusson 1996). MET may have physiological effects regardless of the presence or absence of dysfunction (Fryer 2004).

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Why it is important to do this review

According to a study by Johnson and Kurtz (Johnson 2003), together with the soft-tissue technique and high-velocity low-amplitude spinal manipulation, MET is one of the three most commonly used techniques applied by American osteopaths. Similarly, MET is commonly used by osteopaths in Australia (Orrock 2009) and the United Kingdom (Fryer 2010b).

Despite the fact that MET is typically used as part of a treatment package, there has been a growing number of studies examining the effectiveness of MET as a stand-alone technique. Explanatory studies have reported short-term improvements in spinal range of motion and in the extensibility of muscles following an application of MET (Fryer 2013). Several studies (Cassidy 1992; Salvador 2005; Selkow 2009; Wilson 2003) have researched the effectiveness of MET for the treatment of LBP and reported promising results. Over the last few years, there have been a growing number of studies that have investigated MET for the treatment of LBP. Given the fact that MET is a commonly applied therapeutic intervention for a common, relevant and expensive health problem, and that there is some evidence of its effectiveness, a comprehensive systematic review of this topic is warranted.

OBJECTIVES

The objective of this review was to examine the effectiveness of MET in the treatment of non-specific LBP compared with control interventions, with particular emphasis on subjective pain and disability outcomes.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised clinical studies (RCTs) which were written in English, French, Spanish, Portuguese, Italian, Dutch or German. The studies were published or readily available (for example, scholarly theses). For ongoing trials, the necessary data were required to be available on request.

Types of participants

We included studies of adults (older than 18 years) with non-specific LBP (that is, pain between the lumbo-pelvic region and the 12th rib). Trials including a mix of participants with (sub)acute and chronic symptoms were only included if data for the (sub)acute and chronic samples were reported separately. Trials not reporting the duration of participants' symptoms were included but the impact of not clearly reporting the duration was assessed in a subgroup analysis.

We excluded studies which included participants with specific LBP (back pain with a specific cause, such as compression fracture, a tumour or metastasis, ankylosing spondylitis, infection) and studies involving pregnant participants.

Types of interventions

The intervention was required to be in accordance with the definition of the isometric form of MET. This included the following:

1. diagnosis of the restricted motion of a joint or shortened muscle, and
2. positioning of the joint or muscle to engage the end range of restricted motion or stretch of muscle, and
3. voluntary gentle isometric contraction of the stretched muscle, in a direction away from the restricted range, against the resistance of the therapist.

We included studies in which the trial authors described the intervention as a form of MET; however, we also considered techniques which were applied under a different name but were similar to the defined MET procedure. We considered differently named techniques sufficiently similar to MET if the criteria listed under 1 to 3 were met. In cases where we were unclear if the reported technique should be considered similar to MET, we attempted to contact the authors of the trial for more detailed information. The MET or similar-to-MET intervention must have been performed by a manual therapist (for example, osteopath, chiropractor, physiotherapist).

We only considered studies where an effect size could be assigned to the MET intervention. Four types of comparisons were possible:

1. MET plus any intervention versus that same intervention alone;
2. MET versus no treatment;
3. MET versus sham MET;
4. MET versus all other therapies.

Types of outcome measures

Since LBP is a symptom that requires reporting, in the first place we considered patient-reported parameters and consequences of the condition on problem specific and generic measures of activities of daily living and quality of life for this review. In addition, we also evaluated physiological measures such as range of movement.

Primary outcomes

- Pain measured by a visual analogue scale (VAS), number rating scale (NRS) or McGill Pain Questionaire
- Results of functional disability questionnaires (Roland-Morris Disability Questionnaire (RMDQ), Oswestry Disability Index (ODI) or another valid instrument)

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- If available, scales of general well-being (e.g., quality of life measured with the Short Form-36 (SF-36), SF-12 or EuroQuol)

We reported the timing of measured outcomes separately as short-term (closest to four weeks), intermediate-term (closest to six months) and long-term (closest to one year).

Secondary outcomes

- Any kind of adverse events
- Change in medication
- Range of movement

Search methods for identification of studies

Electronic searches

We used the methods outlined by Furlan 2009 and Chapter 6 "Searching for Studies" in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011) to guide the development of our search strategies.
We performed a literature search on MET in the following electronic databases, from the beginning of the database to the present date:

- Cochrane Central Register of Controlled Trials (CENTRAL, which includes the Back Review Group Trials Registry; Cochrane Library) up to May 2014 (Appendix 1);
- MEDLINE (OvidSP) up to May 2014 (Appendix 2);
- EMBASE (OvidSP) (1947 to 2014 week 21) up to May 2014 (Appendix 3);
- Cumulative Index to Nursing and Allied Health Literature (CINAHL, EBSCO) up to June 2014 (Appendix 4);
- Physiotherapy Evidence Database (PEDro), Osteopathic Medicine Digital Repository (OSTMED-DR), OSTEOPATHIC RESEARCHWEB, GOOGLE SCHOLAR up to June 2014 (Appendix 5).

In addition to these databases, we also searched ClinicalTrials.gov and The World Health Organization International Clinical Trials Registry Platform (WHO ICTRP) for ongoing trials from inception to June 2014 (Appendix 6).
These searches were supplemented by citation tracking of the identified trials and a manual search of the reference lists of all relevant papers not listed in the electronic database.
The searches of EMBASE and the clinical trials registries were performed by the Trials Search Co-ordinator of the Cochrane Back Review Group (CBRG). The EMBASE study design filter was updated from previous searches in 2012 and 2013 and a new term was added to the search strategy for 2014. See Appendix 3 for details.

Searching other resources

We also personally communicated with experts in the field of MET to identify additional studies.

Data collection and analysis

Two review authors independently conducted the following aspects of the review. Neither of the review authors was an author or co-author of any of the included trials.

Selection of studies

Two review authors independently screened titles and abstracts of the results identified by the search strategy. Potentially eligible studies were read in full text and independently evaluated for inclusion. Disagreement between author evaluations was resolved through discussion or by consulting a third review author. The search strategy was not limited by language.

Data extraction and management

Two review authors independently extracted the study data using a data extraction form. The following data were extracted: author, year, country, study design, aim of the study, reported inclusion and exclusion criteria, dropouts, number of treatments and period of treatment, measurement, number of patients, age (mean), gender, number of patients in the intervention and control groups, randomisation, blinding (patients), reported or observed side effects, index intervention, comparison and control interventions, reported results, study sponsorship, characteristics of treatment providers. The data extraction form was based on the data extraction form recommended by the CBRG and was piloted for this review in 2010.

Assessment of risk of bias in included studies

Two review authors independently assessed the risk of bias. A consensus method was used to resolve disagreements and a third review author was consulted where disagreement persisted. If the article did not contain sufficient information on one or more of the criteria, the trial authors were contacted for additional information. If the authors could not be be contacted, or if the information was no longer available, the criterion was scored as 'unclear'. We used the updated Cochrane risk of bias tool from the *Cochrane Handbook for Systematic Reviews of Interventions* (Version 5.1, updated March 2011) (Higgins 2011) to assess the risk of bias (Appendix 7). All criteria was scored as 'low risk', 'high risk' or 'unclear'. Acording to the recommendations of the CBRG, studies were rated as having 'low risk of bias' when at least six criteria were met and the study had no serious flaws (for example, large dropout rate) (van Tulder 2009). We performed a sensitivity analysis to determine whether the overall results were the same when studies with different definitions of low or high risk of bias were analysed.

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Measures of treatment effect

We evaluated the studies regarding their clinical homogeneity (study population, treatment procedure, control group, timing of follow-up and measurement instruments). On the basis of these evaluations, and if the studies were clinically homogenous, we pooled the data for our outcome measures, pain, functional status and, if possible, quality of life. Where available, analysis would be made for short-, intermediate- and long-term follow-up measures. For pain, functional status, and quality of life, we used a standardised mean difference (SMD) to combine studies that measured the same outcome but with different methods. With Review Manager 5.1, the results of each RCT were plotted as point estimates with corresponding 95% confidence intervals (95% CI). We reported the results in a forest plot using a random-effects model. We did not perform a meta-analysis when the studies were too heterogeneous.

Where pain was scored on a 10-point scale, means and standard deviations were multiplied by 10 to create a common metric for the pooled estimates. This enabled effect sizes to be expressed in units related to the most commonly used pain intensity measurement instruments.

All analyses was conducted separately for acute or subacute LBP versus chronic LBP.

Assessment of clinical relevance

Two review authors independently scored the clinical relevance of the included studies according to five questions recommended by the CBRG (Furlan 2009). Each question was scored positive (+) if the clinical relevance item was fulfilled, negative (-) if the item was not fulfilled, and unclear (?) if data were not available. To assess minimal clinically important changes for LBP and function, we used a 30% change on the VAS and NRS, two to three points (or 8% to 12%) on the Roland-Morris Disability Questionnaire or 10 for the Oswestry Disability Index for function (Bombardier 2001; Ostelo 2008).

For the assessment of the clinical relevance the following questions were investigated.

1. Are the patients described in detail so that you can decide whether they are comparable to those that you see in your practice?
2. Are the interventions and treatment settings described well enough so that you can provide the same for your patients?
3. Were all clinically relevant outcomes measured and reported?
4. Is the size of the effect clinically important?
5. Are the likely treatment benefits worth the potential harms?

Unit of analysis issues

In cases where three or more interventions were evaluated in a single study, we included each pair-wise comparison separately. In this case, the total number of participants in the MET intervention group were divided approximately evenly among the comparison groups.

Dealing with missing data

We attempted to contact the corresponding authors in cases where data were missing. Where data were reported in a graph and not in a table or the text, we estimated the means and standard deviations. When standard deviations were not reported, we estimated these from the CIs or other measures of variance, where possible. If the standard deviations for follow-up measurements were missing, we used the standard deviation for that measure at baseline for subsequent follow-up measurements. Finally, if no measure of variation was reported anywhere in the text, we estimated the standard deviation based upon other studies with a similar population and risk of bias.

Assessment of heterogeneity

Assessment of heterogeneity involved calculation of the I^2 statistic. The *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011) provides a rough guide for interpretation of I^2 values (Higgins 2011): 0% to 30%, might not be important; 30% to 60%, may represent moderate heterogeneity; 50% to 90%, may represent substantial heterogeneity; 75% to 100%, considerable heterogeneity. Data from studies that were clearly heterogeneous was not pooled.

Assessment of reporting biases

In the event that we included enough studies, we calculated a funnel plot to examine publication bias.

Data synthesis

Regardless of whether there were sufficient data available for quantitative analyses, we assessed the overall quality of the evidence for each outcome. To accomplish this, we used an adapted GRADE approach, as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011) and by the updated CBRG method guidelines (Furlan 2009). The quality of the evidence for a specific outcome was based on the performance against five factors: study design and risk of bias, consistency of results, directness (generalisability), precision (sufficient data), and reporting of the results across all studies that measured that particular outcome. The quality of evidence was graded down by one level for risk of bias, where studies included in a comparison did not meet the threshold of six items on the Cochrane risk of bias scale. It was also graded down for consistency of results where the I^2 statistic was greater than 60% (substantial heterogeneity according to the *Cochrane Handbook for Systematic Reviews of Interventions*) and graded down for precision where there were less than a total of 400 participants in the comparison, following the recommendations of Guyatt (Guyatt 2011).

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The quality started at high when RCTs with a low risk of bias provided results for the outcome, and was reduced by a level for each of the factors not met.

High quality evidence: there are consistent findings among at least 75% of RCTs with no limitations of the study design; consistent, direct and precise data; and no known or suspected publication biases. Further research is unlikely to change either the estimate or our confidence in the results.

Moderate quality evidence: one of the domains is not met. Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality evidence: two of the domains are not met. Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality evidence: three of the domains are not met. We are very uncertain about the results.

No evidence: no RCTs were identified that addressed this outcome.

Subgroup analysis and investigation of heterogeneity

Where possible, subgroup analysis was used to evaluate the differences in effectiveness of 'true' MET and techniques with another name that showed a similarity to the described MET procedure.

Sensitivity analysis

We would explore the robustness of the treatment effect using sensitivity analyses if sufficient data were available. The results of the risk of bias assessment would be used to exclude studies with a high risk of bias.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies

Results of the search

In our search, 23 studies were identified, 11 of which were excluded for a variety of reasons (see Characteristics of excluded studies). Twelve studies with a total of 14 comparisons fulfilled the inclusion criteria (Figure 1). Six studies came from India (Bindra 2012; Dhinkaran 2011; Mesquita 2012; Naik 2010; Patil 2010; Rana 2009a; Rana 2009b), two from the USA (Geisser 2006a; Geisser 2006b; Selkow 2009), two from Egypt (Ellythy 2012; Ellythy 2012a), and one each from Brazil (Salvador 2005) and South Africa (Pillay 2005). All trials were published in English with the exception of the study from Brazil (Salvador 2005), which was published in Portuguese.

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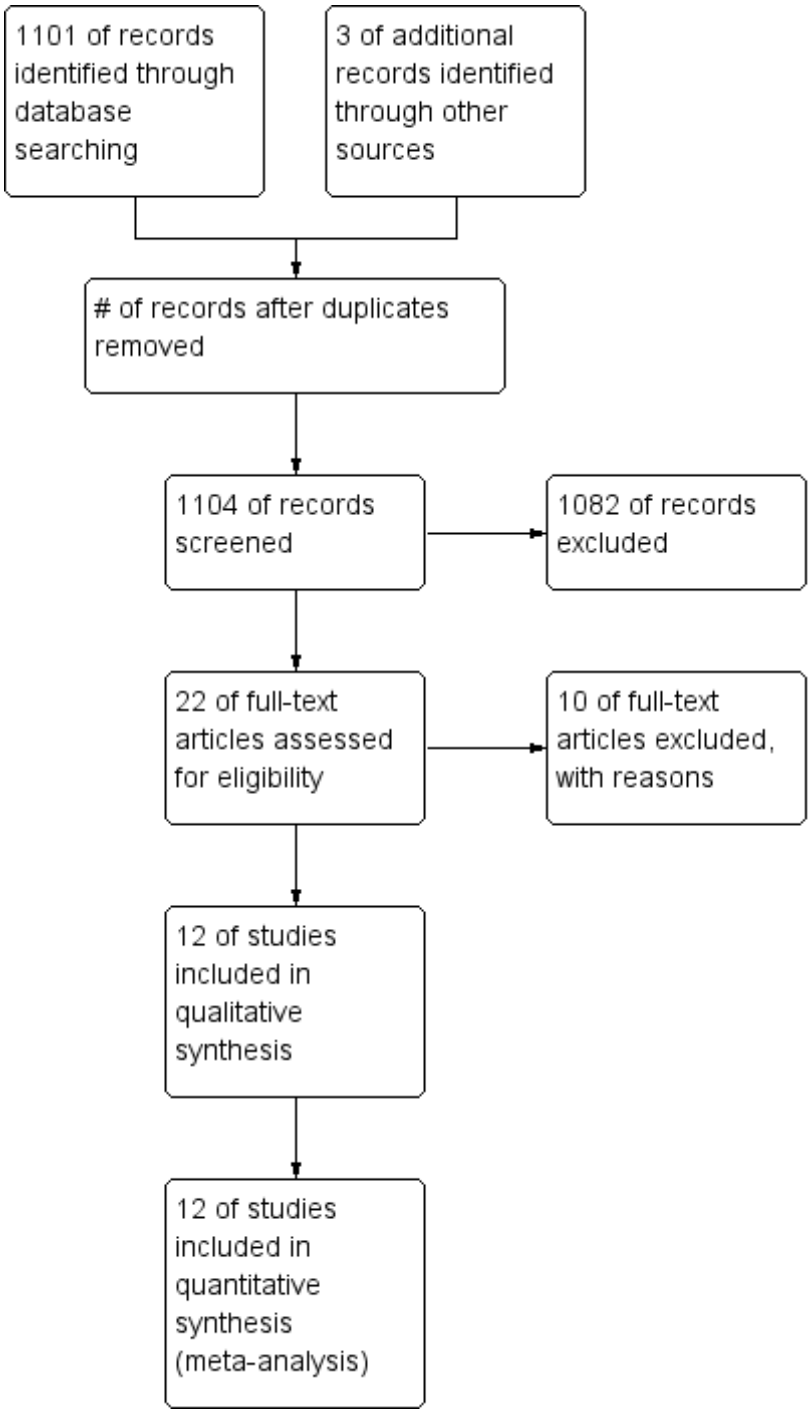
Figure 1. Study flow diagram. Muscle energy technique for non-specific low-back pain.



