Clinical effects of Muscle Energy Technique (MET) for nonspecific back pain. A systematic review

by

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Approval Page

This Thesis Proposal was submitted by Helge Franke, whose committee was composed of the persons indicated below. It was submitted to the dean of the Post-graduate School of Osteopathic Clinical Research and approved in partial fulfillment of the requirements for the degree of Master of Science in Osteopathic Clinical Research at A.T. Still University of Health Sciences.

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For my wife Christel in deep gratitude
and my son Jan-David – the most beautiful present in my life.

Special thanks to my teacher Prof. Dr. med. Karl-Ludwig Resch.
He was a source of inspiration in every way.

"Of course it is not always possible to apply an instrument
that scale can measure directly the success of therapeutic efforts.
But whenever a patient has a relevant problem, the induced
therapeutic change can be quantified.„

Prof. Dr. med. Karl-Ludwig Resch

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„…there was always the thought that some day the needed
research would be performed. Some day has arrived, and in
this age governed by the scientific method, anecdotes no longer
suffice — osteopathic medicine must be supported by high-quality
and rigorous scientific inquiry.“

John Heard, Ph.D.

Abstract

Title: Clinical effects of MET on nonspecific back pain. A systematic review. Franke, Helge, 2010: Thesis, Post-graduate School of Osteopathic Clinical Research, A.T. Still University of Health Sciences /M.Sc. /Osteopathic Clinical Research.
Background: Non-specific back pain is common, disabling, and costly. The clinical effects of the osteopathic Muscle Energy Technique (MET) remain unclear.
Objectives: To assess in a qualitative and quantitative synthesis of studies if MET treatments on subjects with nonspecific back pain lead to a reduction of subjective pain parameters. A minor aspect of the review is to assess if MET applications on subjects without nonspecific back pain but with restriction in their active range of motion lead to an increased range of motion or if MET interventions change the threshold of pressure pain in the back of asymptomatic subjects.
Search strategy: Computerized bibliographic databases including MEDLINE, EMBASE, COCHRANE, and others were searched without language restrictions. This search was supplemented by a manual search in the reference lists of all relevant papers which are not listed in the electronic database. The applied search strategy was sensitive and focused on the isometric form of MET.
Selection criteria: The studies had to be randomized clinical studies, controlled clinical studies, or clinical studies. The examiners had to describe the applied technique as MET and the received effect size must be assigned to MET.
Data collection and analysis: Citation identification, study selection, data abstraction, and methodological quality assessment were conducted. Using a random effects model, overall effect size and standardized mean differences were calculated.
Main results: Eight studies could be found for the qualitative synthesis, five were included in the quantitative synthesis (meta-analysis). The studies focus on the short time effect (up to 4 weeks) and show a significant improvement in scores of pain and functional pain questionnaire (pooled SMD / -1.54 (95% CI: -2.62 to -0.46). In comparison to Passive Mobilization or Maitland's Mobilization 2 studies detected no greater benefit in pain relief (pooled SMD / 0.00 (95% CI: -0.41 to 0.41).
Conclusion: MET significantly reduces nonspecific back pain. In comparison to other manual techniques 2 studies found no greater reduction of subjective pain parameters. It would be important for future studies on MET to give clear information on the manual diagnostic approach.

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Chapter 1: Background

1.1 Nonspecific Back Pain

Functional ailments of the motor system usually affect the back. Back pain (BP) can develop in association with a number of causes, including muscle strain, injury to the back, overuse, muscle disorders, pressure on a nerve root, poor posture, and many others. Despite improved clinical examinations as well as the latest lab- and imaging procedures, the cause of BP can usually not be determined precisely. Medline (Medline, 2009) defines nonspecific back pain as a pain in the back of unknown cause. The clinical guideline of low back pain, developed by the British National Collaborating Centre for Primary Care (National Institute for Health and Clinical Excellence, 2009), defines nonspecific low back pain 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. Several structures in the back, including the joints, discs and connective tissues, may contribute to symptoms". Muscle strains and ligamentous sprains are the most common causes of acute low back and neck pain among the general population (Meleger & Krivickas, 2007). Deyo and Weinstein (2001) estimate that 85% of patients with isolated low back pain cannot be given a precise pathoanatomical diagnosis. In a literature review, Vuori (2001) says that 85% of the cases of lower back pain (LBP) are unspecific and functional. Nachemson (1994) even claims that 97% of the lumbar spine problems are classified as "unspecific".

According to a study by the Agency for Health Care Policy and Research (Rockville, 1994) more than 95% of the pain in the lumbar spine within the population at working age are ascribed to changes in the soft tissue (especially muscles, tendons, ligaments). Deyo (Deyo, Rainville, & Kent, 1992) mentions that of all back pain patients in primary care in the USA 4% had a compression fracture, 3% spondylolisthesis, 0.7% a tumor or metastasis, 0.3% spondylitis ankylopetica and 0.01% an infection. Bogduk (Bogduk, 2009) holds the view that, although disc herniation is the most common cause of radicular pain, it is not a common cause of back pain. The vast majority of patients with nociceptive back pain neither have radicular pain nor a disc herniation.

More than 90% of all patients' back pain had an unknown cause. In a systematic review of observational studies van Tulder (van Tulder, Assendelft, Koes, & Bouter, 1997) said that no firm evidence for the presence or absence of a causal

relationship between radiographic findings and nonspecific low back pain can be found. Jensen examined the prevalence of abnormal findings on magnetic resonance imaging (MRI) scans of the lumbar spine in people without back pain and came to the result that “many people without back pain have disk bulges or protrusions but not extrusions. Given the high prevalence of these findings and of back pain, the discovery by MRI of bulges or protrusions in people with low back pain may frequently be coincidental” (Jensen et al., 1997, p.69).

In another study Jensen, Kelly, & Brant-Zawadzki (1994) pointed out that in addition to the unknown etiology of disc degeneration, the relationship between degenerative disc disease and LBP has not been firmly established and caution is urged before blaming a particular anatomic finding for the patient's low back pain. Bogduk (Bogduk, 2009) argues that plain radiographs, MRI scans, or 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.