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Included studies

Overall, 500 participants were included in the trials. Study sample sizes ranged from 20 to 72 (median 40, interquartile range (IQR) 26). With the exception of one study without age restriction (Selkow 2009) and another lacking any reference to an age limit (Salvador 2005), all studies specified age ranges between 18 and 65 years. Only three studies included participants older than 50 years (Geisser 2006a; Geisser 2006b; Mesquita 2012; Naik 2010). Five studies focused on acute non-specific LBP (Naik 2010; Patil 2010; Pillay 2005; Salvador 2005; Selkow 2009) whereas the other seven studies included participants with chronic non-specific back pain (Ellythy 2012; Ellythy 2012a; Bindra 2012; Dhinkaran 2011; Geisser 2006a; Geisser 2006b; Rana 2009a; Rana 2009b; Mesquita 2012). Six studies compared MET plus a specific intervention with other therapies plus that intervention: MET with moist heat versus positional release therapy with moist heat (Naik 2010), MET with physical therapy versus myofascial release with physical therapy (Ellythy 2012), MET with physical therapy versus strain counterstrain with physical therapy (Ellythy 2012a), MET with specific exercises versus sham treatment with specific exercises (Geisser 2006a), MET with non-specific exercises versus sham treatment with non-specific exercises (Geisser 2006b), MET with corrective exercises versus TENS with corrective exercises (Dhinkaran 2011), MET with conventional therapy versus trunk muscle stabilization exercises with conventional therapy (Mesquita 2012), and MET with exercises versus Maitland's mobilization with exercises (Rana 2009a). One study compared MET to a sham manual treatment (Selkow 2009) and three studies compared MET to other treatments: passive mobilization (Pillay 2005); ultrasound, TENS and exercises (Bindra 2012); and TENS (Salvador 2005). Two studies compared MET plus a specific intervention with that intervention alone: one using interferential therapy (Patil 2010) and the other using exercises (Rana 2009b) Table 1

The average number of treatments reported in the protocol of the included studies was 6 (SD = 4) and the average treatment period was 13 days (SD = 11). All studies measured pain intensity as an outcome using a VAS, with the exception of two studies that used a NRS (Dhinkaran 2011; Pillay 2005) and another two studies that used the McGill Pain Questionnaire (Ellythy 2012; Ellythy 2012a). Eight studies reported on pain, functional disability status and range of motion (Ellythy 2012; Ellythy 2012a; Geisser 2006a; Geisser 2006b; Mesquita 2012; Naik 2010; Patil 2010; Pillay 2005; Rana 2009a). One study reported pain, functional disability status and functional leg length measurement (Bindra 2012), whereas other studies reported pain and functional disability status (Dhinkaran 2011), pain and pain provocation testing (Selkow 2009) and pain and muscle length (Salvador 2005). Functional disability status was measured by the Oswestry-Disability Index (Dhinkaran 2011; Ellythy 2012; Ellythy 2012a; Pillay 2005; Rana 2009a; Rana 2009b), a modified Oswestry Disability Index (Bindra 2012; Mesquita 2012; Naik 2010; Patil 2010), or the Quebec Back Pain Disability Scale (Geisser 2006a; Geisser 2006b).

Seven studies reported that no adverse effects occurred (including additional information) (Bindra 2012; Dhinkaran 2011; Ellythy 2012; Ellythy 2012a; Pillay 2005; Rana 2009a; Rana 2009b; Selkow 2009), whereas the remaining seven studies did not mention adverse effects (Geisser 2006a; Geisser 2006b; Mesquita 2012; Naik 2010; Patil 2010; Salvador 2005).

Excluded studies

Ten studies were excluded for different reasons: three studies were not RCTs (Brodin 1982; Lamberth 2005; Wilson 2003), in three studies the intervention did not meet the operational definition of MET (use of isotonic contractions, no isometric procedure) (Adamczyk 2009; Franca 2012; Kofotolis 2006), one study focused on specific back pain (Stodolny 1989), and three studies did not report the outcomes of interest (only strength of muscle) (Alaksiev 1996; Martin 1986; Risch 1993).

Risk of bias in included studies

All studies had a high risk of bias with the exception of one study which met the criteria for low risk (Selkow 2009). Figure 2 shows the review authors' judgements about each risk of bias item presented as percentages across all included studies. Figure 3 summarizes review authors' judgements about each risk of bias item for each included study.

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Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

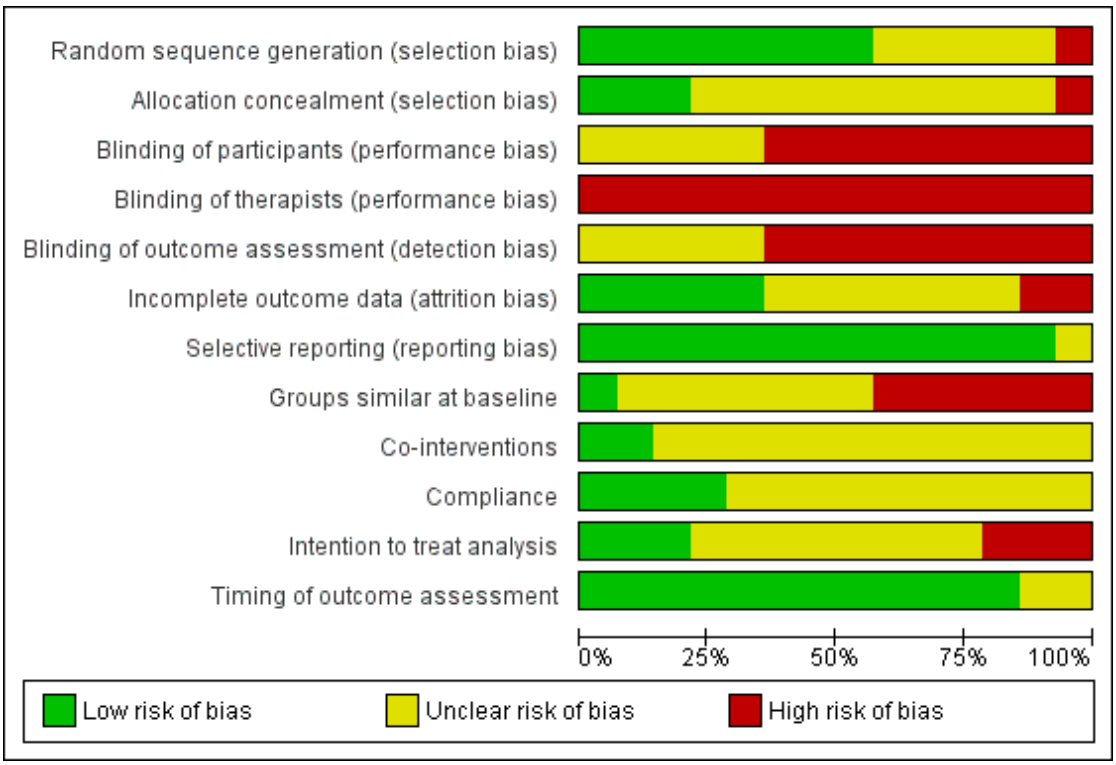

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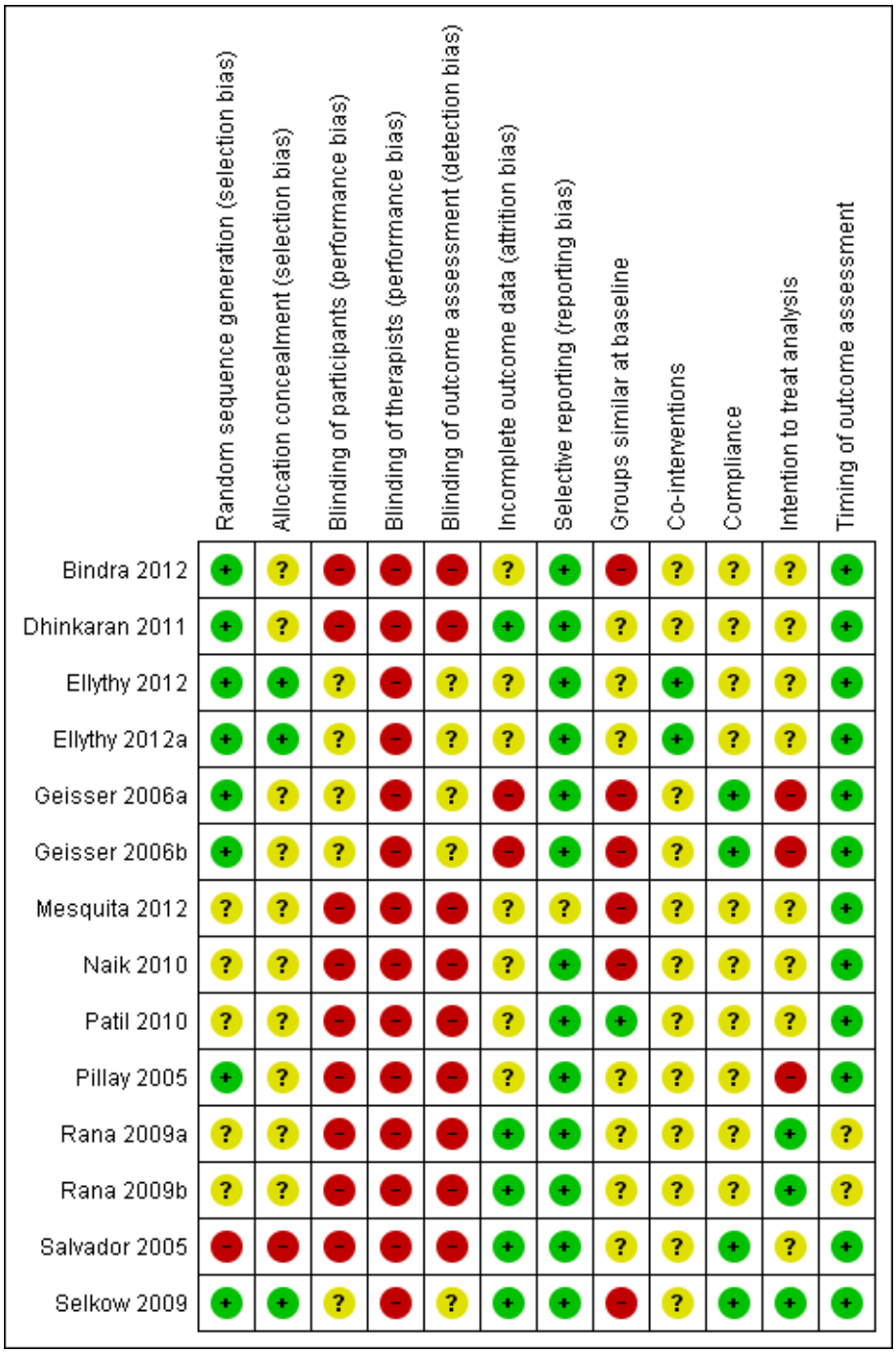
Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



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Allocation

Seven studies reported an adequate randomisation procedure (Bindra 2012; Dhinkaran 2011; Ellythy 2012; Ellythy 2012a; Geisser 2006a; Geisser 2006b; Pillay 2005; Selkow 2009), in four studies the randomisation procedure was unclear (Ellythy 2012; Ellythy 2012a; Mesquita 2012; Naik 2010; Patil 2010; Rana 2009a; Rana 2009b). One study was judged to have high risk of bias due to use of an inappropriate allocation method (alternation) (Salvador 2005). One study used an appropriate method of allocation concealment (Selkow 2009), but in the remaining 11 studies concealment of allocation was unclear.

Blinding

Four of 12 studies blinded the patients in order to provide a sham treatment in the control group (Ellythy 2012; Ellythy 2012a; Geisser 2006a; Geisser 2006b; Selkow 2009). In these studies the participants got no information on which treatment procedure was performed in the intervention and control groups. The success of blinding was not tested and the procedure was therefore assessed as unclear.

Selective reporting

None of the included studies were found to have a registered protocol, so it was not possible to compare the planned and published outcomes. This aspect alone created the potential for selective outcome reporting. However, considering the fact that the included studies were small and had a short treatment period with only five treatments on average, the reporting of at least one primary and one secondary outcome made selective outcome reporting unlikely. Eight of the included studies reported on two primary outcomes (pain and functional status) and five studies reported on a secondary outcome (range of motion).

Other potential sources of bias

In five studies, primary outcome baselines were dissimilar (Bindra 2012; Geisser 2006a; Geisser 2006b; Mesquita 2012; Naik 2010; Selkow 2009), and another six studies did not report enough information to assess the comparability of important prognostic characteristics at baseline (Dhinkaran 2011; Ellythy 2012; Ellythy 2012a; Pillay 2005; Rana 2009a; Rana 2009b; Salvador 2005). In total, 72 of 144 criteria points in the risk of bias (RoB) assessment were unclear, indicating an overall poor standard of reporting amongst the included studies.

Effects of interventions

See: **Summary of findings for the main comparison** MET plus any intervention compared to other therapies plus that intervention for chronic non-specific low-back pain (LBP); **Summary of findings 2** MET compared to sham MET for acute non-specific low-back pain (LBP); **Summary of findings 3** MET compared to all other therapies for acute non-specific low-back pain (LBP); **Summary of findings 4** MET compared to all other therapies for chronic non-specific low-back pain (LBP); **Summary of findings 5** MET plus any intervention compared to that same intervention alone for acute non-specific low-back pain (LBP); **Summary of findings 6** MET plus any intervention compared to that same intervention alone for chronic non-specific low-back pain (LBP); **Summary of findings 7** MET plus any intervention compared to other therapies plus that intervention for acute non-specific low-back pain (LBP)

MET plus any intervention versus other therapies plus that intervention for chronic non-specific LBP

Seven studies (Dhinkaran 2011; Ellythy 2012; Ellythy 2012a; Geisser 2006a; Geisser 2006b; Mesquita 2012; Rana 2009a) with 232 participants were found for this comparison. The studies provided low-quality evidence (high RoB, imprecision) of no difference regarding pain (MD 0.0, 95% CI -2.97 to 2.98) and functional status (SMD -0.18, 95% CI -0.43 to 0.08).

MET versus sham MET for acute non-specific LBP

Only one study (Selkow 2009) was found to have a low risk of bias. The small study (20 participants) demonstrated low level evidence (downgraded due to imprecision and indirectness) of no clinically relevant difference between MET and sham MET (MD 14.20, 95% CI -10.14 to 38.54) on pain. The reliability of the information reported in this study can be questioned given the unusual pattern of baseline pain scores among the two groups. Worst pain in the MET group was much higher than worst pain in the control group (29.3 versus 18.1), but current pain was much lower in the MET group than current pain in the control group (18.2 versus 36.6).

MET versus all other therapies for acute non-specific LBP

Two studies (Pillay 2005; Salvador 2005) with high risk of bias and involving 88 people were included for this comparison. For pain there was very low-quality evidence (high RoB, inconsistency, imprecision) of no clinically relevant difference between MET and other therapies (MD -10.72, 95% CI -32.57 to 11.13). For functional status, which was based only on one study (Pillay 2005)

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with 60 participants, there was low-quality evidence (high RoB, imprecision) of no difference between MET and other therapies (MD 0.87, 95% CI -6.31 to 8.05).

MET versus all other therapies for chronic non-specific LBP

Based upon one study (Bindra 2012) with 30 participants, there was low-quality evidence (high RoB, imprecision) of no clinically relevant difference between MET and other therapies regarding pain (MD -9.70, 95% CI -20.20 to 0.80) and functional status (MD -4.10, 95% CI -9.53 to 1.33).

MET plus any intervention versus that same intervention alone for acute non-specific LBP

Based upon one study (Patil 2010) with 40 participants, there was low-quality evidence (high RoB, imprecision) of no clinically relevant difference between MET plus any intervention versus that same intervention for acute non-specific LBP regarding pain (MD -3, 95% CI -11.37 to 5.37) and low-quality evidence of an effect in favour of MET for functional status (MD -17.6, 95% CI -27.05 to -8.15).

MET plus any intervention versus that same intervention alone for chronic non-specific LBP

Based upon one study (Rana 2009b) with 30 participants, there was low-quality evidence (high RoB, imprecision) of an effect in favour of MET plus any intervention versus that same intervention for chronic non-specific LBP regarding pain (MD -34.1, 95% CI -38.43 to -29.77) and functional status (MD -22, 95% CI -27.41 to -16.59).

MET plus any intervention versus other therapies plus that intervention for acute non-specific LBP

One small study (Naik 2010) (20 participants) provided low-quality evidence (high RoB, imprecision) for no difference regarding pain (MD 5.20, 95% CI -3.03 to 13.43) and functional status (MD 6.0, 95% CI -0.49 to 12.49).