1.1.1 Classification of Nonspecific Back Pain

Nonspecific back pain is normally classified according to the duration of back disorders in the patient. In clinical practice, nonspecific low back pain which is present for less than six weeks is classified as “acute”. With a recovery rate of close to 90% within 6 to 8 weeks, acute back pain has a great tendency to be self-limiting (Burton et al., 2006; Waddell, 2004). 90% of the patients with low back pain who consulted a primary care provider will have stopped seeing them with symptoms within three months (Croft, MacFarlane, Papageorgiou, Thomas, & Silman, 1998). When back pain persists between six weeks and three months it is described as “subacute” and longer than three months as “chronic” (van Tulder, Becker, Bekkering, Breen, & del Real, 2006; Koes, van Tulder, & Thomas, 2006). Other authors (Dionne et al., 2008; Cedraschi et al., 1999; Hestbaek et al., 2003) point out that patients with low back pain (LBP) suffer shorter or longer episodes and that the „acute-subacute-chronic scheme“ does not measure the episodic intermittent appearance of the pain. Von Korff (1994) suggests a more detailed classification of “transient back pain, recurrent back pain, chronic back pain, acute back pain, first onset and flare-up”, which have not prevailed yet been accepted. The definition of pain on a unidimensional timeline is based on the belief that chronic pain is

maintained through a sensitization of the central nervous system even if the nociceptive stimuli in the periphery are fading. In their study von Korff and Dunn (2008) doubt that the chronological course of time alone is actually enough to make a statement about the relevance and the prognosis of chronic pain. For patients with chronic back pain the pain pattern is described as different in intensity of pain as well as in its development. In their study the authors (von Korff & Dunn, 2008) came to the conclusion that the introduction of a multivariate risk score allows for a better prognosis of the clinically relevant degree of pain. The predictive value of the multifactorial risk score was essentially higher than that of the pain duration.

Hestbaek refers to the problem in a way that "the term chronic should be used with caution, not to induce unnecessary defeatism to the therapeutic thinking. Furthermore, LBP should not be dismissed as being transient (and therefore neglected), since the condition rarely seems to be self-limiting but merely present itself with periodic attacks and temporary remissions" (Hestbaek et al, 2003, p.218).

In his review, Andersson (1999) works on different studies about the relapse of back pain (see table 1).

Table 1: Recurrence of back pain

Study	% of Study Population	Time (Years)	Type of Study Population
Abenhaim	20.0	1	Prospective occupational BP
	36.3	3	Prospective occupational BP
Anderson	8.9	2	Dockyard workers
Berquist-Ullman	22.0	1	Prospective occupational BP
Biering-Sorensen	38 (men)	1	Prospective random sample
	39 (women)	1	
Choler et al.	12.0	1.5	Work absence prospective
Moens et al.	72.0	Lifetime	Female family care employed
Nachemson	44.0	1	Sickness absence data
Van Doorn	8.6	1	Claims, self-employed
	16.0	2	
	20.0	3	
	47.0	8	

BP = Back Pain. (Andersson, 1999, p.584)

De Vet (De Vet et al., 2002) proposes in a literature review the following three uniform definitions for low back pain episodes: An episode of *low back pain* is defined as a period of pain in the lower back lasting for more than 24 hours, preceded and followed by a period of at least one month without low back pain.

An episode of *care for low back pain* is defined as a consultation or a series of consultations for low back pain, preceded and followed by at least three months without consultation for low back pain.
An episode of *work absence due to low back* pain is defined as a period of work absence due to low back pain, preceded and followed by a period of at least one day at work.

1.1.2 Prevalence and Recurrence of Back Pain

Pain in the motor system, especially back pain, is a significant topic for the health care system in all industrial nations (Dagenais, Caro, & Haldeman, 2008). Low back pain is a common and costly disease (Depont et al., 2010). Estimates of the lifetime prevalence of back pain vary between 50-70% (see table 2)

Table 2: Estimates of U.S. prevalence of back pain in various surveys

	Any Back Pain in Past Year (%) (Louis Harris Survey Group, 1985; n 1,254)	At Least 1 Day of Back Pain in Past 3 Months (%) (NHIS, 2002; n 31,044)	"Frequent" LBP in Past 12 Months (%) (Dayton, Ohio, 1973; n 2,782)	Lifetime Prevalence of LBP Lasting at Least 2 Weeks (NHANES II, 1976–1980)
All adults	56	26.4	18	13.8
Male	53	24.3	15	14.2
Female	57	28.3	20	13.4
Black	46	23.9	19	11.4
White	59	27.4	19	14.2
Over the Age of 65	49	28.8	18	16

(Deyo, Mirza, & Martin, 2006, p.2726)

The lifetime prevalence (proportion of the eligible population that ever had an episode of back pain during their life) of obvious pain in the lumbar spine (for more than 2 weeks) is estimated to be an average of 13.8%. Estimates on the prevalence of LBP within the population at any given time vary between 4.4% and 31% (Boca Raton, 1993). Based on the 2002 National Interview Survey, Deyo (Deyo, Mirza, & Martin, 2006) says that low back pain, which lasted at least a whole day during the past 3 months, was reported by 26.4% of the respondents, and neck pain was reported by 13.8%. There is a remarkable decrease in prevalence related to higher levels of education and income. In a methodological review of literature about the prevalence of LBP in adults, Loney and Straford (1999) quote three studies. Two studies (Deyo

& Tsui-Wu, 1987; Lee, Helewa, Smythe, Bombardier, & Goldsmith, 1985) estimated the mean point prevalence of LBP in North America at 5.6% (LBP for more than 2 weeks) and one study (Cassidy, Carroll, & Cote, 1998) estimated the point prevalence rate at 28.7% (LBP on the day of the survey). 84.1% (55% of the eligible population (2184 Saskatchewan adults from 20 to 69 years of age) responded) had experienced LBP during their lifetime.

Some studies refer to the fact that the prevalence of LBP is approximately the same in the U.S. and Europe (Andersson, 2007; Dagenais et al., 2008). Even though many people recover quickly from back pain, no other illness among those under 45-years old leads to such great limitations of their activities. Back pain is the most common cause of activity limitation in people younger than 45 years of age, the second most frequent reason for visits to the physician, the fifth-ranking cause of admission to hospitals, and the third most common cause of surgical procedures in the USA (Andersson, 2007). Among the 45- to 60-year-olds, problems with the lumbar spine are the most common cause of mobility limitations after arthritis (Loney & Stratford, 1999).

In an extensive survey of the European Commission (2007), carried out in 29 European countries with a total of 28,584 participants, the respondents were asked two questions, whether their daily lives are now or have been affected in the past by muscle-, joint- or back pain. The most common type of pain mentioned was back pain, with 11% of all participants replying that they had experienced low back pain in the week preceding their interview. 8% suffered from pain in their upper back, 7% from neck pain. 9% of all respondents have experienced chronic low back pain at some point in their lives, while 6% complained about problems with their upper back and 5% with their neck. In the UK low back pain affects around one-third of the adult population (National Institute for Health and Clinical Excellence, 2009). A multiregional survey with 9,263 subjects in Germany reported a point prevalence of 37.1%, 1-year prevalence of 76.0%, and lifetime prevalence of 85.5%. Subjects with a low educational level reported substantially more disabling back pain (Schmidt et al., 2007). A secondary data analysis (Ochsmann et al., 2009) with 7,829 subjects in a health survey conducted by the Robert Koch Institute in 2003 showed that women (28.5%) complained about low back pain significantly more often than men (18%).