Secondary outcomes

Seven studies reported range of motion as a secondary outcome. One study (Mesquita 2012) reported a significantly larger mean increase in lumbar flexion ($P < 0.05$) and extension ($P < 0.05$) in the MET group compared to control. One study (Naik 2010) reported no difference in lumbar extension between the MET and control groups. Another study (Rana 2009a; Rana 2009b) reported significantly larger changes in flexion, medial and lateral rotation of the hip in the MET group compared to the exercise control, but insufficient data were reported to calculate an effect size. One study (Ellythy 2012a) reported no difference in lumbar flexion and extension between MET and the control group. Two studies (Ellythy 2012; Pillay 2005) reported there was no between-group difference in range of motion for flexion, extension plus left and right side bending, whereas another study (Patil 2010) concluded that MET and the control intervention were equally effective in increasing side flexion, spinal flexion and spinal extension. Due to the different measures and regions examined for range of motion, no meta-analysis was conducted for this secondary outcome.

Five studies (Bindra 2012; Geisser 2006a; Geisser 2006b; Pillay 2005; Salvador 2005; Selkow 2009) reported outcomes other than those defined as primary or secondary outcomes in this review.

None of the studies reported on changes in medication. Seven studies (Bindra 2012; Dhinkaran 2011; Ellythy 2012; Ellythy 2012a; Pillay 2005; Rana 2009a; Rana 2009b; Selkow 2009) reported that no adverse events were observed, whereas the other five studies (Geisser 2006b; Geisser 2006b; Mesquita 2012; Naik 2010; Patil 2010; Salvador 2005) did not report any information on adverse events.

Sensitivity analyses

This review included only one study with a low RoB and 11 studies with a high RoB, so the planned sensitivity analyses investigating the influence of study methodological quality were not performed. Initially we planned to assess the clinical relevance and incorporate that information in the conclusions. However, the overall level of evidence is such that we feel that it is difficult to draw any firm conclusions. Therefore, we did not use the information regarding the clinical relevance in this review.

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ADDITIONAL SUMMARY OF FINDINGS *[Explanation]*

MET compared to sham MET for acute non-specific LBP

Patient or population: patients with non-specific low-back pain (LBP)
Settings: university physiotherapy department
Intervention: MET
Comparison: sham MET

Outcomes	Treatment effect	No of participants (studies)	Quality of the evidence (GRADE)	Comments
Pain A 0 to 100 visual analogue scale, where 0 equals no pain at all and 100 is the worst pain imaginable Follow-up: post-treatment	The treatment group showed increased pain at the follow-up compared to the control, but this difference was not likely to be clinically relevant	20 (1 study)	⊕⊕◯◯ **low**[1,2]	
Functional status	Not reported Not reported	-	No evidence	-
General well-being	Not reported Not reported	-	No evidence	-
Adverse events	Not reported Not reported	-	No evidence	-

CI: confidence interval

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Sample size <400
[2] Unusual pattern of baseline pain scores

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MET compared to all other therapies for acute non-specific LBP

Patient or population: patients with non-specific low-back pain (LBP)
Settings: university and hospital staff, garbage collectors
Intervention: MET
Comparison: all other therapies

Outcomes	Assumed risk	Comparative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	all other therapies, acute BP	MET			
Pain A 0 to 100 visual or numerical scale, where 0 equals no pain at all and 100 is the worst pain imaginable Follow-up: post- treatment	The mean pain ranged from **25 to 32** points in the control groups	The mean change in pain in the intervention groups was **10.72 lower** (32.57 lower to 11.13 higher)	88 (2 studies)	⊕◯◯◯ **very low**[1,2,3]	This difference is not statistically significant and not likely to be clinically relevant
Functional status Oswestry; 100-point scale where 0 equals no disability and 100 is seriously disabled. Follow-up: post- treatment	The treatment group showed a worse-rated functional status at the follow-up compared to the control, but this difference was not likely to be clinically relevant		60 (1 study)	⊕⊕◯◯ **low**[1,3]	-
General well-being	Not reported Not estimable		-	No evidence	-
Adverse events	Not reported Not estimable		-	No evidence	-

CI: confidence interval

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] High risk of bias in included studies
[2] Substantial heterogeneity, $I^2 > 60\%$
[3] Sample size <400

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MET compared to all other therapies for chronic non-specific LBP

Patient or population: patients with non-specific low-back pain (LBP)
Settings: physiotherapy clinic
Intervention: MET
Comparison: all other therapies

Outcomes	Treatment effect	No of participants (studies)	Quality of the evidence (GRADE)	Comments
Pain A 0 to 100 visual analogue scale, where 0 equals no pain at all and 100 is the worst pain imaginable Follow-up: post-treatment	The treatment group showed decreased pain at the follow-up compared to the control, but this difference was not likely to be clinically relevant	30 (1 study)	⊕⊕◯◯ **low**[1,2]	
Functional status Oswestry; 100-point scale where 0 equals no disability and 100 is seriously disabled Follow-up: post-treatment	The treatment group showed a better-rated functional status at the follow-up compared to the control, but this difference was not likely to be clinically relevant	30 (1 study)	⊕⊕◯◯ **low**[1,2]	
General well-being	Not reported Not estimable	-	No evidence	-
Adverse events	Not reported Not estimable	-	No evidence	-

CI: confidence interval

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] High risk of bias in included studies
[2] Sample size <400

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MET plus any intervention compared to that same intervention alone for acute non-specific LBP

Patient or population: patients with non-specific low-back pain (LBP)
Settings: physiotherapy department
Intervention: MET plus any intervention
Comparison: that same intervention alone

Outcomes	Treatment Effect	No of participants (studies)	Quality of the evidence (GRADE)	Comments
Pain A 0 to 100 visual analogue scale, where 0 equals no pain at all and 100 is the worst pain imaginable Follow-up: post-treatment	The treatment group showed decreased pain at the follow-up compared to the control, but this difference was not likely to be clinically relevant	40 (1 study)	⊕⊕◯◯ **low**[1,2]	-
Functional status Oswestry; 100-point scale where 0 equals no disability and 100 is seriously disabled Follow-up: post-treatment	The treatment group showed a better-rated functional status at the follow-up compared to the control and this difference was may be clinically relevant	40 (1 study)	⊕⊕◯◯ **low**[1,2]	-
General well-being	Not reported Not estimable	-	No evidence	-
Adverse events	Not reported Not estimable	-	No evidence	-

CI: confidence interval

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] High risk of bias in included studies
[2] Sample size <400

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MET plus any intervention compared to that same intervention alone for chronic non-specific LBP

Patient or population: patients with non-specific low-back pain (LBP)
Settings: physiotherapy clinic
Intervention: MET plus any intervention
Comparison: that same intervention alone, chronic BP

Outcomes	Treatment effect	No of participants (studies)	Quality of the evidence (GRADE)	Comments
Pain A 0 to 100 visual analogue scale, where 0 equals no pain at all and 100 is the worst pain imaginable Follow-up: post-treatment	The treatment group showed decreased pain at the follow-up compared to the control and this difference was likely to be clinically relevant	30 (1 study)	⊕⊕◯◯ **low**[1,2]	-
Functional status Oswestry; 100-point scale where 0 equals no disability and 100 is seriously disabled Follow-up: post-treatment	The treatment group showed a better-rated functional status at the follow-up compared to the control and this difference was likely to be clinically relevant	30 (1 study)	⊕⊕◯◯ **low**[1,2]	-
General well-being	Not reported Not estimable	-	No evidence	-
Adverse events	Not reported Not estimable	-	No evidence	-

CI: confidence interval

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] High risk of bias in included studies
[2] Sample size <400

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MET plus any intervention compared to other therapies plus that intervention for acute non-specific LBP

Patient or population: patients with non-specific low-back pain (LBP)
Settings: physiotherapy department
Intervention: MET plus any intervention
Comparison: other therapies plus that intervention, acute back pain (BP)

Outcomes	Treatment effect	No of participants (studies)	Quality of the evidence (GRADE)	Comments
Pain A 0 to 100 visual analogue scale, where 0 equals no pain at all and 100 is the worst pain imaginable Follow-up: post-treatment	The treatment group showed increased pain at the follow-up compared to the control, but this difference was not likely to be clinically relevant	60 (1 study)	⊕⊕◯◯ **low**[1,2]	
Functional status Oswestry; 100-point scale where 0 equals no disability and 100 is seriously disabled Follow-up: post-treatment	The treatment group showed a worse-rated functional status at the follow-up compared to the control, but this difference was not likely to be clinically relevant	60 (1 study)	⊕⊕◯◯ **low**[1,2]	
General well-being	Not reported Not estimable	-	No evidence	-
Adverse events	Not reported Not estimable	-	No evidence	-

CI: confidence interval

GRADE Working Group grades of evidence
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Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] High risk of bias in included studies
[2] Sampe size <400

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DISCUSSION

Summary of main results

Twelve studies met the inclusion criteria for this review, which included a total of 500 participants across all comparisons. The studies were very heterogeneous in regard to the participant populations, duration of low-back pain (LBP), comparison interventions, secondary outcomes and treatment interventions. The populations in each study were small, with sample sizes ranging from 20 to 72. Furthermore, all but one study were judged to have high risk of bias. Only five studies reported on adverse events, and of these studies all reported that no adverse events occurred. Due to the number and sample sizes of the studies, sufficient data were not available for the planned sensitivity analyses.

Due to the few studies involved and the range of comparison groups in these studies, seven comparisons were assessed but most with few studies. One comparison included seven studies, one included two studies, and five comparisons included only one study each. The comparison group with seven studies (MET plus any intervention versus other therapies plus that intervention for chronic non-specific LBP) demonstrated low-quality evidence for a non-significant effect regarding pain and functional status, and most estimates from other comparisons provided low-quality evidence of no difference on pain and disability outcomes. This suggests that MET is not effective in LBP but, given the low-quality of the evidence, no conclusions can be made until larger high-quality studies are available.

All studies measured pain intensity using either VAS, NRS or the McGill Pain Questionnaire, but there was probable heterogeneity in the populations between studies. Several studies recruited patients with specific clinical findings such as shortened muscles or tests purported to detect sacroiliac pain, or the detection of specific clinical aetiologies such as sacroiliac joint dysfunction. Specific examples of clinical inclusion criteria included decreased lumbar range of motion (Pillay 2005), positive Laseque and Valsalva tests (Salvador 2005), restricted lateral flexion (Patil 2010), shortened muscles (Salvador 2005), pain on performing pain provocation tests for sacroiliac dysfunction (Bindra 2012; Dhinkaran 2011), sacroiliac joint hypomobility (Bindra 2012) and anterior innominate rotation (Selkow 2009). Non-specific LBP is not likely to be a homogeneous condition, but the populations of these studies will likely be even less homogenous given the variability of specific clinical inclusion criteria.

Although all included studies treated patients using MET, there was variation between the studies for the type of MET intervention delivered. No study appeared to use a pragmatic MET approach typical of clinical practice where muscle and joint restrictions are addressed in multiple regions according to the clinical findings of the practitioner (local and remote from the site of pain). Instead, most studies focused on isolated clinical findings and treatment was limited to the specific finding or dysfunction. Although some studies allowed treatment to be guided by the clinical findings of the practitioner, detection of the findings were usually limited to a particular region, diagnoses or muscle groups. Thus some studies allowed practitioners to treat according to diagnostic findings but limited to the pelvic region (Geisser 2006a; Geisser 2006b) or a 'diagnosed innominate dysfunction' (Rana 2009a; Rana 2009b). Others limited the treatment to specific dysfunctions, regions or muscle groups, such as treatment for either an 'anterior or posterior innominate rotation' (Bindra 2012; Dhinkaran 2011; Selkow 2009), segmental side bending at L3 (Mesquita 2012), 'fixated spinal joint' (Pillay 2005) or for stretching erector spinal muscles (Naik 2010), quadratus lumborum muscles (Patil 2010) or hip musculature (Salvador 2005). It is likely that many of these treatments do not represent the therapeutic approach advocated by muscle energy authors (Greenman 2003; Mitchell 1999; Mitchell 2001a; Mitchell 2001b) or reflect everyday clinical practice, and results may have been different if these approaches were used.

Although MET is commonly used by osteopaths and other manual therapists, it is rarely delivered as an isolated treatment. In clinical practice, MET is typically performed with other manual and non-manual modalities in an integrated approach (Fryer 2010b; Johnson 2003). It is therefore not surprising that few studies have examined patients with LBP using applications of this isolated treatment modality. A number of clinical trials have examined the effect of osteopathic management on the treatment of LBP where MET has been a component of the treatment. Many of these studies have reported favourable results, but it is not possible to determine the influence of MET in the treatment package. Several systematic reviews have been performed using these studies to determine the effect of osteopathic management for LBP (Licciardone 2005; Orrock 2013) or musculoskeletal pain (Posadzki 2011). The conclusions of theses reviews have differed from generally favourable outcomes (Licciardone 2005) to inconclusive outcomes due the lack of available high-quality studies (Orrock 2013; Posadzki 2011).

Overall completeness and applicability of evidence

The included studies were generally of low-quality with small sample sizes, high risk of bias, and lacked adequate standard treatment protocols and follow-up periods. The analysis involved post-treatment comparisons and there was no evidence regarding the long term effectiveness of the interventions. For these reasons, further research is very likely to have an important impact on the estimate of treatment effect and recommendations for clinical practice.

Quality of the evidence

Overall, the methodological quality of the 12 studies was poor and all but one study (Selkow 2009) was found to have high risk of

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bias. None of the included studies provided complete information regarding the methods or results, with 72 of the criteria determined as being 'unclear'. This lack of information contributed to the determination of high risk for many studies.

In the assessment of selection bias, one study had a high risk of bias in the randomisation and allocation procedures. The randomisation of four other studies was unclear, as were the procedures for allocation in eight other studies. The four studies that used a sham treatment as the control (Geisser 2006a; Geisser 2006b; Selkow 2009) or another treatment (Ellythy 2012; Ellythy 2012a) attempted to blind the patients to the sham nature of the intervention, but the success of the blinding was not tested so the procedure was assessed as unclear. Further risk of bias was found in baseline characteristics, where the primary outcomes in five studies were dissimilar at baseline (Bindra 2012; Geisser 2006a; Geisser 2006b; Mesquita 2012; Naik 2010; Selkow 2009). Another six studies did not provide enough information to determine whether important prognostic characteristics were similar at baseline (Dhinkaran 2011; Ellythy 2012; Ellythy 2012a; Pillay 2005; Rana 2009a; Rana 2009b; Salvador 2005).

Assessment of blinding is an issue for studies using manual therapy because practitioners cannot be easily blinded from the treatment intervention they deliver. Participants inevitably know when manual therapy is delivered and it is far more difficult to mask the applied manual technique compared to interventions such as pharmaceuticals. The difficulty of blinding creates a disadvantage for nearly all manual therapy studies when assessed using the risk of bias tool.

The quality of the evidence was also assessed using the GRADE approach. In all the comparisons except one, the evidence was downgraded because of limitations in design because more than 25% of the participants came from studies with a high risk of bias. The one comparison that was not downgraded for this reason (MET versus sham MET for acute non-specific LBP) involved a single study with low risk of bias (Selkow 2009). Every comparison was downgraded for imprecision because the total number of participants was less than 400 for each outcome. Additionally, one comparison was downgraded due to inconsistency because of the presence of significant statistical heterogeneity and another downgraded due to indirectness. The quality of evidence for the many comparisons ranged from low to very low.

Potential biases in the review process

The main biases in this review can be attributed to the small number of studies, the small sample sizes of the studies, and the high risk of bias in all but one of the studies. Given this, the data analysed in this review were not robust and future high-quality studies may have a large impact on the estimate of effect sizes.

The strengths of this review include the extensive literature search and the outcome measures. The search strategy was not limited to only one language but to different languages (English, French, Spanish, Portuguese, Italian, Dutch and German) and was not limited to the published literature. All studies used primary measures of pain intensity, which is an outcome that is clinically relevant and meaningful to patients.

Agreements and disagreements with other studies or reviews

No agreements or disagreements exist because no other reviews are available.

AUTHORS' CONCLUSIONS

Implications for practice

The quality of research related to testing the effectiveness of MET is poor. Studies are generally small and at high risk of bias due to methodological deficiencies. Studies conducted to date generally provide low-quality evidence that MET is not effective for patients with non-specific LBP. There is not sufficient evidence to reliably determine whether MET is likely to be effective in practice and large, methodologically-sound studies are necessary to investigate this question. Given this, no implications for practice can be made at this stage.

Implications for research

There is a need for larger, higher-quality studies with more robust methodology. Studies should clearly describe all methods, have larger sample sizes, use robust methods of statistical analysis, demonstrate baseline equivalence of patient characteristics between groups, and use treatment protocols that can be generalised to clinical practice.

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* *Indicates the major publication for the study*

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CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by year of study]*

Pillay 2005

Methods	RCT; allocation procedure unclear
Participants	Sixty patients aged between 18 and 45 years; method of randomisation: drawing a piece of paper with group A or B; study setting: chiropractic day clinic at Durban University of Technology 23 males and 37 females; 9 males and 21 females aged 34.23 ± 6 years (MET), 14 males and 16 females aged 31.8 ± 7.65 years (control) Inclusion criteria: patients with low back pain of two months or less duration; pain confined to the lumbar region without radiation to the buttocks and lower extremities; patients aged from 18 to 45 years; decreased lumbar range of motion; an initial pain rating score of 5 to 10 on the numerical pain rating scale Exclusion criteria: patients with paraesthesias and numbness, motor weakness, absent or diminished muscle reflexes; patients with spondylolisthesis, previous back surgery or a history of trauma to the lower back; patients with any organic pathology that may have contributed to low-back pain; patients who received other forms of treatment for low-back pain including massage, manipulation, electro-therapeutic or electromagnetic treatment, acupuncture, traction, low-back exercises and those on any form of medication, including topical rubs; patients who refused to sign the informed consent form; patients who engaged in activities that varied from their normal daily routine; chiropractic students from fourth to sixth year were excluded, and the sample included no more than 10% of first to third year students
Interventions	1) MET (N = 30). 2) passive mobilization (N = 30) Each patient received four treatments over a two week period with a fifth follow-up scheduled one week after treatment ended. Measurements were taken on the first, third and fifth visits
Outcomes	NRS-101 pain scale, Oswestry Disability Index (ODI), lumbar range of motion, pain pressure algometer
Notes	Results: NRS 101 pain (average of pain when it was at its least and when it was at its worst). After 3 weeks: mean change MET group -19.22 mm (± 15.43 mm), control group -18.59 mm (± 10.70 mm) Oswestry Disability Index (ODI) after 3 weeks: mean change MET group -16.05 (± 12. 05), control group -16.92 (± 16.05) Algometer pain pressure threshold after 3 weeks: mean change MET group -1.17 (± 1. 04), control group -1.25 (± 1.13) Adverse events: no adverse events Dropouts: number of dropouts not reported. Dropouts in the study were eliminated and only results of those patients that completed the 5 treatments were considered Conclusion: "The treatment effects between the groups were not significant, indicating that there was no additional benefit of MET over passive mobilization. The treatment was not harmful, but provided as much benefit as the control."

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Pillay 2005 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Drawing paper
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of participants (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible, patient-reported outcomes
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Number of dropouts not reported
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	Unclear risk	Insufficicent data on prognostic factors
Co-interventions	Unclear risk	No information
Compliance	Unclear risk	No information
Intention to treat analysis	High risk	Not described
Timing of outcome assessment	Low risk	One week follow-up

Salvador 2005

Methods	RCT; bias in randomisation and allocation procedure unclear
Participants	A total of 28 subjects randomly allocated to 2 treatment groups; method of randomisation: alternation; study setting: subjects were selected among workers at a garbage collection company 28 males Inclusion criteria: subjects (only males) with an acute mechanical low-back pain for at most 3 weeks; no medical treatment or physical therapy in the last 2 weeks; positive Laseque and Valsalva test. The participants must have also one shortened muscle (M erector spinae longissimus, M biceps femoris, M semimembranosus, M semitendinosus, M piriformis or M quadratus lumborum) Exclusion criteria: chronic back pain; rheumatoid arthritis; osteoporosis or fracture

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Salvador 2005 (*Continued*)

Interventions	1) Muscle energy technique (N = 14); 2) transcutaneous electrical nerve stimulation (TENS) (N = 14) One treatment was given in each group.
Outcomes	Pain perception on Visual Analogue Scale (VAS) 100 mm for current pain and muscle length test after treatment
Notes	Results Current pain: baseline mean MET group 43.9 mm (± 20.2 mm), control group 32.1 mm (± 27.0 mm) (P = 0.12) After intervention: mean MET group 17.4 mm (± 15.0 mm), control group not specified Differences in mean: MET group 30.1 mm (± 28.5 mm), control group 7.1 mm (± 5.4 mm) (P = 0.0008) Adverse events: not reported Dropouts: not reported Conclusion: "Muscle energy technique with post-contraction relaxation proves efficient to reduce mechanical acute low back pain…mainly in the cases with severe pain and spasms."

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	Alternation
Allocation concealment (selection bias)	High risk	Alternation
Blinding of participants (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible, patient-reported outcomes
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	Low risk	No evidence of selective reporting
Groups similar at baseline	Unclear risk	Insufficient information
Co-interventions	Unclear risk	No information
Compliance	Low risk	One treatment only
Intention to treat analysis	Unclear risk	Not described

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Salvador 2005 (*Continued*)

Timing of outcome assessment	Low risk	Immediately post- treatment

Geisser 2006b

Methods	RCT; unclear allocation treatment assignment
Participants	A total of 100 subjects randomly allocated to 4 treatment groups; randomisation procedure: block randomisation scheme; study setting: subjects were recruited from individuals presenting to the University of Michigan Spine Program for treatment 41 males and 59 females; age 40.7 ± 11.3 years: age group, 1 39.3 ± 12.8; group 2, 38.7 ± 9.4; group 3, 36.5 ± 14.4; group 4, 46.3 ± 9.5; mean duration of pain 76.9 ± 97.4 months: group 1, 63.1 ± 109.6; group 2, 82.1 ± 99.5; group 3, 88.2 ± 105.8; group 4, 63.1 ± 67.8 18 subjects had previous lumbar surgery (laminectomy or discectomy) Inclusion criteria: age between 18 and 65 years; a single or primary complaint of CLBP; musculoskeletal pain based on evaluation by the physician or physical therapist Exclusion criteria: Down's syndrome; osteoporosis of the spine; agenesis of the odontoid process; primary joint disease such as active rheumatoid arthritis; metabolic bone disease; malignant bone disease; fracture; hypermobility of the lumbar or sacral spine; cardiovascular or other medical disorder; evidence of radiculopathy or primary complaint of radiating pain; pregnancy; severe psychiatric disturbance
Interventions	1) Muscle energy technique and specific exercises (N = 21); 2) sham treatment and specific exercises (N = 18); 3) muscle energy technique and non-specific exercises (N = 15); 4) sham treatment and non-specific exercises (N = 18) Five treatments were given in each group Subjects were allowed to continue their use of pain medications, but were asked to not change their usage during the course of the study
Outcomes	Pain perception on Visual Analogue Scale (VAS), McGill Pain Questionnaire, Quebec Back Pain Disability Scale, Multidimensional Pain Inventory, Manual Medicine Screening Evaluation, satisfaction with treatment
Notes	Results: visual analogue scale for pain Pretreatment mean: group 1, 4.45 ± 2.3; group 2, 3.84 ± 2.0; group 3, 3.91 ± 2.5; group 4, 5.20 ± 2.2 Postreatment mean: group 1, 2.40 ± 2.0; group 2, 3.46 ± 2.0; group 3, 3.39 ± 2.5); group 4, 4.29 ± 2.7 McGill Pain Questionnaire Pretreatment mean: group 1, 22.24 ± 12.7; group 2, 22.00 ± 7.6; group 3, 25.13 ± 11.6; group 4, 23.39 ± 12.6 Postreatment mean: group 1, 12.86 ± 10.9; group 2, 18.00 ± 10.3; group 3, 22.67 ± 16.6); group 4, 22.11 ± 11.9 Quebec Back Pain Disability Scale Pretreatment mean: Group 1, 36.05 ± 20.8; group 2, 34.25 ± 19.6; group 3, 38.47 ± 16.0; group 4, 51.08 ± 18.6 Postreatment mean: Group 1, 31.05 ± 19.1; group 2, 33.28 ± 19.4; group 3, 31.80 ± 18.0; group 4, 42.50 ± 19.3

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Geisser 2006b (*Continued*)

	Interference Subscale of the Multidimensional Pain Inventory Pretreatment mean: Group 1, 37.24 ± 14.1; group 2, 36.01 ± 14.4; group 3, 35.07 ± 14.0; group 4, 43.83 ± 9.8 Postreatment mean: Group 1, 32.86 ± 13.6; group 2, 36.06 ± 14.9; group 3, 27.67 ± 15.1; group 4, 38.89 ± 11.5 Satisfaction with and perception of treatment: group differences are not statistically significant Adverse events: not reported Dropouts: 28 dropouts. Group 1 = 5, group 2 = 7, group 3 = 9, group 4 = 7 dropouts. Persons who dropped out of the study were more likely to be receiving compensation (Chi^2 = 4.23, P = 0.04) and reported higher levels of pain on the VAS (t = −2.34, P = 0.02) and the MPQ (t = −5.04, P < 0.001). Subjects who did not complete the study perceived themselves as being more disabled on the QBPDS (t = −2.60, P = 0.02) and the MPI Interference subscale (t = −2.37, P = 0.02). They also had a higher likelihood of being male (Chi^2 = 4.19, P = 0.04). No differences were observed for age, litigation, surgical status, pain duration, or work status Conclusion: "When controlling for pretreatment scores, subjects receiving manual therapy with specific adjuvant exercise reported significant reductions in pain."

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Block randomisation
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of participants (performance bias)	Unclear risk	Unclear, blinding not tested
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear, patient-reported outcomes
Incomplete outcome data (attrition bias) All outcomes	High risk	High dropout rate
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	High risk	Between group difference in pain intensity
Co-interventions	Unclear risk	No information
Compliance	Low risk	No difference between groups
Intention to treat analysis	High risk	Not described

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Geisser 2006b (*Continued*)

Timing of outcome assessment	Low risk	After five treatments

Geisser 2006a

Methods	RCT; unclear allocation treatment assignment
Participants	A total of 100 subjects randomly allocated to 4 treatment groups; randomisation procedure: block randomisation scheme; study setting: subjects were recruited from individuals presenting to the University of Michigan Spine Program for treatment 41 males and 59 females; age 40.7 ± 11.3 years: age group 1, 39.3 ± 12.8; group 2, 38.7 ± 9.4; group 3, 36.5 ± 14.4; group 4 46.3 ± 9.5 Mean duration of pain 76.9 ± 97.4 months: group 1, 63.1 ± 109.6; group 2, 82.1 ± 99.5; group 3, 88.2 ± 105.8; group 4, 63.1 ± 67.8 18 subjects had previous lumbar surgery (laminectomy or discectomy) Inclusion criteria: age between 18 and 65 years; a single or primary complaint of CLBP; musculoskeletal pain based on evaluation by the physician or physical therapist Exclusion criteria: Down's syndrome; osteoporosis of the spine; agenesis of the odontoid process; primary joint disease such as active rheumatoid arthritis; metabolic bone disease; malignant bone disease; fracture; hypermobility of the lumbar or sacral spine; cardiovascular or other medical disorder; evidence of radiculopathy or primary complaint of radiating pain; pregnancy; severe psychiatric disturbance
Interventions	1) Muscle energy technique and specific exercises (N = 21); 2) sham treatment and specific exercises (N = 18); 3) muscle energy technique and non-specific exercises (N = 15); 4) sham treatment and non-specific exercises (N = 18) Five treatments were given in each group Subjects were allowed to continue their use of pain medications, but were asked to not change their usage during the course of the study
Outcomes	Pain perception on Visual Analogue Scale (VAS), McGill Pain Questionnaire, Quebec Back Pain Disability Scale, Multidimensional Pain Inventory, Manual Medicine Screening Evaluation, satisfaction with treatment
Notes	Results: VAS for pain Pretreatment mean: group 1, 4.45 ± 2.3; group 2, 3.84 ± 2.0; group 3, 3.91 ± 2.5; group 4, 5.20 ± 2.2 Postreatment mean: group 1, 2.40 ± 2.0; group 2, 3.46 ± 2.0; group 3, 3.39 ± 2.5); group 4, 4.29 ± 2.7 McGill Pain Questionnaire Pretreatment mean: group 1, 22.24 ± 12.7; group 2, 22.00 ± 7.6; group 3, 25.13 ± 11.6; group 4, 23.39 ± 12.6 Postreatment mean: group 1, 12.86 ± 10.9, group 2, 18.00 ± 10.3; group 3, 22.67 ± 16.6); group 4, 22.11 ± 11.9 Quebec Back Pain Disability Scale Pretreatment mean: group 1, 36.05 ± 20.8; group 2, 34.25 ± 19.6; group 3, 38.47 ± 16.0; group 4, 51.08 ± 18.6 Postreatment mean: group 1, 31.05 ± 19.1; group 2, 33.28 ± 19.4; group 3, 31.80 ± 18.0); group 4, 42.50 ± 19.3

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	Interference Subscale of the Multidimensional Pain Inventory Pretreatment mean: group 1, 37.24 ± 14.1; group 2, 36.01 ± 14.4; group 3, 35.07 ± 14.0; group 4, 43.83 ± 9.8 Postreatment mean: group 1, 32.86 ± 13.6; group 2, 36.06 ± 14.9; group 3, 27.67 ± 15.1); group 4, 38.89 ± 11.5 Satisfaction with and perception of treatment Group differences are not statistically significant Adverse events: not reported Dropouts: 28 dropouts. Group 1 = 5, group 2 = 7, group 3 = 9, group 4 = 7 dropouts. Persons who dropped out of the study were more likely to be receiving compensation (Chi^2 = 4.23, P = 0.04) and reported higher levels of pain on the VAS (t = −2.34, P = 0.02) and the MPQ (t = −5.04, P < 0.001). Subjects who did not complete the study perceived themselves as being more disabled on the QBPDS (t = −2.60, P = 0.02) and the MPI Interference subscale (t = −2.37, P = 0.02). They also had a higher likelihood of being male (Chi^2 = 4.19, P = 0.04). No differences were observed for age, litigation, surgical status, pain duration, or work status Conclusion: "When controlling for pretreatment scores, subjects receiving manual therapy with specific adjuvant exercise reported significant reductions in pain."

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Block randomisation
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of participants (performance bias)	Unclear risk	Unclear, blinding not tested
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear, patient-reported outcomes
Incomplete outcome data (attrition bias) All outcomes	High risk	High dropout rate
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	High risk	Between group difference in pain intensity
Co-interventions	Unclear risk	No information
Compliance	Low risk	No difference between groups
Intention to treat analysis	High risk	Not described

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Geisser 2006a (*Continued*)

Timing of outcome assessment	Low risk	After five treatments

Rana 2009b

Methods	RCT; allocation procedure unclear
Participants	A total of 45 subjects randomly allocated to 3 treatment groups; randomisation procedure: lottery draw; study setting: private clinic and hospital 45 subjects mean age 22.82 ± 2.9 Inclusion criteria: patients' age between 18 and 30, with chronic low back pain for more than 3 months; not associated with any neurological symptoms; Oswestry Disability Index between 20% and 80% Exclusion criteria: traumatic or infectious conditions; tumours
Interventions	1) Muscle energy technique and exercises (N = 15); 2) Maitland's mobilization and exercises (N = 15); 3) exercises (N = 15) 6 treatments were given in group 1 and 2 over 6 days
Outcomes	Pain perception on Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), hip range of motion
Notes	Results (VAS for pain) Baseline mean: MET group 3.53 ± 0.51, Maitland group 3.73 ± 0.70, control group 3.53 ± 0.52 After 6 treatments, mean: MET group 0.20 ± 0.41, Maitland group 0.33 ± 0.48, control group 3.6 ± 0.51 Differences in mean: MET group 3.33 ± 0.62, Maitland group 3.40 ± 0.83, control group -0.07 ± 0.59 Oswestry Disability Index Baseline mean: MET group 29.6 ± 5.2, Maitland group 27.8 ± 5, control group 28.5 ± 5.3 After 6 treatments mean: MET group 2.4 ± 5.2, Maitland group 5.7 ± 5.7, control group 23.3 ± 7.6 Differences in mean: MET group 27.2 ± 5.6, Maitland group 22.1 ± 6.8, control group 5.2 ± 9.1 Hip range of motion: significant changes in flexion, medial and lateral rotation in the MET and Maitland group. Data were only shown in a table Adverse events: no adverse events Dropouts: no dropouts Conclusion: "This study resulted in benefits of manual therapy techniques such as Muscle Energy Technique, G.D. Maitland's concept of mobilization in improving the pain and functional ability…"

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**

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Rana 2009b (*Continued*)

Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Not stated
Blinding of participants (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible, patient-reported outcomes
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	Unclear risk	Insufficent data
Co-interventions	Unclear risk	No information
Compliance	Unclear risk	No information
Intention to treat analysis	Low risk	No dropouts
Timing of outcome assessment	Unclear risk	Unclear