It seems that the recurrence rate of LBP is high. Studies stated that 47% to 84% of individuals who have an episode of LBP will suffer a recurrence within 1 year

(Stanton et al., 2008). But the definition of recurrence is not exactly clear. In a systematic review of 53 studies Stanton et al. (Stanton, Latimer, Maher, & Hancock, 2009) identify the definitions of recurrence and recovery. They came to the result that in view of an unclear terminology it is very difficult to compare the recurrence rates between the studies. Accordance in recurrence and recovery definitions are necessary. "True recurrence requires that the patient has firstly recovered from the original episode and then experiences a new episode of LBP. Logically a definition of recurrence needs to include operational definitions for the conclusion of an episode and the commencement of a new episode" (Stanton et al., 2009). De Vet (de Vet et al., 2002) gives recommendations for definitions of recurrence and recovery as well(see table 3).

Table 3: Recommendations for definitions of recurrence (and recovery) of an episode of LBP

Recurrence of LBP
Preceded by a period of recovery from LBP as defined below.
Minimum duration of LBP of at least 24 h for new episode.
Intensity >= MIC (minimal important change) for chosen scale (VAS/NRS or equivalent) and/or
Functional limitation >= MIC for chosen functional limitation/disability scale
Recovery from LBP
Minimum duration of pain-free for at least 1 month
Intensity: pain-free (on applicable pain rating scale)

(de Vet, 2002)

1.1.3 Diagnosis of Nonspecific Back Pain

Often it is not possible to render a pathoanatomical diagnosis for back pain. Nonspecific back pain (NSBP) is a diagnosis which is based on exclusion. It is revealed if no structural tissue damage is detected in the implemented examination, though the absence of a symptom does not automatically result in a homogeneous group.

Numerous studies come to the result that "nonspecific LBP" (NSLBP) is a heterogeneous condition. Bogduk refers to the fact that many diagnostic labels for back pain are illegitimate, inappropriate, or fanciful. ""Sprain" or "strain" are inferences about what caused the back pain, but are based on what the patient reports. They can not be proven clinically and therefore may or may not be correct inferences" (Bogduk, 2000, p. 401). According to Bogduk labels such as osteopathic "segmental dysfunction" are only metaphors with no established biological correlation.

Kent (Kent & Keating, 2005) analysed the data of a postal survey from 651 Australian primary-care clinicians of six different professional disciplines. They asked the therapist if they could recognise subgroups of NSLBP. 90% of the clinicians chose a descriptive label indicating an alleged pathoanatomic source of nonspecific back pain. The agreement of the specific signs and symptoms for different subgroups were low. Only 10% of the clinicians agreed on the three most common signs and symptoms of any subgroup. The authors also discovered that the most consensus that indicated NSLBP subgroups came from the different disciplines. Only a little consensus was found throughout the professional disciplines.

To this day it is not possible to predict who will develop NSLBP and what the reasons for that development are. It is also not known why some people recover from acute LBP without recurrence in later times whereas other patients often have back pain attacks. Leboeuf-Yde and Manniche (Leboeuf-Yde & Manniche, 2001) argue that most researchers see NSLBP as a disease entity and therefore most clinical trials are based on four basic causal models: (1) a Single cause, a single disease; (2) a Single cause, several diseases; (3) Several causes, a single disease; (4) Several causes, several diseases. “More studies based on any of the four main causal models would therefore simply add to the confusion by producing different outcomes depending on which particular subgroup of LBP happened to be included in the individual studies. Such a disproportionality of subgroups is likely to be the result when different target populations are used (such as different specific occupational groups or different particular clinical populations), when the sampling method of general populations is inadequate, or when the sample size is too small to give all of the subentities a chance to participate” (Leboeuf-Yde & Manniche, 2001, p. 63).

If NSLBP is based on several distinct subentities, each with its own causes and its own therapy approach then the results of the studies and the therapies must vary considerably when they don’t consider the different symptoms and signs of the subentities (see figure 1 and 2).

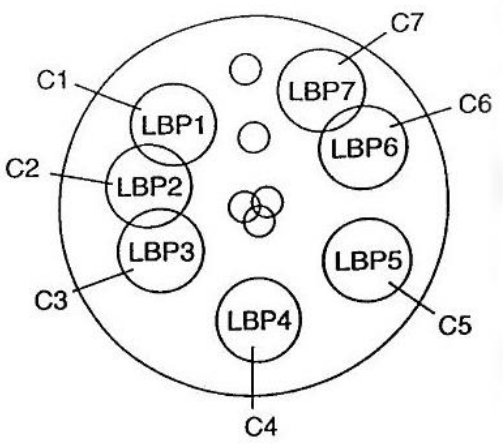


Figure 1: Nonspecific low back pain (large circle) may consist of a number of largely unidentified subentities (smaller circles LBP1, LBP2, etc), each having its own set of causal mechanisms (C1, C2, etc).
(Leboeuf-Yde & Manniche, 2001, p. 65)

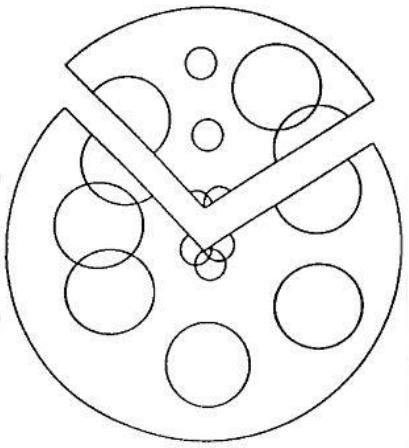


Figure 2: Sampling method in one study may result in a disproportionately large number of people from one or several specific subentities of LBP.
(Leboeuf-Yde & Manniche, 2001, p. 65)

Because the identification of a pathoanatomical cause is elusive for many patients with low back pain, some studies developed subgroups for patients with the label of nonspecific low back pain, which were, depending on the different signs and symptoms, recommended by clinicians. Subgroup specific therapy was then applied. In a study Brennan (Brennan et al., 2006) placed divided 123 subjects with acute/subacute low back pain into one of three treatment subgroups (manipulation, stabilization or specific exercise), based on their initial signs and symptoms. Then he randomly allocated one of the three treatments for these patients. The evaluation

showed that patients receiving the treatment matched to their subgroup had better outcomes than patients selected at random (see figure 3).

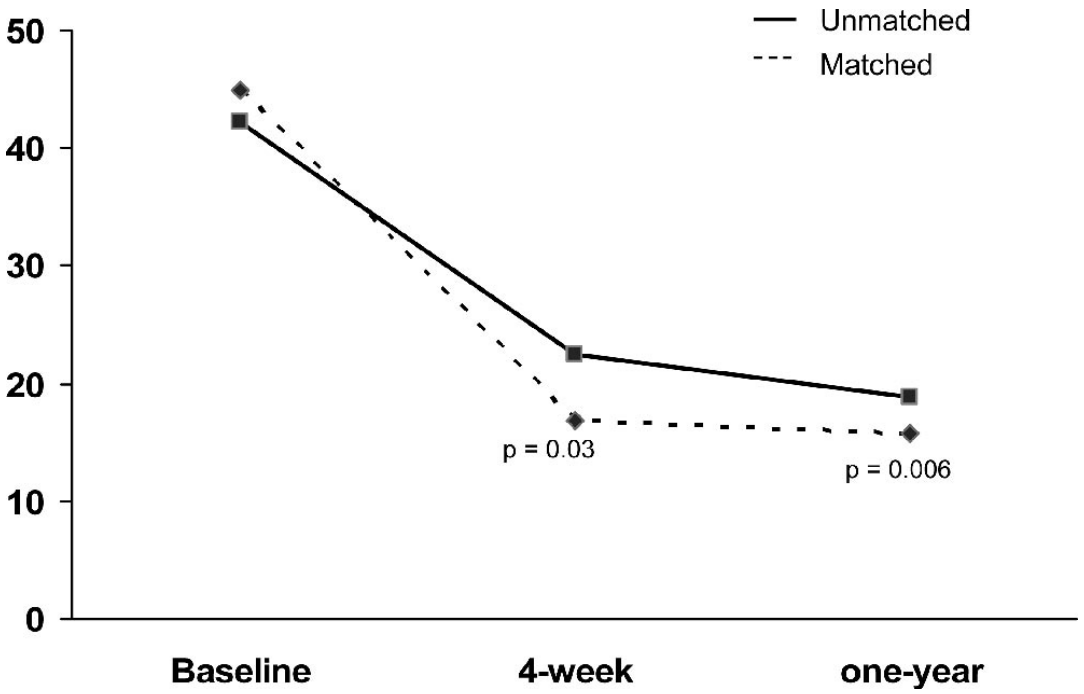


Figure 3: Oswestry scores for patients receiving matched or unmatched treatments (intention-to-treat analysis, p-values represent differences between the baseline and follow-up scores). (Brennan et al., 2006, p. 628)

The author concludes that the treatment of nonspecific low back pain, based on subgroups, can improve the resulting quality of care.

In a pilot study with 78 patients, which took place in 5 chiropractic clinics for 18 weeks, Kongsted and Leboeuf-Yde (Kongsted & Leboeuf-Yde, 2009) showed that patients with nonspecific LBP have a number of different course-patterns. Two extreme groups were identified. The first group of patients improved quickly, remained recovered and had the fewest days with LBP over 18 weeks. The second group consisted of patients who worsened at an early stage, then developed a fluctuating course. The subjects in this group had the highest total number of days with LBP within the study period. The authors conclude that distinct LBP course patterns could be attributed to different subgroups of patients with different reasons for back pain.

The applied classification systems vary from a relative simple first- and second-level (Delitto, Erhard, & Bowling, 1995) to a multi-level system, whose

classification procedure takes very long per patient. For example Fersum (Fersum et al., 2009) examined the inter-examiner reliability of a classification system for patients with nonspecific low back pain. In the study, the patients were examined in detail, then had to fill out several questionnaires. This included a pain drawing, the functional assessment chart from the Dartmouth Primary Care Cooperative Information Project (COOP/WONCA), the Oswestry Disability Index (ODI), the Hopkins Symptoms Check List (HSCL), the Fear Avoidance Beliefs Questionnaire (FABQ) and the Ørebro Musculoskeletal Pain Screening Questionnaire (Ørebro MSPSQ).

In another trial Fritz (Fritz, Delitto, & Erhard, 2003) compared the effectiveness of classification-based physical therapy (Delitto et al., 1995; Fritz & George, 2000) (see table 4) with a therapy based on clinical practice guidelines (Agency for Health Care Policy and Research guidelines) for patients with low back pain with a duration of less than 3 weeks.

Table 4: Treatment classifications used for the classification-based group

Classification	**Examination Findings**	**Treatment**
Mobilization Sacroiliac Pattern	Unilateral symptoms without signs of nerve root compression, positive findings for sacroiliac region dysfunction (pelvic asymmetry, standing and seated flexion tests)	Joint mobilization or manipulation techniques and spinal active range of motion exercises
Lumbar Pattern	Unilateral symptoms without signs of nerve root compression, asymmetrical restrictions of lumbar side-bending motion, lumbar segmental hypomobility	Joint mobilization or manipulation techniques and spinal active range of motion exercises
Specific Exercise Flexion Pattern	Patient's preference for sitting versus standing, centralization with lumbar flexion motions	Lumbar flexion exercises, avoidance of extension activities
Extension Pattern	Patient's preference for standing versus sitting, centralization with lumbar extension motions	Lumbar extension exercises, avoidance of flexion activities
Immobilization	Frequent previous episodes, positive response to prior manipulation or bracing as treatment, presence of "instability catch" or lumbar segmental hypermobility	Trunk strengthening and stabilization exercises
Traction	Radicular signs present, unable to centralize with movements, may have lateral shift deformity	Mechanical- or auto-traction

(Fritz et al., 2003)

Outcomes of the impairment index, the Oswestry scale and the SF-36 component scores resulted in more satisfied patients, the reduction of medical costs

and an increased return-to-work rate. 78 patients from five outpatient clinics of the Employee Health Services were included. Subjects who received a classification-based therapy showed greater change on the modified Oswestry Index and the SF-36 physical component after 4 weeks. Patient satisfaction was greater and were more likely to return to a full-duty work status after 4 weeks in the classification-based group.

In a cross-sectional study within the framework of a 5-year prospective project, Leboeuf-Yde (Leboeuf-Yde, Lauritsen, & Lauritzen, 1997) analysed the data of 1,370 subjects. Participants were asked if they had any kind of pain in the lower back during the preceding year. The pain group was then further divided into two groups of subsets, each containing two subdefinitions of LBP, based on the information on duration and location of the problem during the preceding year. These were: LBPshort (LBP for a maximum of 30 days), LBPlong (LBP for more than 30 days), LBPnoNECK (LBP but no pain in neck or upper extremities) and LBPandNECK (LBP and pain in the neck or upper extremities).

Six correlates of LBP were selected from the data, age, sex, marital status, attitude toward a healthy life-style, self-reported amount of physical activity at work, and smoking. Each of these variables was then cross-tabulated with the five definitions of LBP in a series of bivariate analyses, and the prevalence odds ratios (OR) calculated with their 95% confidence intervals (CI) (see figure 4).

In the LBPall group there was statistically significant evidence that people who carry out heavy physical labor suffer from LBP more often than people who only do light physical labor. It is interesting however that patients with long-term back pain respond more clearly to correlating factors (except for the age factor) than patients of the LBPshort group. Patients with LBPandNeck show a similar pattern as members of the LBPlong group, but show more obvious differences to the LBPnoNeck group. It is assumed that the different reactions to the correlating factors result from the different clinical symptoms which logically result in different therapeutic methods for therapy. The authors concluded that when searching for the LBP causes it is “essential to identify and classify people with LBP into specific and clinically relevant subgroups“ (Leboeuf-Yde et al., 1997, p. 881).