Rana 2009a

Methods	RCT; allocation procedure unclear
Participants	A total of 45 subjects randomly allocated to 3 treatment groups; randomisation procedure: lottery draw; study setting: private clinic and hospital 45 subjects, mean age 22.82 ± 2.9 Inclusion criteria: patients' age between 18 and 30 years, with chronic low-back pain for more than 3 months; not associated with any neurological symptoms; Oswestry Disability Index between 20% and 80% Exclusion criteria: traumatic or infectious conditions; tumours
Interventions	1) Muscle energy technique and exercises (N = 15); 2) Maitland's mobilization and exercises (N = 15); 3) exercises (N = 15) Six treatments were given in group 1 and 2 over six days
Outcomes	Pain perception on Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), hip range of motion

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Rana 2009a (*Continued*)

Notes	Results (VAS for pain) Baseline mean: MET group 3.53 ± 0.51, Maitland group 3.73 ± 0.70, control group 3.53 ± 0.52 After 6 treatments, mean: MET group 0.20 ± 0.41, Maitland group 0.33 ± 0.48, control group 3.6 ± 0.51 Differences in mean: MET group 3.33 ± 0.62, Maitland group 3.40 ± 0.83, control group -0.07 ± 0.59 Oswestry Disability Index Baseline mean: MET group 29.6 ± 5.2, Maitland group 27.8 ± 5, control group 28.5 ± 5.3 After 6 treatments, mean: MET group 2.4 ± 5.2, Maitland group 5.7 ± 5.7, control group 23.3 ± 7.6 Differences in mean: MET group 27.2 ± 5.6, Maitland group 22.1 ± 6.8, control group 5.2 ± 9.1 Hip range of motion: significant changes in flexion, medial and lateral rotation in the MET and Maitland group. Data were only shown in a table Adverse events: no adverse events Dropouts: no dropouts Conclusion: "This study resulted in benefits of manual therapy techniques such as Muscle Energy Technique, G.D. Maitland's concept of mobilization in improving the pain and functional ability…"

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Not stated
Blinding of participants (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible, patient-reported outcomes
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	Unclear risk	Insufficent data
Co-interventions	Unclear risk	No information

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Rana 2009a (*Continued*)

Compliance	Unclear risk	No information
Intention to treat analysis	Low risk	No dropouts
Timing of outcome assessment	Unclear risk	Unclear

Selkow 2009

Methods	RCT; adequate allocation procedure
Participants	A total of 20 subjects randomly allocated to 2 treatment groups, study setting: military academy 16 males and 4 females; age 24.1 ± 7.1 (MET), 29.7 ± 11.9 (control); height 174.6 ± 12.8 cm (MET), 174.0 ±9.2 cm (control); mass 75.9 ± 19.0 kg (MET), 81.6 ± 9.8 kg (control) Inclusion criteria: acute episode of lumbopelvic pain (LPP) within the previous 6 weeks and an anterior innominate rotation as defined by a bilateral difference of 2 ° or greater Exclusion criteria: acute episode of LBP lasted longer than 6 weeks; pain radiated past the knee; history of previous back surgery; diagnosed specific cause of LBP
Interventions	1) Muscle energy technique (N = 10); 2) sham manual treatment (N = 10) 1 treatment was given in each group
Outcomes	Pain perception on Visual Analogue Scale (VAS) for current pain, worst pain over the past 24 hours and pain produced during provocation test; pain provocation test which caused the most pain
Notes	Results Current pain: baseline MET group 18.2 ± 9.0 mm, control group 36.6 ± 26.2 mm 24 hours after treatment: MET group 17.2 ± 14.3, control group 21.4 ± 24.7 Worst pain, baseline worst pain over the past 24 hours: MET group 29.3 ± 19.1 mm, control group 18.1 ± 14.3 mm 24 hours after treatment worst pain over past 24 hours: MET 25.0 ± 20.6 mm, control group 35.2 ± 28.0 mm Pain resulting during provocation test, before treatment: MET group 25.9 ± 20.0 mm, control group 34.0 ± 27.7 mm Immediately after treatment pain with provocation test: MET group 21.8 +/- 23.5mm, control group 31.3 +/- 25.6 mm 24 hours after treatment: MET group 15.7 ± 20.5 mm, control group 29.2 ± 27.4 mm Adverse events: no adverse events Dropouts: no dropouts Conclusion: "The main finding of this study was that the MET group demonstrated a decrease in VAS worst pain over the past 24 hours… Although statistically significant, the change for the MET group was less than half a point on the 10-point pain scale."

Risk of bias

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Selkow 2009 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number generator
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants (performance bias)	Unclear risk	Unclear if techniques distinguishable
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Patient-reported outcomes, unclear if interventions were distinguishable
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low dropout
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	High risk	Between group differences in pain intensity
Co-interventions	Unclear risk	No information
Compliance	Low risk	Single intervention
Intention to treat analysis	Low risk	No dropouts
Timing of outcome assessment	Low risk	24 hours after baseline

Naik 2010

Methods	RCT; randomisation and allocation procedure unclear
Participants	A total of 60 subjects randomly allocated to 2 treatment groups, study setting: female and male patients were recruited from physiotherapy outpatient department of KLES Dr. Prabhakar Kore Hospital and medical research centre, KLES Ayurved Hospital and Research centre, Belgaum 40 males and 20 females: 19 males and 11 female mean age 31.6 ± 13.82 (MET), 21 males and 9 females mean age 34.8 ± 13.42 (control) Inclusion criteria: non-specific LBP; symptoms less than 3 weeks; LBP without radiation to buttock; thigh or leg, age 20 to 65 years Exclusion criteria: history of spinal surgery; motor weakness; altered sensation such as paraesthesia, numbness, hyperaesthesia, anaesthesia; altered deep tendon reflexes; subjects receiving muscle relaxants

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Interventions	1) Muscle energy technique and hot moist (N = 30); 2) positional release therapy and hot moist (N = 30) 8 treatments in each group over a period of 8 days
Outcomes	Pain perception on Visual Analogue Scale (VAS), modified Oswestry Disabilty Index (MODQ), range of motion lumbar extension
Notes	Results (VAS): MET group mean VAS score pre-treatment from 6.62 (SD ± 1.41) to 1. 9 (SD ± 0.73) post-treatment on the eighth day. Control group mean VAS score from 6.94 (SD ± 1.48) to 1.7 (SD ± 0.76) MODQ: MET group mean MODQ score pre-treatment from 23 (SD ± 9) to 10 (SD ± 4) post-treatment on the eighth day. Control group mean MODQ score from 30 (SD ± 14) to 11 (SD ± 6) Mean active lumbar extension ROM: MET group mean active lumbar extension ROM from 3.30 cm (SD ± 0.61) pre-treatment to 4.27 cm (SD ± 0.39) post-treatment on the eighth day. Control group from 3.30 cm (SD ± 0.56) to 4.34 cm (SD ± 0.26) Adverse events: not reported Dropouts: not reported Conclusion: "The participants treated within groups showed a statistically significant decrease in pain…, but there was no statistically significant difference when compared between groups."

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of participants (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible, patient-reported outcomes
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Dropouts not reported
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	High risk	Between group difference in disability
Co-interventions	Unclear risk	No information

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Naik 2010 (*Continued*)

Compliance	Unclear risk	No information
Intention to treat analysis	Unclear risk	Not described
Timing of outcome assessment	Low risk	After eight days

Patil 2010

Methods	RCT; randomisation and allocation procedure unclear
Participants	A total of 40 subjects randomly allocated to 2 treatment groups, study setting: female and male patients were recruited from physiotherapy outpatient department of KLES Dr. Prabhakar Kore Hospital and medical research centre, KLES Ayurved Hospital and Research centre, Belgaum 21 males and 19 females age between 19 to 46 years: 11 males and 9 female mean age 27.5 ± 7.66 (MET), 10 males and 10 females mean age 29.1 ± 7.04 (control). Body mass index (BMI) in the two groups from 18.30 to 28.4. Mean duration of symptoms in MET group: 13 ± 11.35 days, in control group 11.6 ± 10.93 days Inclusion criteria: age between 18 and 50 years; participants with clinical diagnosis of acute LBP; participants who will have duration of pain for 6 weeks or less; participants with non-specific and postural LBP; participants with lumbar pain and pain at the attachments of quadratus lumborum i.e. iliac crest and lower ribs; participants with restricted lateral flexion; participants willing to participate in the study Exclusion criteria: participants who will have duration of pain more than 6 weeks; participants suffering from specific LBP like prolapsed intervertebral discs with instability or any radicular symptoms, lumbar spondylosis, lumbar canal stenosis, spondylolisthesis, sensory deficits, malignancies and tuberculosis; participants suffering from osteoporosis, psychiatric disorders, pain relief patches or injections or slow releasing hormonal capsules, fracture or dislocation, haematomas or abscesses; any clinical condition that contraindicates the application of interferential therapy such as patients wearing cardiac pacemakers, thrombosis, recent haemorrhage, pregnancy, fever, tumours or with any metallic implants; any other local or systemic major illness; participants with history of spinal surgery
Interventions	1) Muscle energy technique and interferential therapy (N = 20) 2) Interferential therapy (N = 20) 8 treatments in each group over a period of 8 days
Outcomes	Pain perception on Visual Analogue Scale (VAS), modified Oswestry Disabilty Index (MODQ), lumbar range of motion
Notes	Results (VAS): MET group mean VAS score pre-treatment from 7.6 (SD ± 1.01) to 3.5 (SD ± 0.92) post-treatment on the eighth day. Control group mean VAS score from 7.6 (SD ± 0.94) to 3.8 (SD ± 0.94). No significant difference in the reduction of pain when compared between the groups (P = 0.33) MODQ: MET group mean MODQ score pre-treatment from 64.7% (SD ± 12.25) to 19% (SD ± 8.22) post-treatment on the eighth day. Control group mean MODQ score from 69.9% (SD ± 11,47) to 41.8% (SD ± 10.76). Significant difference in the

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	reduction of percentage of disability within the groups (P < 0.0001) and when compared between the groups (P < 0.001) Lumbar ROM: MET group mean ride side flexion from 53.9 cm (SD ± 2.47) pre-treatment to 45.1 cm (SD ± 2.15) post-treatment on the eighth day. Control group from 54.2 cm (SD ± 3.44) to 50.6 cm (SD ± 3.63) MET group mean left side flexion from 53.9 cm (SD ± 2.55) pre-treatment to 45 cm (SD ± 2.15) post-treatment on the eighth day. Control group from 54.1 cm (SD ± 3. 57) to 50.4 cm (SD ± 3.88) MET group mean spinal extension from 13.5 cm (SD ± 0.53) pre-treatment to 10.8 cm (SD ± 0.78) post-treatment on the eighth day. Control group from 13.5 cm (SD ± 0. 51) to 12.1 cm (SD ± 0.92) MET group mean spinal flexion from 16.7 cm (SD ± 0.75) pre-treatment to 21 cm (SD ± 0.94) post-treatment on the eighth day. Control group from 17 cm (SD ± 0.97) to 19. 1 cm (SD ± 1.35) Interventional group was found to be more effective in improving the spinal range of motion as compared to the control group (P < 0.001). Both groups were equally effective in increasing the spinal range of motion (P < 0.0001) Adverse events: not reported Dropouts: not reported Conclusion: "Results from this study suggest that MET on quadratus lumborum combined with IFT was superior to IFT alone for decreasing disability and improving the range of motion in patients with acute low back pain."

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of participants (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible, patient-reported outcomes
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	Low risk	Table
Co-interventions	Unclear risk	No information

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Patil 2010 (*Continued*)

Compliance	Unclear risk	No information
Intention to treat analysis	Unclear risk	Not described
Timing of outcome assessment	Low risk	After eight days

Dhinkaran 2011

Methods	RCT; adequate allocation procedure
Participants	A total of 30 subjects randomly allocated to 2 treatment groups; randomisation procedure: lottery draw method; study setting: medical college and hospital; male and female patients were recruited from Department of Physiotherapy, Christian Medical College and Hospital 9 males and 21 females, mean age 33.4 ± 2.11 Inclusion criteria: subjects between 18 and 35 years complaining of LBP (more than 3 months), pain on performing pain provocation tests for sacroiliac dysfunction, Oswestry Disability Index above 20% but below 80%, BMI 25 to 29.9 kg/m^2 Exclusion criteria: participants suffering from specific LBP like PIVD with instability or any radicular symptoms, lumbar spondylosis, lumbar canal stenosis, spondylolisthesis, sensory deficits, malignancies and tuberculosis, any traumatic conditions around the pelvis and lower limbs, any infection, tumours around the pelvis, cardiac pacemakers, thrombosis, recent haemorrhage, associated neurological symptoms, patients who do not understand the study or are non-cooperative, pregnancy, any lower limb abnormalities, any recently undergone abdominal and low-back surgery
Interventions	1) Muscle energy technique with corrective exercises (N = 15); 2) transcutaneous electrical nerve stimulation (TENS) with corrective exercises (N = 15) 6 treatments over 6 continuous days were given in each group. The treatment followed corrective exercises performed by the patient under supervision of the therapist and a set of abdominal strengthen and isometric abdominal exercises at home
Outcomes	Numeric pain rating scale and Oswestry Disability Index
Notes	Results Differences in mean: ODI relief for MET group 7.49 ± 5.71 and for control group 7.49 ± 3.39; numeric pain rating relief for MET group 0.80 ± 0.737 and for control group 0.8. ± 0.51. The average Oswestry Disability Index (%) relief decrease for MET group was 27.15% and for control group 19.67%; average numeric pain rating scale relief for MET group was 3.40 and for control group 2.60 Adverse events: no adverse events Dropouts: no dropouts Conclusion: "The result of the study showed that along with corrective exercises, MET is moderately significant over conventional physiotherapy i.e. TENS with corrective exercises in improving functional ability and decreasing pain."

Risk of bias

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Dhinkaran 2011 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Lottery draw method
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of participants (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible, patient-reported outcomes
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	Unclear risk	No information
Co-interventions	Unclear risk	No information
Compliance	Unclear risk	No information
Intention to treat analysis	Unclear risk	Not described
Timing of outcome assessment	Low risk	After six days

Ellythy 2012

Methods	RCT; randomisation and allocation procedure unclear
Participants	40 subjects randomly allocated to 2 treatment groups; method of randomisation: unclear; study setting: unclear 40 males and females Inclusion criteria: subjects with chronic low-back pain for more than 3 months; age between 30 and 55 years Exclusion criteria: unclear
Interventions	1. Muscle energy technique in form of post-isometric relaxation (PIR) plus specific physical therapy program (infrared radiation, ultrasonic, TENS, therapeutic exercise program) (N = 20); 2) myofascial release (MFR) program plus specific physical therapy program (infrared radiation, ultrasonic, TENS, therapeutic exercise program) (N = 20) 12 treatments over 4 weeks were given in each group

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Ellythy 2012 (*Continued*)

Outcomes	Pain perception with Short Form McGill pain questionnaire; lumbar spine range of movement in standing using inclinometers; Oswestry Disability Index Questionnaire
Notes	Pain MET group revealed a statistical significant difference between pre and post-treatment; pain intensity pre-treatment (7.7 ± 1.42) and post-treatment (5 ± 1.34), t-value (7.37) and P value (0.0001) MFR group revealed a statistical significant difference between pre and post-treatment; pain intensity pre-treatment (8.31 ± 1.59) and post-treatment (5.36 ± 1.56), t-value (7. 15) and P value (0.0001) Ostwestry Disability Index MET had a significant difference between pre and post-treatment in functional disability; functional disability pre-treatment (56 ± 12.06) and post-treatment (41.25 ± 7.39), t-value (9.05) and P value (0.0001) MFR had a significant difference between pre and post-treatment in functional disability; functional disability pre-treatment (55 ± 10.07) and post-treatment (33.57 ± 11), t-value (9.04) and P value (0.0001) Range of motion MET: lumbar flexion pre-treatment (30.75 ± 11.96) and post-treatment (41.25±7.39), t-value (4.22) and P value (0.001). Lumbar extension pre-treatment (8.25 ± 2.86) and post-treatment (16.25 ± 4.14), t-value (4.97) and P value (0.001). Lumbar side bending right pre-treatment (6.25 ± 3.49) and post-treatment (11.75 ± 2.91), t-value (5.14) and P value (0.001). Lumbar side bending left pre-treatment (7 ± 2.91) and post-treatment (12 ± 3.32), t-value (5.05) and P value (0.001) MFR: lumbar flexion pre-treatment (27.89 ± 12.7) and post-treatment (41.05 ± 8.36), t-value (4.77) and P value (0.003). Lumbar extension pre-treatment (7.89 ± 3.74) and post-treatment (15.78 ± 6.74), t-value (8.72) and P value (0.001). Lumbar side bending right pre-treatment (6.57 ± 3.64) and post-treatment (10.52 ± 3.58), t-value (7.68) and P value (0.002). Lumbar side bending left pre-treatment (6.89 ± 3.68) and post-treatment (11.05 ± 4.16), t-value (5.63) and P value (0.004) Adverse events: no adverse events reported Dropout: no dropouts reported Conclusion: "The findings of this study support the view that the functional integration of specific manipulative techniques directed at the low back muscles are effective in reducing pain and functional disability and improving lumbar spine mobility in patients with CLBP."

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Shuffling envelopes
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants (performance bias)	Unclear risk	Not tested

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Ellythy 2012 (*Continued*)

Blinding of therapists (performance bias)	High risk	Not possible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Patient- reported outcome
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No information
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	Unclear risk	No information
Co-interventions	Low risk	Co-interventions described and similar for both groups
Compliance	Unclear risk	No information
Intention to treat analysis	Unclear risk	No information
Timing of outcome assessment	Low risk	After four weeks

Ellythy 2012a

Methods	RCT; randomisation and allocation procedure unclear
Participants	A total of 30 subjects randomly allocated to 2 treatment groups; method of randomisation: unclear; study setting: unclear 30 males and females Inclusion criteria: subjects with chronic low-back pain for more than 3 months; age between 30 and 50 years Exclusion criteria: unclear
Interventions	1. Muscle energy technique plus specific physical therapy program (infrared radiation, ultrasonic, TENS, therapeutic exercise program) (N = 15); 2) strain counter strain plus specific physical therapy program (infrared radiation, ultrasonic, TENS, therapeutic exercise program) (N = 15) 12 treatments over 4 weeks were given in each group
Outcomes	Pain perception with Short Form McGill pain questionnaire; lumbar spine range of movement in flexion and extension; Oswestry Disability Index Questionnaire
Notes	Pain MET group revealed a statistical significant difference between pre and post-treatment; pain intensity pre-treatment (6.66 ± 0.89) and post-treatment (2.4 ± 1.05); t-value (20. 69) and P value (0.000) SCS group showed a statistical significant difference between pre and post-treatment;

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Ellythy 2012a (*Continued*)

	pain level pre-treatment (7.13 ± 1.06) and post-treatment (3.33 ± 1.44); t-value (11.64) and P value (0.000) Ostwestry Disability Index MET had a significant difference between pre and post-treatment in functional disability; functional disability pre-treatment (38.73 ± 2.6) and post-treatment (31.6 ± 3.52), t-value (9.73) and P value (0.000) SCS had a significant difference between pre and post-treatment in functional disability; functional disability pre-treatment (38.26 ± 3.43) and post-treatment (32.6 ± 3.83), t-value (9.34) and P value (0.000) Range of motion MET: lumbar flexion pre-treatment (20.5 ± 1.1) and post-treatment (21.5 ± 1.06), t-value (3.66) and P value (0.002). Lumbar extension pre-treatment (12.1 ± 0.76) and post-treatment (10.23 ± 1.74), t-value (4.26) and P value (0.001) SCS: lumbar flexion pre-treatment (19.76 ± 1.42) and post-treatment (21.0 ± 1.86), t-value (3.58), P value (0.003). Lumbar extension pre-treatment (12.2 ± 0.99) and post-treatment (11.23 ± 1.08), t-value (4.09) and P value (0.001) Adverse events: no adverse events reported Dropout: no dropouts reported Conclusion: "The current results proved that both MET and SCS techniques are effective in reducing pain and functional disability in patients with chronic low back pain."

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Shuffling envelopes
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants (performance bias)	Unclear risk	Blinding not tested
Blinding of therapists (performance bias)	High risk	Not possible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Patient-reported outcome
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No information
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	Unclear risk	No information
Co-interventions	Low risk	Co-interventions described and similar for both groups

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Ellythy 2012a (*Continued*)

Compliance	Unclear risk	No information
Intention to treat analysis	Unclear risk	No information
Timing of outcome assessment	Low risk	After four weeks

Mesquita 2012

Methods	RCT; unclear allocation treatment assignment
Participants	A total of 45 subjects randomly allocated to 3 treatment groups; randomisation procedure: unclear; treatment allocation procedure: unclear; study setting: medical college and hospital; male and female patients were recruited from KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum and from KLES Aryuveda Hospital and Research Centre, Belgaum 12 females and 33 males in all groups Group 1: age 36.9 ± 13.3; 4 females and 11 males; height of 169 ± 7.2 cm, weight of 68.9 ± 7.96 kg and BMI of 23.8 ± 1.72 Group 2: age 36.9 ± 13.3; 4 females and 11 males; height of 166 ± 7.1 cm, weight of 67.7 ± 9.8 kg and BMI of 24.9 ± 2.6 Group 3: age 36.9 ± 13.3; 4 females and 11 males; height of 166 ± 7.2 cm, weight of 66.6 ± 10.4 kg and BMI of 24.4 ± 3.78 Inclusion criteria: subjects between 18 and 65 years complaining of low-back pain (more than 3 months) with or without radiating pain Exclusion criteria: history of spinal surgery in previous 6 months; knee and ankle pathology causing limitation of movement; any clinical condition that contraindicates mobilization; subjects with ankylosing spondylitis, spondylolisthesis; subjects with psychological low-back pain, altered deep tendon reflexes; motor weakness, subjects with mental disorders; tumours, malignancies; any other major illness
Interventions	1) Trunk muscle stabilization exercises with conventional therapy (moist heat, TENS, conventional exercises) (N = 15); 2) muscle energy technique with conventional therapy (moist heat, TENS, conventional exercises) (N = 15); 3. muscle energy technique and trunk muscle stabilization with conventional therapy (moist heat, TENS, conventional exercises) (N = 15) 8 treatments over 2 weeks were given in each group
Outcomes	Pain perception on Visual Analogue Scale (VAS); range of motion (lumbar flexion and extension); Modified Oswestry Disability Index
Notes	Results (VAS) Group 1: pre-treatment 7.61 ± 1.24, post-treatment 3.8 ± 1.18, differences in mean 3.9 Group 2: pre-treatment 7.4 ± 1.08, post-treatment 4.1 ± 1.05, differences in mean 3.3 Group 3: pre-treatment 7.7 ± 0.98, post-treatment 2.8 ± 0.67, differences in mean 4.89 Modified Oswestry Disability Index Group 1: pre-treatment 65.3 ± 12.9, post-treatment 38.8 ± 14.8, differences in mean 26.5

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	Group 2: pre-treatment 68.5 ± 8.9, post-treatment 45.5 ± 8.7, differences in mean 23 Group 3: pre-treatment 51 ± 18.9, post-treatment 27.7 ± 10.6, differences in mean 23.2 Range of motion Group 1: increase flexion mean 1.03 cm, extension mean 1.03 cm Group 2: increase flexion mean 2.04 cm, extension mean 1.7 cm Group 3: increase flexion mean 2.15 cm, extension mean 1.8 cm Adverse events: no adverse events reported Dropouts: no dropouts reported Conclusion: "The present study demonstrates that the two treatment techniques with Trunk muscle stabilization exercises and Muscle energy technique are effective in relieving pain, improving range of motion and reducing disability in subjects with recurrent low back pain"

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of participants (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible, patient-reported outcomes
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Unclear risk	Unclear
Groups similar at baseline	High risk	Between group difference in disability
Co-interventions	Unclear risk	No information
Compliance	Unclear risk	No information
Intention to treat analysis	Unclear risk	Not described
Timing of outcome assessment	Low risk	After two weeks

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Bindra 2012

Methods	RCT; unclear allocation treatment assignment
Participants	A total of 30 subjects allocated to 2 treatment groups; randomisation procedure: lottery draw method; study setting: university outpatient department services 24 females and 6 males aged 30 to 50 yrs (41 ± 7.61); height of 158 ± 7.34 cm and weight of 66.2 ± 10.59 kg Inclusion criteria: chronic LBP of greater than 3 months duration; subjects aged between 30 and 50 years; tenderness over the sacroiliac joint, particularly on the sacral sulcus; mechanical LBP; sacroiliac joint hypomobility; positive three out of four common tests of movement and symmetry for sacroiliac dysfunction; positive three out of five pain provocation tests for sacroiliac joint dysfunction Exclusion criteria: acute injury or fracture; pregnancy; inflammatory pathology; presence of neurological signs such as any abnormal sensibility, abnormal DTRs, profound muscle weakness and SLR less than 45 °; any hip joint pathology; spondylolisthesis, stenosis or disc disease; history of any major lumbar spine surgery; congenital spinal anomaly; hypermobility of sacroiliac joint; sacralization of the lumbar vertebra or lumbarization of the sacral vertebra; true leg length discrepancy as in polio or post-fracture cases; subjects taking analgesics
Interventions	1) Muscle energy technique (N = 15); 2) Ultrasound, transcutaneous electrical nerve stimulation (TENS) and mobility exercises (N = 15) 6 treatments in 6 days were given in each group
Outcomes	Pain perception on Visual Analogue Scale (VAS); Disability score on Revised Oswestry Disability Index; functional leg length measurement
Notes	Results (VAS): MET group mean VAS score pre-treatment from 6.41 (SD ± 2.01) to 1. 64 (SD ± 1.33) post-treatment on the sixth day. Control group mean VAS score from 6.88 (SD ± 1.68) to 3.07 (SD ± 1.34). Differences in mean: MET group 4.77 (SD ± 1. 60), control group 3.80 (SD ± 1.32) RODI: MET group mean RODI score pre-treatment from 36.26 (SD ± 12.78) to 18. 53 (SD ± 6.52) post-treatment on the sixth day. Control group mean RODI score from 46.8 (SD ± 12.46) to 33.06 (SD ± 10.57). Differences in mean: MET group 17.73 (SD ± 8.25), control group 13.60 (SD ± 6.77) Significant reduction in VAS scores in both groups, P < 0.001. Intergroup differences for VAS were significant at P < 0.05. Significant reduction in disability score in both groups at P < 0.01. The mean values for MET group shows very significant (P < 0.001) decrease in leg length difference on day 6. The mean values for the control group shows (P < 0.05) significant difference in LLD on day 6 Adverse events: no adverse events Droouts: 8 subjects (2 MET group, 6 conventional therapy) were lost due to lack of follow-up Conclusion: "As far as reduction in pain and disability are concerned, both the groups showed almost similar results."

Risk of bias

Bias	Authors' judgement	Support for judgement

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Bindra 2012 (*Continued*)

Random sequence generation (selection bias)	Low risk	Lottery draw method
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of participants (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of therapists (performance bias)	High risk	Not possible, techniques distinguishable
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible, patient-reported outcomes
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No information on missing data
Selective reporting (reporting bias)	Low risk	Important outcomes reported
Groups similar at baseline	High risk	Between group difference in disability
Co-interventions	Unclear risk	No information
Compliance	Unclear risk	No information
Intention to treat analysis	Unclear risk	Not stated
Timing of outcome assessment	Low risk	After six days

Characteristics of excluded studies *[ordered by year of study]*

Study	Reason for exclusion
Brodin 1982	No RCT, no valid pain score, no description of procedure
Martin 1986	Isometric exercises to strengthen abdominal and pelvic muscles. No outcomes according to the protocol
Stodolny 1989	Only specific back pain (lumbar discopathy)
Risch 1993	Isometric exercises to strengthen lumbar extensor muscles. No outcomes according to the protocol
Alaksiev 1996	No outcomes according to the protocol
Wilson 2003	Patients are not randomised but matched
Lamberth 2005	No RCT, multiple single case study

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(*Continued*)

Kofotolis 2006	Operational definition different - use of isotonic contractions
Adamczyk 2009	Several techniques - no single isometric technique
Franca 2012	Operational definition different - no isometric procedure

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DATA AND ANALYSES

Comparison 1. MET plus any intervention versus other therapies plus that intervention for chronic non-specific LBP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain	7	232	Mean Difference (IV, Random, 95% CI)	0.00 [-2.97, 2.98]
2 Functional status	7	232	Std. Mean Difference (IV, Random, 95% CI)	-0.18 [-0.43, 0.08]

Comparison 2. MET versus sham MET for acute non-specific LBP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain	1	20	Mean Difference (IV, Random, 95% CI)	14.2 [-10.14, 38.54]

Comparison 3. MET versus all other therapies for acute non-specific LBP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain	2	88	Mean Difference (IV, Random, 95% CI)	-10.72 [-32.57, 11.13]
2 Functional status	1	60	Mean Difference (IV, Random, 95% CI)	0.87 [-6.31, 8.05]

Comparison 4. MET versus all other therapies for chronic non-specific LBP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain	1	30	Mean Difference (IV, Random, 95% CI)	-9.70 [-20.20, 0.80]
2 Functional status	1	30	Mean Difference (IV, Random, 95% CI)	-4.1 [-9.53, 1.33]

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Comparison 5. MET plus any intervention versus that same intervention alone for acute non-specific LBP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain	1	40	Mean Difference (IV, Random, 95% CI)	-3.0 [-11.37, 5.37]
2 Functional status	1	40	Mean Difference (IV, Random, 95% CI)	-17.6 [-27.05, -8.15]

Comparison 6. MET plus any intervention versus that same intervention alone for chronic non-specific LBP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain	1	30	Mean Difference (IV, Random, 95% CI)	-34.10 [-38.43, -29.77]
2 Functional status	1	30	Mean Difference (IV, Random, 95% CI)	-22.0 [-27.41, -16.59]

Comparison 7. MET plus any intervention versus other therapies plus that intervention for acute non-specific LBP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain	1	60	Mean Difference (IV, Random, 95% CI)	5.20 [-3.03, 13.43]
2 Functional status	1	60	Mean Difference (IV, Random, 95% CI)	6.0 [-0.49, 12.49]

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Analysis 1.1. Comparison 1 MET plus any intervention versus other therapies plus that intervention for chronic non-specific LBP, Outcome 1 Pain.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 1 MET plus any intervention versus other therapies plus that intervention for chronic non-specific LBP

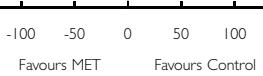
Outcome: 1 Pain

Study or subgroup	MET N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Geisser 2006b	15	-5.2 (35.4)	18	-9.1 (34.8)		1.5 %	3.90 [-20.17, 27.97]
Geisser 2006a	21	-20.5 (30.5)	18	-3.8 (28.3)		2.6 %	-16.70 [-35.17, 1.77]
Rana 2009a	15	-33.3 (6.2)	15	-34 (8.3)		32.3 %	0.70 [-4.54, 5.94]
Dhinkaran 2011	15	-8 (7.4)	15	-8 (5.1)		42.9 %	0.0 [-4.55, 4.55]
Mesquita 2012	15	-33.3 (15.1)	15	-39 (17.1)		6.7 %	5.70 [-5.84, 17.24]
Ellythy 2012a	15	-42.6 (12.6)	15	-38 (16.3)		8.2 %	-4.60 [-15.03, 5.83]
Ellythy 2012	20	-27 (18.4)	20	-29.5 (20.9)		6.0 %	2.50 [-9.70, 14.70]
Total (95% CI)	**116**		**116**			**100.0 %**	**0.00 [-2.97, 2.98]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 5.16$, df = 6 (P = 0.52); $I^2 = 0.0\%$

Test for overall effect: Z = 0.00 (P = 1.0)

Test for subgroup differences: Not applicable



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Analysis 1.2. Comparison 1 MET plus any intervention versus other therapies plus that intervention for chronic non-specific LBP, Outcome 2 Functional status.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 1 MET plus any intervention versus other therapies plus that intervention for chronic non-specific LBP

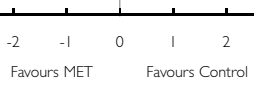
Outcome: 2 Functional status

Study or subgroup	MET N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Geisser 2006a	21	-5 (28.24)	18	-0.97 (27.33)		17.0 %	-0.14 [-0.77, 0.49]
Geisser 2006b	15	-6.67 (24.08)	18	-8.58 (26.8)		14.4 %	0.07 [-0.61, 0.76]
Rana 2009a	15	-27.2 (5.6)	15	-22.1 (6.8)		12.1 %	-0.80 [-1.54, -0.05]
Dhinkaran 2011	15	-7.49 (5.71)	15	-7.49 (3.39)		13.2 %	0.0 [-0.72, 0.72]
Ellythy 2012	20	-25.7 (14.2)	20	-21.4 (14)		17.3 %	-0.30 [-0.92, 0.32]
Mesquita 2012	15	-23 (12.45)	15	-26.5 (19.74)		13.1 %	0.21 [-0.51, 0.92]
Ellythy 2012a	15	-7.1 (4)	15	-5.7 (4.7)		13.0 %	-0.31 [-1.03, 0.41]
Total (95% CI)	**116**		**116**			**100.0 %**	**-0.18 [-0.43, 0.08]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 4.77$, df = 6 (P = 0.57); $I^2 = 0.0\%$