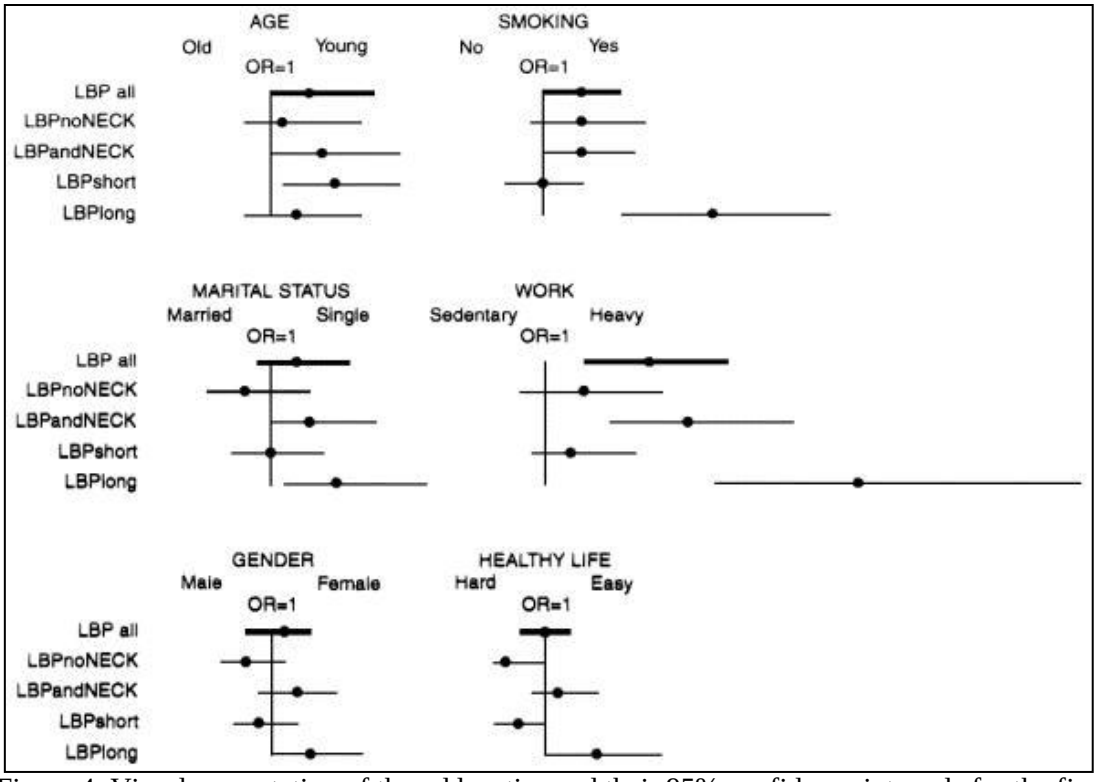


Figure 4: Visual presentation of the odds ratios and their 95% confidence intervals for the five different definitions and the six correlates of low back pain.
(Leboeuf-Yde et al., 1997, p. 880)

There is growing evidence that subgrouping patients and an appropriate therapy, based on the different signs and symptoms of the group, improves the patients' outcome (Nachemson, 1999; Skouen, Grasdal, Haldorsen, & Ursin, 2002). For now, the development of subgroups appears to be a way out of the dilemma, of not being able to render a pathoanatomical diagnosis for nonspecific back pain.

A cross-sectional study in England with 1,446 children, aged between 11 and 14, showed that the 1-month period prevalence of low back pain was 24%. The rate was higher in girls (29%) than in boys (19%) and increased with age in both sexes. The prevalence rate for the 14-year-olds reached a magnitude which equalled half of the peak level for adults between 45 and 59 years of age (Watson et al., 2002). The authors of the study asked themselves whether the presence of LBP in children could have an influence on a later development of LBP in their adult lives. In a Danish study, Harreby (Harreby, Neergard, Hesselsoe, & Kjer, 1995) observed that out of 640 14-year-old children 11% suffered from back pain and that 25 years later 84% of them suffered from back pain which increased in duration and intensity. A nationwide cohort-based cross-sectional study evaluated the prevalence of low back pain among

1,171 Finnish children and adolescents. The authors concluded: “The prevalence of back pain was low (1%) among the 7-year-old and 10-year-old (6%) schoolchildren, but increased with age, being 18% both among 14- and 16-year-old adolescents. No gender difference was found. Recurrent or chronic pain was reported by 26% of the boys and 33% of the girls who reported low back pain, and the proportion of recurrent and chronic pains of all low back pain incidents increased with age. …Low back pain is a relatively common complaint at adolescence. In addition, a significant part of the pains are recurrent or chronic already with 14-year-old adolescents” (Taimela, Kujala, Salminen, & Viljanen, 1997, p.1132).

Watson (Watson et al., 2003) carried out a cross-sectional study in a population of 1446 British schoolchildren aged 11–14 years of age. The study concludes that LBP in schoolchildren with no apparent clinical cause is not associated with mechanical factors such as physical activity and school bag weight. Strong associations with LBP were observed for emotional problems, behavioural problems, troublesome headaches, abdominal pain, sore throats and daytime tiredness. The results “suggest that psychosocial factors rather than mechanical factors are more important in LBP occurring in young populations and could possibly be a reflection of distress in schoolchildren” (Watson et al., 2003, p.12).

In 1994 and again in 2002, Hestbaek, Leboeuf-Yde & Kyvik (2006) interviewed nearly 10,000 twins who were born between 1972 and 1982. The questionnaires dealt with various aspects of general health, including the prevalence of LBP. The predictor variables used in this study were LBP, headache, asthma and atopic disease at baseline, the outcome variable was persistent LBP (>30 days during the past year) at follow-up. Hestbaek et al. concluded that headache and asthma are positively associated with future LBP and that a large clustering of LBP, headache and asthma in adolescence exists.

1.1.4 Back Pain and Economic Consequences

Economic consequences of back pain are enormous. Over 30% of the workers' lost-time compensation claims in Ontario and the U.S. were paid for LBP cases (Boca Raton, 1993). On the basis of insurance figures, Webster and Snook (1994) calculated the amount of worker’s compensation paid due to LBP in the U.S. in 1989 added up to 11.4 billion dollars. Back pain has become the most expensive impairment for the

working population in the U.S. and it doesn't look like the costs will decrease over the next years either. In 2005, more than 14 billion people in the U.S., who suffered from back pain, consulted a doctor (Cherry, Woodwell, & Rechtsteiner, 2007). Martin et al. (2009) analyzed data from the Medical Expenditure Panel Survey, a multistage survey sample designed to produce unbiased national estimates of health care utilization and expenditure. An average of 1,774 respondents with spine problems were surveyed per year. The authors conclude that "the proportion suggested an increase in the number of people who sought treatment for spine problems in the United States from 14.8 million in 1997 to 21.9 million in 2006" (p. 2077).