Test for overall effect: Z = 1.32 (P = 0.19)

Test for subgroup differences: Not applicable



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Analysis 2.1. Comparison 2 MET versus sham MET for acute non-specific LBP, Outcome 1 Pain.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 2 MET versus sham MET for acute non-specific LBP

Outcome: 1 Pain

Study or subgroup	MET N	Mean(SD)	Sham MET N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Selkow 2009	10	-1 (16.9)	10	-15.2 (35.45)		100.0 %	14.20 [-10.14, 38.54]
Total (95% CI)	**10**		**10**			**100.0 %**	**14.20 [-10.14, 38.54]**

Heterogeneity: not applicable

Test for overall effect: Z = 1.14 (P = 0.25)

Test for subgroup differences: Not applicable

Analysis 3.1. Comparison 3 MET versus all other therapies for acute non-specific LBP, Outcome 1 Pain.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 3 MET versus all other therapies for acute non-specific LBP

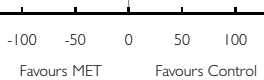
Outcome: 1 Pain

Study or subgroup	MET N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Pillay 2005	30	-19.2 (15.4)	30	-18.6 (10.7)		54.8 %	-0.60 [-7.31, 6.11]
Salvador 2005	14	-30.1 (28.5)	14	-7.1 (5.4)		45.2 %	-23.00 [-38.19, -7.81]
Total (95% CI)	**44**		**44**			**100.0 %**	**-10.72 [-32.57, 11.13]**

Heterogeneity: $Tau^2 = 214.97$; $Chi^2 = 6.99$, df = 1 (P = 0.01); $I^2 = 86\%$

Test for overall effect: Z = 0.96 (P = 0.34)

Test for subgroup differences: Not applicable



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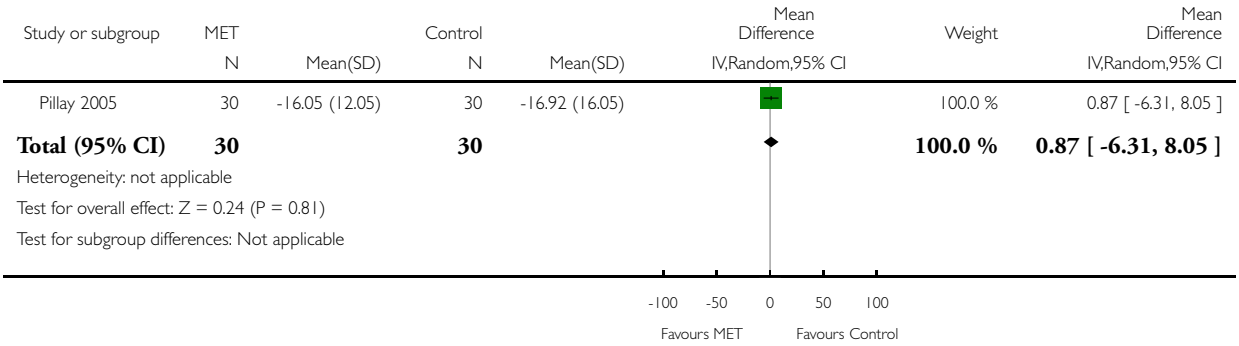
Analysis 3.2. Comparison 3 MET versus all other therapies for acute non-specific LBP, Outcome 2 Functional status.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 3 MET versus all other therapies for acute non-specific LBP

Outcome: 2 Functional status

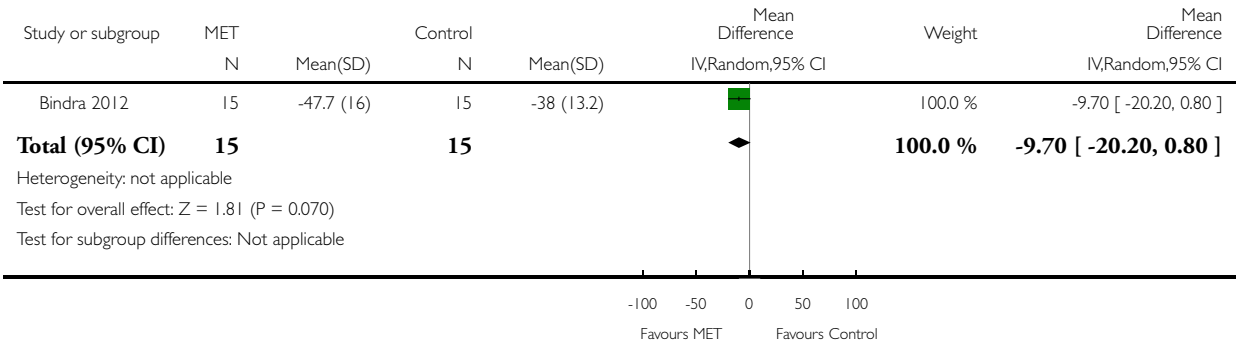


Analysis 4.1. Comparison 4 MET versus all other therapies for chronic non-specific LBP, Outcome 1 Pain.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 4 MET versus all other therapies for chronic non-specific LBP

Outcome: 1 Pain



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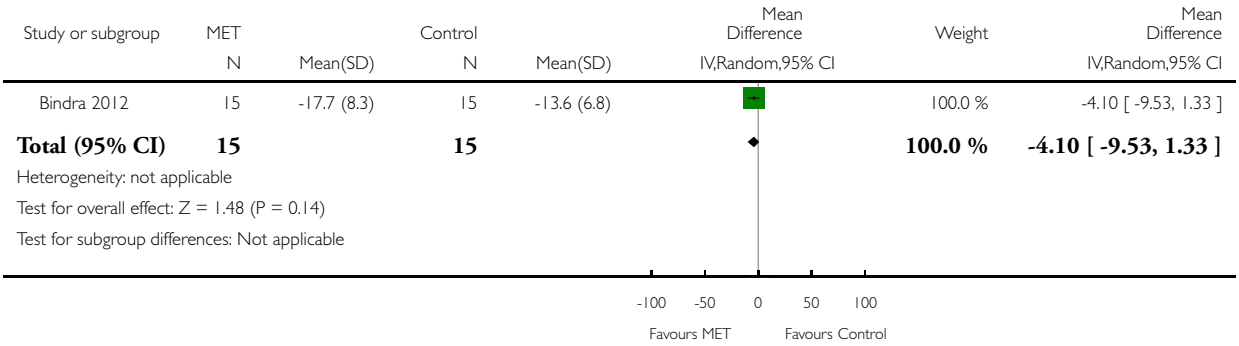
Analysis 4.2. Comparison 4 MET versus all other therapies for chronic non-specific LBP, Outcome 2 Functional status.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 4 MET versus all other therapies for chronic non-specific LBP

Outcome: 2 Functional status

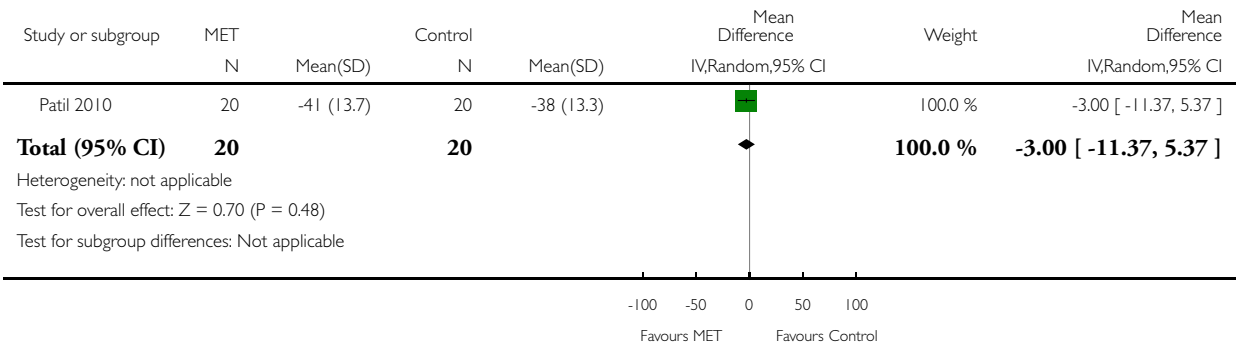


Analysis 5.1. Comparison 5 MET plus any intervention versus that same intervention alone for acute non-specific LBP, Outcome 1 Pain.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 5 MET plus any intervention versus that same intervention alone for acute non-specific LBP

Outcome: 1 Pain



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Analysis 5.2. Comparison 5 MET plus any intervention versus that same intervention alone for acute non-specific LBP, Outcome 2 Functional status.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 5 MET plus any intervention versus that same intervention alone for acute non-specific LBP

Outcome: 2 Functional status

Study or subgroup	MET N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Patil 2010	20	-45.7 (14.75)	20	-28.1 (15.73)		100.0 %	-17.60 [-27.05, -8.15]
Total (95% CI)	**20**		**20**			**100.0 %**	**-17.60 [-27.05, -8.15]**

Heterogeneity: not applicable

Test for overall effect: Z = 3.65 (P = 0.00026)

Test for subgroup differences: Not applicable

Analysis 6.1. Comparison 6 MET plus any intervention versus that same intervention alone for chronic non-specific LBP, Outcome 1 Pain.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 6 MET plus any intervention versus that same intervention alone for chronic non-specific LBP

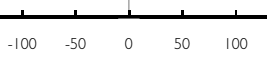
Outcome: 1 Pain

Study or subgroup	MET N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Rana 2009b	15	-33.3 (6.2)	15	0.8 (5.9)		100.0 %	-34.10 [-38.43, -29.77]
Total (95% CI)	**15**		**15**			**100.0 %**	**-34.10 [-38.43, -29.77]**

Heterogeneity: not applicable

Test for overall effect: Z = 15.43 (P < 0.00001)

Test for subgroup differences: Not applicable



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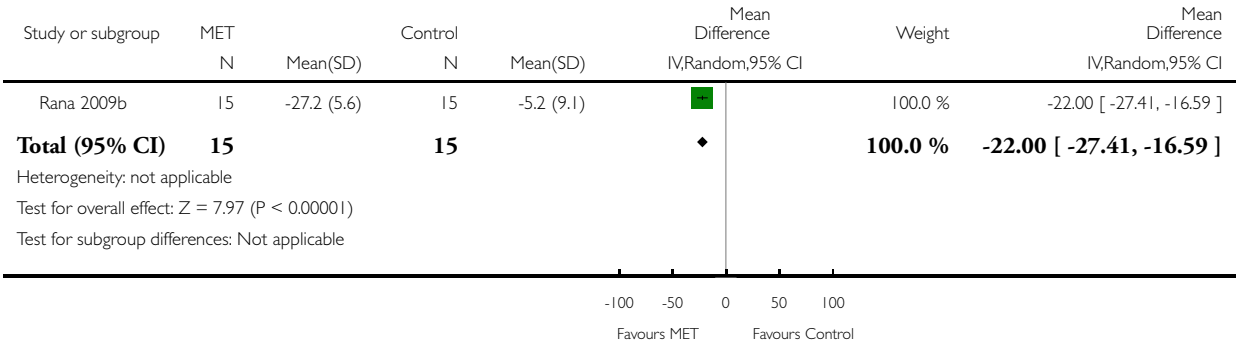
Analysis 6.2. Comparison 6 MET plus any intervention versus that same intervention alone for chronic non-specific LBP, Outcome 2 Functional status.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 6 MET plus any intervention versus that same intervention alone for chronic non-specific LBP

Outcome: 2 Functional status

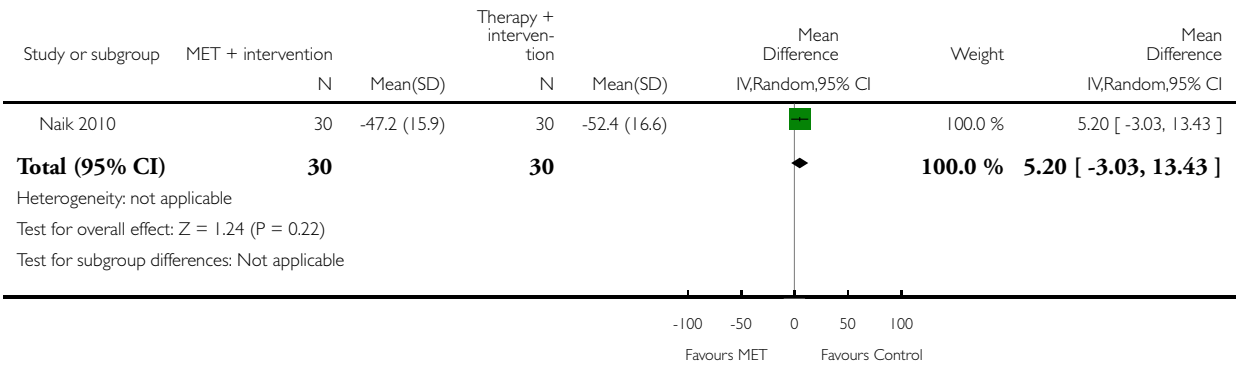


Analysis 7.1. Comparison 7 MET plus any intervention versus other therapies plus that intervention for acute non-specific LBP, Outcome 1 Pain.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 7 MET plus any intervention versus other therapies plus that intervention for acute non-specific LBP

Outcome: 1 Pain



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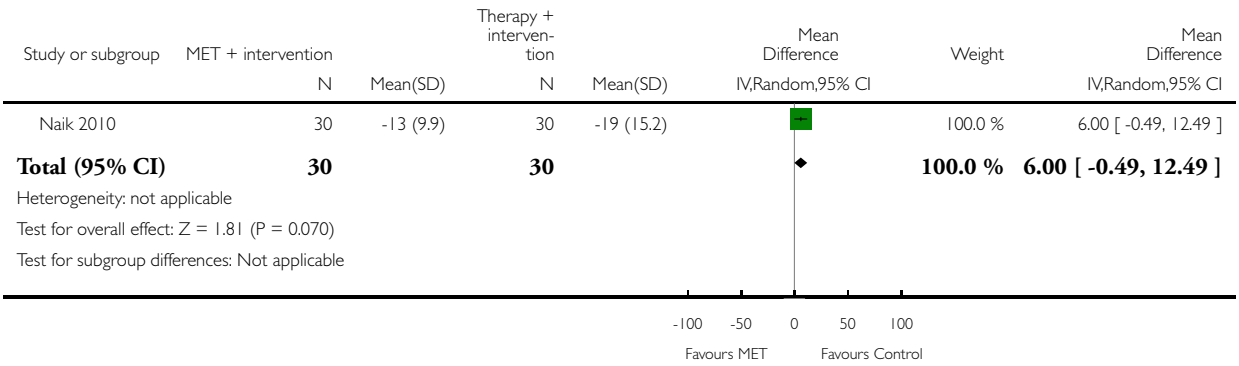
Analysis 7.2. Comparison 7 MET plus any intervention versus other therapies plus that intervention for acute non-specific LBP, Outcome 2 Functional status.

Review: Muscle energy technique for non-specific low-back pain

Comparison: 7 MET plus any intervention versus other therapies plus that intervention for acute non-specific LBP

Outcome: 2 Functional status



ADDITIONAL TABLES

Table 1. Specific clinical and treatment characteristics of the included studies

Author	Number of patients, age according to inclusion criteria	Duration LBP according to inclusion criteria	Number of treatments, duration of treatment	Control group	Outcomes
Pillay 2005	60, 18 to 45	2 months or less	4, 2 weeks	Passive mobilization	Pain, functional disability status, range of motion, pain pressure
Salvador 2005	28, no age restriction reported	3 weeks or less	1, not reported	TENS	Pain, muscle length test
Geisser 2006a Geisser 2006b	72, 18 to 65	More than 3 months	5, 5 weeks	Sham treatment + specific exercises; Sham treatment and non-specific exercises	Pain, functional disability status, satisfaction with treatment, manual medicine screening evaluation

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Table 1. Specific clinical and treatment characteristics of the included studies (*Continued*)

Rana 2009a Rana 2009b	45, 18 to 30	More than 3 months	6, 6 days	Maitland's mobilization and exercises; exercises	Pain, functional disability status, range of motion
Selkow 2009	20, no restriction	Within last 6 weeks	1, 1 day	Sham manual treatment	Pain, pain provocation test
Naik 2010	60, 20 to 65	3 weeks or less	8, 8 days	Positional release therapy and hot moist	Pain, functional disability status, range of motion
Patil 2010	40, 18 to 50	6 weeks or less	8, 8 days	Interferential therapy	Pain, functional disability status, range of motion
Dhinkaran 2011	30, 18 to 35	More than 3 months	6, 6 days	Tens with exercises	Pain, functional disability status
Bindra 2012	30, 30 to 50	More than 3 months	6, 6 days	Ultrasound, TENS, exercises	Pain, functional disability status, functional leg length measurement
Mesquita 2012	45, 18 to 65	More than 3 months	8, 2 weeks	Trunk muscle stabilization with conventional therapy; MET and trunk muscle stabilization with conventional therapy	Pain, functional disability status, range of motion
Ellythy 2012	40, 30 to 55	More than 3 months	12, 4 weeks	Myofascial release	Pain, functional disability status, range of motion
Ellythy 2012a	30, 30 to 50	More than 3 months	12, 4 weeks	Strain counter strain	Pain, functional disability status, range of motion

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APPENDICES

Appendix 1. CENTRAL search strategy

#1 MeSH descriptor Back Pain explode tree 1
#2 back
#3 MeSH descriptor Low Back Pain, this term only
#4 (lumbopelvic pain)
#5 (low next back next pain)
#6 (lbp)
#7 (#1 OR #2 OR #3 OR #4 OR #5 OR #6)
#8 muscle next energy next technique
#9 postisometric relaxation
#10 (isometric next contraction)
#11 (isometric stretching): ti, ab, kw
#12 (proprioceptive neuromuscular facilitation): ti, ab, kw
#13 (#8 OR #9 OR #10 OR #11 OR#12)
#14 (#7 AND #13)

Appendix 2. MEDLINE search strategy

1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized.ab.
4. placebo.ab,ti.
5. drug therapy.fs.
6. randomly.ab,ti.
7. trial.ab,ti.
8. groups.ab,ti.
9. or/1-8
10. (animals not (humans and animals)).sh.
11. 9 not 10
12. dorsalgia.ti,ab.
13. exp Back Pain/
14. backache.ti,ab.
15. (lumbar adj pain).ti,ab.
16. coccyx.ti,ab.
17. coccydynia.ti,ab.
18. sciatica.ti,ab.
19. sciatic neuropathy/
20. spondylosis.ti,ab.
21. lumbago.ti,ab.
22. exp low back pain/
23. lumbopelvic pain.mp.
24. or/12-23
25. 11 and 24
26. muscle energy technique.mp.
27. postisometric relaxation.mp.
28. post-isometric relaxation.mp.
29. isometric stretching.mp.
30. Muscle Stretching Exercises/
31. Isometric Contraction/
32. isometric contract*.mp.

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33. proprioceptive neuromuscular facilitation
34. or/26-33
34. 25 and 34

Appendix 3. EMBASE search strategy

For the May 2014 search, line 21 was changed from cross?over to (cross over or cross-over or crossover); line 23 was changed from follow?up to (followup or follow-up); line 31 was changed from 14 and 30 to 14 or 30; and line 56 isometrics/ was added
1. Clinical Article/
2. exp Clinical Study/
3. Clinical Trial/
4. Controlled Study/
5. Randomized Controlled Trial/
6. Major Clinical Study/
7. Double Blind Procedure/
8. Multicenter Study/
9. Single Blind Procedure/
10. Phase 3 Clinical Trial/
11. Phase 4 Clinical Trial/
12. crossover procedure/
13. placebo/
14. or/1-13
15. allocat$.mp.
16. assign$.mp.
17. blind$.mp.
18. (clinic$ adj25 (study or trial)).mp.
19. compar$.mp.
20. control$.mp.
21. (cross over or cross-over or crossover).mp.
22. factorial$.mp.
23. (followup or follow-up).mp.
24. placebo$.mp.
25. prospectiv$.mp.
26. random$.mp.
27. ((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$)).mp.
28. trial.mp.
29. (versus or vs).mp.
30. or/15-29
31. 14 or 30
32. exp animals/ or exp invertebrate/ or animal experiment/ or animal model/ or animal tissue/ or animal cell/ or nonhuman/
33. human/ or normal human/ or human cell/
34. 32 and 33
35. 32 not 34
36. 31 not 35
37. dorsalgia.mp.
38. back pain.mp.
39. exp BACKACHE/
40. (lumbar adj pain).mp.
41. coccyx.mp.
42. coccydynia.mp.
43. sciatica.mp.
44. exp ISCHIALGIA/

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45. spondylosis.mp.
46. lumbago.mp.
47. exp Low Back Pain/
48. or/37-47
49. muscle energy technique.mp.
50. postisometric relaxation.mp.
51. post-isometric relaxation.mp.
52. isometric stretching.mp.
53. isometric contract$.mp.
54. muscle isometric contraction/
55. proprioceptive neuromuscular facilitation.mp.
56. isometrics/
57. or/49-56
58. 36 and 48 and 57

The animal study filter (lines 32 to 36) was updated for the May 2013 search (from March 2012, lines 32 to 40)

1. Clinical Article/
2. exp Clinical Study/
3. Clinical Trial/
4. Controlled Study/
5. Randomized Controlled Trial/
6. Major Clinical Study/
7. Double Blind Procedure/
8. Multicenter Study/
9. Single Blind Procedure/
10. Phase 3 Clinical Trial/
11. Phase 4 Clinical Trial/
12. crossover procedure/
13. placebo/
14. or/1-13
15. allocat$.mp.
16. assign$.mp.
17. blind$.mp.
18. (clinic$ adj25 (study or trial)).mp.
19. compar$.mp.
20. control$.mp.
21. cross?over.mp.
22. factorial$.mp.
23. follow?up.mp.
24. placebo$.mp.
25. prospectiv$.mp.
26. random$.mp.
27. ((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$)).mp.
28. trial.mp.
29. (versus or vs).mp.
30. or/15-29
31. 14 and 30
32. exp animals/ or exp invertebrate/ or animal experiment/ or animal model/ or animal tissue/ or animal cell/ or nonhuman/
33. human/ or normal human/ or human cell/
34. 32 and 33
35. 32 not 34
36. 31 not 35

Study design filter used in March 2012 search

1. Clinical Article/

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2. exp Clinical Study/
3. Clinical Trial/
4. Controlled Study/ 3715937
5. Randomized Controlled Trial/
6. Major Clinical Study/
7. Double Blind Procedure/
8. Multicenter Study/
9. Single Blind Procedure/
10. Phase 3 Clinical Trial/
11. Phase 4 Clinical Trial/
12. crossover procedure/
13. placebo/
14. or/1-13
15. allocat$.mp.
16. assign$.mp.
17. blind$.mp.
18. (clinic$ adj25 (study or trial)).mp.
19. compar$.mp.
20. control$.mp.
21. cross?over.mp.
22. factorial$.mp.
23. follow?up.mp.
24. placebo$.mp.
25. prospectiv$.mp.
26. random$.mp.
27. ((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$)).mp.
28. trial.mp.
29. (versus or vs).mp.
30. or/15-29
31. 14 and 30
32. human/
33. Nonhuman/
34. exp ANIMAL/
35. Animal Experiment/
36. 33 or 34 or 35
37. 32 not 36
38. 31 not 36
39. 37 and 38
40. 38 or 39

Appendix 4. CINAHL search strategy

1 randomized controlled trial.pt
2 controlled clinical trial.pt
3 randomized.ab
4 randomly.ab
5 trial.ab
6 1 or 2 or 3 or 4 or 5
7 back pain.mj
8 low back pain.mj
9 lumbopelvic pain.ab
10 lumbopelvic pain.ti

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11 7 or 8 or 9 or 10
12 muscle energy technique.ti
13 muscle energy technique.ab
14 postisometric relaxation.ti
15 postisometric relaxation.ab
16 post-isometric relaxation.ti
17 post-isometric relaxation.ab
18 isometric contract*.ti
19 isometric contract*.ab
20 proprioceptive neuromuscular facilitation.ti
21 proprioceptive neuromuscular facilitation.ab
22 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21
23 6 and 11 and 22

Appendix 5. PEDro, OSTMED-DR, Osteopathic Research Web, Google Scholar search strategy

PEDro

1. muscle energy technique.ti/ab. and lumbar spine, sacro-iliac joint or pelvis.bodypart
2. post-isometric relaxation.ti/ab . and lumbar spine, sacro-iliac joint or pelvis.bodypart
3. isometric contraction.ti/ab. and lumbar spine, sacro-iliac joint or pelvis.bodypart
4. proprioceptive neuromuscular facilitation.ti/ab. and lumbar spine, sacro-iliac joint or pelvis.bodypart

OSTMED-DR

1. “muscle energy technique”.keyword or “post-isometric relaxation”.keyword or “isometric contraction”.keyword or ”proprioceptive neuromuscular facilitation“.keyword

Osteopathic Research Web

1. muscle energy technique. all fields
2. post-isometric relaxation. all fields
3. postisometric relaxation. all fields
4. isometric contraction. all fields
5. proprioceptive neuromuscular facilitation. all fields

Google Scholar

1. “muscle energy technique” ”randomized clinical trial“ back pain
2. “post-isometric relaxation””randomized clinical trial“ back pain
3. “postisometric relaxation””randomized clinical trial“ back pain
4. ”proprioceptive neuromuscular facilitation” “randomized clinical trial” “back pain”

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Appendix 6. WHO ICTRP, ClinicalTrials.gov search strategy

WHO ICTRP

"back pain" and "muscle energy", basic search

ClinicalTrials.gov

"muscle energy" and "back pain", basic search

Appendix 7. Criteria for assessing risk of bias for internal validity (Higgins 2011)

Random sequence generation (selection bias)

Selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence

There is a low risk of selection bias if the investigators describe a random component in the sequence generation process such as: referring to a random number table, using a computer random number generator, coin tossing, shuffling cards or envelopes, throwing dice, drawing of lots, minimisation (minimisation may be implemented without a random element, and this is considered to be equivalent to being random).

There is a high risk of selection bia*s* if the investigators describe a non-random component in the sequence generation process, such as: sequence generated by odd or even date of birth, date (or day) of admission, hospital or clinic record number; or allocation by judgement of the clinician, preference of the participant, results of a laboratory test or a series of tests, or availability of the intervention.

Allocation concealment (selection bias)

Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment

There is a low risk of selection bias if the participants and investigators enrolling participants could not foresee assignment because one of the following, or an equivalent method, was used to conceal allocation: central allocation (including telephone, web-based and pharmacy-controlled randomisation); sequentially numbered drug containers of identical appearance; or sequentially numbered, opaque, sealed envelopes.

There is a high risk of bias if participants or investigators enrolling participants could possibly foresee assignments and thus introduce selection bias, such as allocation based on: using an open random allocation schedule (e.g. a list of random numbers); assignment envelopes were used without appropriate safeguards (e.g. if envelopes were unsealed or non-opaque or not sequentially numbered); alternation or rotation; date of birth; case record number; or other explicitly unconcealed procedures.

Blinding of participants

Performance bias due to knowledge of the allocated interventions by participants during the study

There is a low risk of performance bias if blinding of participants was ensured and it was unlikely that the blinding could have been broken; or if there was no blinding or incomplete blinding, but the review authors judge that the outcome is not likely to be influenced by lack of blinding.

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Blinding of personnel and care providers (performance bias)

Performance bias due to knowledge of the allocated interventions by personnel and care providers during the study

There is a low risk of performance bias if blinding of personnel was ensured and it was unlikely that the blinding could have been broken; or if there was no blinding or incomplete blinding, but the review authors judge that the outcome is not likely to be influenced by lack of blinding.

Blinding of outcome assessor (detection bias)

Detection bias due to knowledge of the allocated interventions by outcome assessors

There is low risk of detection bias if the blinding of the outcome assessment was ensured and it was unlikely that the blinding could have been broken; or if there was no blinding or incomplete blinding, but the review authors judge that the outcome is not likely to be influenced by lack of blinding, or:

- for patient-reported outcomes in which the patient was the outcome assessor (e.g. pain, disability): there is a low risk of bias for outcome assessors if there is a low risk of bias for participant blinding (Boutron 2005);
- for outcome criteria that are clinical or therapeutic events that will be determined by the interaction between patients and care providers (e.g. co-interventions, length of hospitalisation, treatment failure), in which the care provider is the outcome assessor: there is a low risk of bias for outcome assessors if there is a low risk of bias for care providers (Boutron 2005);
- for outcome criteria that are assessed from data from medical forms: there is a low risk of bias if the treatment or adverse effects of the treatment could not be noticed in the extracted data (Boutron 2005).

Incomplete outcome data (attrition bias)

Attrition bias due to amount, nature or handling of incomplete outcome data

There is a low risk of attrition bias if there were no missing outcome data; reasons for missing outcome data were unlikely to be related to the true outcome (for survival data, censoring unlikely to be introducing bias); missing outcome data were balanced in numbers, with similar reasons for missing data across groups; for dichotomous outcome data, the proportion of missing outcomes compared with the observed event risk was not enough to have a clinically relevant impact on the intervention effect estimate; for continuous outcome data, the plausible effect size (difference in means or standardised difference in means) among missing outcomes was not enough to have a clinically relevant impact on observed effect size, or missing data were imputed using appropriate methods (if drop-outs are very large, imputation using even "acceptable" methods may still suggest a high risk of bias) (van Tulder 2003). The percentage of withdrawals and drop-outs should not exceed 20% for short-term follow-up and 30% for long-term follow-up and should not lead to substantial bias (these percentages are commonly used but arbitrary, not supported by literature) (van Tulder 2003).

Selective reporting (reporting bias)

Reporting bias due to selective outcome reporting

There is low risk of reporting bias if the study protocol is available and all of the study's pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way, or if the study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon).

There is a high risk of reporting bias if not all of the study's pre-specified primary outcomes have been reported; one or more primary outcomes is reported using measurements, analysis methods or subsets of the data (e.g. subscales) that were not pre-specified; one or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect); one or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis; the study report fails to include results for a key outcome that would be expected to have been reported for such a study.

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Group similarity at baseline (selection bias)

Bias due to dissimilarity at baseline for the most important prognostic indicators.
There is low risk of bia*s* if groups are similar at baseline for demographic factors, value of main outcome measure(s), and important prognostic factors (examples in the field of back and neck pain are duration and severity of complaints, vocational status, percentage of patients with neurological symptoms) (van Tulder 2003).

Co-interventions (performance bias)

Bias because co-interventions were different across groups

There is low risk of bias if there were no co-interventions or they were similar between the index and control groups (van Tulder 2003).

Compliance (performance bias)

Bias due to inappropriate compliance with interventions across groups

There is low risk of bias if compliance with the interventions was acceptable, based on the reported intensity/dosage, duration, number and frequency for both the index and control intervention(s). For single-session interventions (e.g. surgery), this item is irrelevant (van Tulder 2003).

Intention-to-treat analysis

There is low risk of bias if all randomised patients were reported/analysed in the group to which they were allocated by randomisation.

Timing of outcome assessments (detection bias)

Bias because important outcomes were not measured at the same time across groups

There is low risk of bias if all important outcome assessments for all intervention groups were measured at the same time (van Tulder 2003).

Other bias

Bias due to problems not covered elsewhere in the table

There is a low risk of bias if the study appears to be free of other sources of bias not addressed elsewhere (e.g. study funding).

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CONTRIBUTIONS OF AUTHORS

Helge Franke and Gary Fryer wrote the background. Helge Franke drafted the protocol with help from the other authors.

Gary Fryer and Helge Franke performed the search, study selection and data extraction.

Helge Franke and Steve Kamper performed the data analyses.

Raymond Ostelo, Steve Kamper and Helge Franke assessed the risk of bias.

Steve Kamper performed the GRADE approach.

Gary Fryer, Steve Kamper and Helge Franke wrote main results, discussion, conclusion, abstract and plain language summary.

All authors read and approved the final version.

DECLARATIONS OF INTEREST

None of the authors has made or is involved in a clinical study which fulfils the inclusion criteria of this review. One of the authors, Gary Fryer, has been involved in several trials of MET, but none of his studies met the criteria to be included in this review.

SOURCES OF SUPPORT

Internal sources

- No internal sources of support given, Other.

External sources

- No external sources of support given, Other.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

An update of the search was made between 24 May 2014 and 3 June 2014.

INDEX TERMS

Medical Subject Headings (MeSH)

Acute Pain [*therapy]; Chronic Pain [*therapy]; Low Back Pain [therapy]; Manipulation, Osteopathic; Muscle Contraction [*physiology]; Randomized Controlled Trials as Topic; Selection Bias

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MeSH check words

Humans

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