In Great Britain, between 1986 and 1992 the inability to work due to back pain increased by 104%, while the inability to work due to other reasons rose by 60%. In 1988 and 1989, back pain was the largest single cause of total sick days with 12.5% (Frank, 1993). The national Labour Force Survey (LFS) reported the following data (Health and Safety Executive, 2009):

"In 2007/08, an estimated 241 000 people in Great Britain who had worked in the last year believed they were suffering from a musculoskeletal disorder mainly affecting the back that was caused or made worse by their current or past work... This equates to 800 per 100,000 people (0.8%) in Great Britain who worked in the last 12 months. Of these, just under a third, 74,000 people, first became aware of their work-related musculoskeletal disorder mainly affecting the back in the previous 12 months. This equates to an estimated 240 per 100,000 people (0.24%) with a new work-related musculoskeletal disorder mainly affecting the back in this period... This incidence rate was statistically significantly lower than in both 2001/02 and 2006/07, but of a similar order to 2003/04, 2004/05 and 2005/06. The LFS shows that an estimated 4.1 million working days (full-day equivalent) were lost in 2007/08 through musculoskeletal disorders mainly affecting the back caused or made worse by work. On average, each person suffering took an estimated 17.2 days off in that 12 month period. This equates to an annual loss of 0.17 days per worker. The number of days lost per worker in 2007/08 was statistically significantly lower than in 2001/02 but of a similar order to other years over the period 2003/04 to 2006/07."

Only a small percentage of patients with chronic or episodic LBP account for a large proportion of cost. Various factors have been shown to be correlated or predictive of chronic LBP including the characteristics of the initial episode, pain, psychosocial issues and occupation. (Neubauer, Junge, Pirron, Seemann, &

Schiltenwolf, 2006). In addition to direct costs – treatment and incapacity benefit payments – there are indirect costs, such as those incurred by businesses due to the loss of human resources (Maniadakis & Gray, 2000). Nachemson (Nachemson, Waddell, & Norlund, 2000) notes that nearly 80% of healthcare costs for back pain are created by 10% of people with chronic pain and disability.

Dagenais (Dagenais, Caro, & Haldeman, 2008) points out in a systematic review of low back pain cost-of-illness studies that the total costs can approximately be calculated by using the mean value of several studies to calculate the relation between direct and indirect costs. According to this calculation the direct costs account to only 14.5%, while the indirect costs add up to 85.5%.

A study of Musculoskeletal Disorders and the European workforce (Bevan et al., 2009) comes to the conclusion: "It is estimated that half of the European population will suffer from back pain at some time in their lives and in excess of a third of the European workforce suffer from low back pain. The costs of this back pain have been estimated to exceed €12 billion. About 85% of people with back pain take less than 7 days off, yet this accounts for only half of the number of working days lost by back pain. The rest is accounted for by the 15 % who are absent for over a month. Swedish back- and neck patients on sick leave from work, for example, represent a total cost of about 7 per cent of the nation's expenditure on health services."

After the an examination of 18 studies, Göbel (Gobel, 2001) assembled a review about the occurrence of back pain in different countries. The overall loss of work force amounted to 2% in the US, Canada and the UK, in Germany and Netherlands 4%; and, in Sweden 8%. The results of an analysis by Moffeh et al. is shown in table 5).

Table 5: Costs of back pain in the UK, Sweden and Netherlands (in US $)

	United Kingdom		**Sweden**		**Netherlands**	
Costs	Costs in US $ Million (% of Total)	Costs/ Capita	Costs in US $ Million (% of Total)	Costs/ Capita	Costs in US $ Million (% of Total)	Costs/ Capita
Direct Costs	385 (11.5)	7	213 (8)	24	368 (7.4)	24
Indirect Costs	2948 (88.5)	113	2262 (92)	266	4600 (92.6)	299
Total Costs	3333 (100)	120	2475 (100)	290	4968 (100)	323

(Moffeh et al., 1995, cited in (van Tulder M., Koes, & Bombardier, 2002)

1.1.5 Back Pain and the Individual

Not only are the socio-economic factors substantial, but newer cross-sectional studies refer to changed social behavior, retreat from activities of daily life and reduced life quality of people who suffer from back pain (Croft & Papageorgiou, 1994). The "European Guidelines for Prevention in Low Back Pain" (Burton et al., 2004, p.7) consider "that, overall, nonspecific low back pain is important not so much for its existence as for its consequences…Consequences are important from the perspectives of the individual and of society. They include broad issues such as recurrence (including severity and disability), work loss, care seeking, health-related quality of life, and compensation." Krimser and van Tulder (2007, p.80) point out that "the impact of LBP on the individual can be evaluated within the framework of the WHO International Classification on Functioning, Disability and Health" (WHO, 2004).

Non specific LBP tends, depending to severity, to lead to a loss of functions, limitations of activities and participation in of social life. Fear avoidance belief may also limit activities.

1.1.6 Risk Factors of Nonspecific Low Back Pain

Many studies have been done about the risk factors of nonspecific back pain. The result is not homogeneous. Van Tulder, Koes, & Bombardier (2002) have put together the most common factors, associated with nonspecific low back pain, in table 6.

Van Tulder et al. refer to different systematic reviews, which stated that smoking and body weight should be accounted as weak risk factors (Leboeuf-Yde, 1999; Leboeuf-Ide, 2000b). No evidence was found for an influence through alcohol consumption (Leboeuf-Yde, 2000a), standing or walking, sitting, sports, and total leisure-time physical activities (Hoogendoorn, van Poppel, Bongers, Koes, & Bouter, 1999). Lakke (Lakke, Soer, Takken, & Reneman, 2009) conducted a systematic review of systematic reviews to evaluate risk factors of nonspecific musculoskeletal pain (MSP), classified according to the International Classification of Functioning, Disability and Health (ICF). Although heterogeneity of the included reviews could cause an effect bias, the authors come to the conclusion that only increased lumbar

spine mobility and low job satisfaction are high-evidence risk factors for low back pain.

Table 6: Risk factor occurrence and chronicity of nonspecific low back pain

	Occurrence	**Chronicity**
Individual Factors	Age Physical fitness Strength of back and abdominal muscles Smoking	Obesity Low educational level High levels of pain and disability
Psychosocial Factors	Stress Anxiety Mood/emotions Cognitive functioning Pain behaviour	Distress Depressive mood Somatisation
Occupational Factors	Manual handling of materials Bending and twisting Whole-body vibration Job dissatisfaction Monotonous tasks Work relations/social support Control	Job dissatisfaction Unavailability of light duty upon return to work Job requirement of lifting for 3/4 of the day

(van Tulder M., Koes, & Bombardier (2002, p.767)

A critical literature review of co-morbidity with LBP (Hestbaek, Leboeuf-Yde, & Manniche, 2003) points out, that the most reviewed studies demonstrated a positive association between LBP and other disorders (for example, headaches/migraines, cardiovascular diseases or respiratory disorders). The authors conclude that LBP is part of this pattern and therefore cannot be regarded as a separate and unique entity. Thus, a purely biomechanical explanatory model for the development of LBP does not seem to be broad enough (Hestbaek et al., 2003, p.251). Gilkey et al (Gilkey, Keefe, Peel, Kassab, & Kennedy, 2010) stated that BP is multifactorial and different chains of causation make it very difficult to isolate risk factors. In a cross-sectional study which included 963 survey results they evaluated the associations between common college-life health behaviors and back pain occurrence within the past school year. Back pain was the most frequent physical health disorder among college students. 38% of college students reported having had back pain within the last school year. Psychosocial factors were identified as being associated with back pain.

1.1.7 Nonspecific Back Pain and Guidelines

At the initiative of the European Commission some years ago guidelines for the management of low back pain were developed. Three working groups have been established:

1) Working group on European guidelines for acute nonspecific low back pain,
2) Working group on European guidelines for chronic nonspecific low back pain,
3) Working group on European guidelines for prevention of low back pain.

For the treatment of acute nonspecific low back pain the "European Guidelines for the Management of Acute Nonspecific Low Back Pain" in primary care (van Tulder, 2006) recommended: Adequate information, positive reinforcement for patients, no bed rest as treatment, advising patients to stay active, prescribing medication (paracetamol, NSAID) or a short course of muscle relaxants if paracetamol or NSAIDs have failed to reduce pain, referral to spinal manipulation for patients who are failing to return to normal activities and multidisciplinary treatment programs in occupational settings.

The "European Guidelines for Chronic Nonspecific Low Back Pain" (Airaksinen et al., 2006) recommend the use of different diagnostic tests to exclude specific spinal pathology and nerve root pain and suggest an assessment of prognostic factors, work related factors, psychosocial distress, depressive mood, severity of pain and functional impact, prior episodes of LBP and the patients' expectations. The workgroup suggests conservative treatments like cognitive behavioral therapy, supervised exercise therapy, brief educational interventions and multidisciplinary treatment. Back schools and short courses on manipulation/mobilization can also be considered. The use of NSAIDs and weak opioids are recommended as pharmacological treatment. The guideline does not recommend surgery for nonspecific chronic low back pain unless 2 years of all other recommended conservative treatments did not bring any positive results.

The workgroup of the „European Guidelines for Prevention in Low Back Pain" points out that the most powerful reason for new episodes of back pain is a previous history of back pain (Burton et al., 2004). The guideline recommends physical exercise to prevent sick leave due to LBP and the occurrence or duration of further episodes (no recommendation for or against any specific type or intensity of exercise). It suggests informing and educating the patients about back problems, if

they are based on biopsychosocial principles (not primarily focused on a biomedical or biomechanical model). Common back schools, lumbar supports or back belts, any specific chair or mattress or manipulative treatment for the prevention of low back pain are not recommended.

In May 2009, the National Institute for Health and Clinical Excellence (2009) in the UK published a guideline for the early management of nonspecific LBP. The suggestions of the so-called "NICE Clinical Guideline 88" are structured somewhat different from regular guidelines. A key focus is how a person can improve the self-management of persistent back pain in order to reduce the pain and its impact on daily life. The guideline emphasizes the necessity of a good communication between healthcare professionals and patients and points out that the information is tailored to the patients' needs, culture, possible handicaps and their ability to speak or read English. Families and carers should support the treatment. Patients should be offered one of the following treatments:

1. A group exercise programme
2. A course of manual therapy (including spinal manipulation)
3. A course of acupuncture

The clinical practice guideline from the American College of Physicians and the American Pain Society (Chou et al., 2007) includes recommendations for the diagnosis and the treatment of LBP. For the diagnosis, the therapist should try to determine to which of the 3 categories his patient's condition belongs after a targeted physical examination and history:

1. Nonspecific back pain
2. Back pain possibly associated with radiculopathy or spinal stenosis
3. Back pain possibly associated with another specific spinal cause.

In the interview, the psychosocial risk factors should be considered specifically.
For therapy, the following recommendations are listed in table 7:

Table 7: Intervention recommendations for low back pain

	Low Back Pain Duration	Acute < 4 Weeks	Subacute or Chronic > 4 Weeks
Self-care	Advice to remain active	x	x
	Books, handout	x	x
	Application of superficial heat	x	
Pharmacologic Therapy	Acetaminophen	x	x
	NSAIDs	x	x
	Skeletal muscle relaxants	x	
	Antidepressants (TCA)		x
	Benzodiazepines	x	x
	Tramadol, opioids	x	x
Nonpharmaco-logic Therapy	Spinal manipulation	x	x
	Exercise therapy		x
	Acupuncture		x
	Yoga		x
	Cognitive-behavioural therapy		x
	Progressive relaxation		x
	Intensive interdisciplinary rehabilitation		x
	X interventions supported by grade B evidence (at least fair-quality evidence of moderate benefit, or small benefit but no significant harms, costs, or burdens). No intervention was supported by grade A evidence (good-quality evidence of substantial benefit).		

(Chou et al. (2007, p.482)

Bouwmeester, van Ernst, & van Tulder (2009) conducted a systematic review which included 14 international guidelines for the management of acute- and chronic LBP and compared their recommendations. Most guidelines had similar references for the diagnosis of acute- and chronic LBP and for the treatment of acute LBP. The recommendations for the treatment of chronic LBP varied.

The Canadian "Clinic on Low-Back Pain in Interdisciplinary Practice" (Clip) guideline (Rossignol, Arsenault, Dionne, Poitras, & Truchon, 2007) recommends a broad set of treatments adjusted to the specified context (acute- or subacute or persistent LBP). Every recommendation is allocated to a grade of scientific evidence (high, moderate, low). The guideline also includes a column with non-recommended common interventions as well as a column with therapies which can neither be recommended nor rejected due to insufficient information. The recommendations or disapprovals respectively are each assigned to specifically applied studies, which easily allow for more detailed research.

Penney (Penney, 2009) compared Australian (Australian Acute Musculoskeletal Pain Guidelines Group, 2003) and European (van Tulder M. et al.,

2006) guidelines for intervention in acute, nonspecific low back pain. He found five European guideline recommendations which don't agree with the Australian rating of evidence (see table 8).

Table 8: Comparison of evidence grading for the treatment of acute nonspecific low back pain in European/Australian guidelines

Recommendation For Treatment of Acute Nonspecific Low Back Pain	Level of Evidence: European	Level of Evidence: Australian
Give adequate information and reassurance to the patient	Level B	Consensus, Level II
Do not prescribe bed rest as a treatment	Level A	Insufficient evidence
Advise patients to stay active and continue normal daily activities including work, if possible	Level A	Level I, II
Prescribe medication, if necessary for pain relief; preferably time contingent, first choice, paracetamol, second choice NSAIDs	Level A	Consensus, but evidence considered to be conflicting/insufficient
Consider adding a short course of muscle relaxants alone or together with NSAIDs if paracetamol or NSAIDs have failed to reduce pain levels	Level A	Conflicting Level I evidence
Consider (referral for) spinal manipulation for patients who are failing to return to normal activities	Level A	Conflicting Level I evidence
Multidisciplinary treatment programs in occupational settings may be an option for workers with subacute low back pain and sick leave for more than 4–8 weeks	Level B	Insufficient, no Level I or II evidence
European levels: Level A: Generally consistent findings provided by (a systematic review of) multiple high quality randomised controlled trials (RCTs) Level B: Generally consistent findings provided by (a systematic review of) multiple low quality RCTs or non-randomised controlled trials (CCTs) Australian levels: Level I evidence obtained from a systematic review of all relevant randomised controlled trials Level II evidence obtained from at least one properly designed randomised controlled trial		

(Penney, 2009), p.66, modified)

A systematic review of 17 guidelines for low back pain treatment, published between 1994 and 2002 in different countries (USA, Canada, European-Union countries, Australia and New Zealand) noted that the "methodological criteria for grading the strength of the recommendations varied and were often insufficiently specified. … With regard to the recommendations, there was consensus for some of the interventions for acute pain (analgesics and NSAIDs, maintaining physical activity and avoiding bed rest), but explicit recommendations were lacking or

ambiguous for 41% of the interventions. Most of the guidelines did not contemplate specific recommendations for chronic pain" (Arnau et al., 2006, p.543).

The American Osteopathic Association Guidelines for Osteopathic Manipulative Treatment (OMT) for Patients with Low Back Pain (2009) only recommended OMT for the treatment of LBP. The recommendations are substantially based on the systematic review of osteopathic manipulative treatment for low back pain by Licciardone, Brimhall, & King (2005).

All of the guidelines partially vary in their recommendations. Van Tulder and Koes (2007) mention that recommendations in guidelines are not based on scientific evidence alone. "Guideline committees might consider various arguments differently, such as the magnitude of the effects, potential side effects, cost-effectiveness, and current routine practice and available resources in their country… This does not necessarily mean that one guideline is better than another or that one is right and another is wrong. It merely shows that when translating the evidence into clinically relevant recommendations, many aspects play a role, and that these aspects will vary locally or nationally" (van Tulder M. & Koes, 2007, p.457-458). Another aspect in the relationship between guidelines and clinical practice is the challenge to develop more effective implementation strategies for the treatment of LBP (van Tulder & Waddell, 2005). A workgroup at the Fifth International Forum on Low Back Pain in Primary Care in Canada in 2002 came to the general agreement that multi-faceted interventions are most effective for implementing guidelines, but the feasibility of doing this in busy clinical settings is questionable (Breen et al., 2006). An observational study on 3,831 general practitioners from Victoria and New South Wales, Australia in 1997, 2000 and 2004, came to the conclusion that a special interest in back pain is associated with back pain management beliefs contrary to the best available evidence (Buchbinder, Staples, & Jolley, 2009).

1.1.8 Interventions for Back Pain

The number of approaches to treat back pain is growing. Haldeman (Haldeman & Dagenais, 2008) presented a partial list of commonly used treatment options for chronic low back pain (CLBP) in the Spine Journal: 60 pharmaceutical products, 32 different manual therapies, 20 different exercise programs, 26 different passive physical modalities, 9 educational and psychological therapies, over 20 different

injections therapies, some minimally invasive interventions and some more traditional and newer surgical approaches. In contrast to many offered therapies, available evidence for the efficacy of interventions is limited. Koes (Koes, Malmivaara, & van Tulder, 2005) gives an overview of the number and quality of randomized controlled studies (RCTs) which were included in the systematic reviews conducted and published within the framework of the Cochrane Collaboration Back Review Group (see table 9).

Table 9: Number, Median (Range) and Mean (SD) quality scores of RCTs for conservative interventions for low back pain

Intervention (Scale)	**No. of RCTs**	**Quality Score**	
		Median (range)	**Mean (SD)**
Acupuncture	35	45% (9–91)	46% (24%)
Advice to stay active	4	75% (36–91	68% (24%)
Back schools	20	36% (9–73)	38% (19%)
Bedrest	9	64% (27–91)	60% (23%)
Behavioural treatment	21	45% (9–91)	45% (21%)
Exersise therapies	61	55% (9–100)	52% (23%)
Lumbar supports	6	45% (36–82)	50% (18%)
Massage	8	55% (36–82)	57% (16%)
Multidisciplinary (chronic)	10	36% (9–64)	40% (16%)
Muscle relaxants	30	55% (27–82)	57% (12%)
Neuroreflexotherapy	3	82% (36–91)	70% (29%)
NSAIDs	51	55% (9–91)	52% (17%)
Spinal manipulative therapy	39	45% (9–82)	51% (17%)
TENS	5	55% (27–100)	60% (28%)
Work conditioning	18	55% (27–91)	58% (18%)

(Koes et al., 2005)

The review comes to the conclusion that the methodological quality of RCTs has not improved over the past decades. “The efficacy of many interventions for low back pain is still unclear” and “high quality randomized clinical trials are needed to provide evidence for or against the efficacy of interventions for low back pain (Koes et al., 2005), p.538).

1.1.9 Back Pain and Osteopathy

Data of the Osteopathic Survey of Health Care in America (Licciardone & Herron, 2001) suggest that the majority of patients with back pain see osteopathic doctors for a treatment of musculoskeletal problems. Pain in the lumbar spine (lower back pain) is the most common reason for visiting osteopaths in the U.S. “Osteopathic

physicians were more likely than allopathic physicians to provide medical care during LBP patient visits (OR, 2.61; 95% CI, 1.75–3.92)… There was an even stronger association between osteopathic physicians and chronic LBP patient visits (OR, 4.39; 95% CI, 2.47–7.80)" (Licciardone, 2008).

In 1992 in Great Britain, 5% of the back pain patients saw an osteopath, according to estimates of the Osteopathic Information Service. In two thirds of all osteopathic sessions, back pain was treated (Pringle & Tyreman, 1993). In 1998, osteopaths carried out 4.38 million treatments for low back pain in the United Kingdom (Maniadakis & Gray, 2000).

Dionne (Dionne et al., 1999) compared pain, functional limitations, and work status indices as measures of outcome for back pain patients in a prospective study with a 2-year follow-up and came to the conclusion that pain and functional limitations were not equivalent but related.

A restricted range of motion, a high sensitivity of pressure-pain thresholds and myofascial triggerpoints are often associated with back pain and the concept of somatic dysfunction (Travell & Simons, 2001; Kuchera, 2007; Kuchera, 2005). The somatic dysfunction is defined as "impaired or altered function of related components of the somatic (body framework) system: skeletal, arthrodial and myofascial structures, and their related vascular, lymphatic, and neural elements" (Educational Council on Osteopathic Principles (ECOP) of the American Association of Colleges of Osteopathic Medicine, 2006). A mnemonic for four diagnostic criteria of somatic dysfunctions is TART: Tissue texture abnormality, asymmetry, restriction of motion and tenderness. In a study, Snider (Snider, Johnson, Snider, & Degenhardt, 2008) was able to prove that a somatic dysfunction is more common in human beings with chronic back pain than in individuals who do not suffer from these symptoms.

In a retrospective analysis of the Outpatient Osteopathic SOAP Note Form (data collected in 1998 and 1999 by 20 osteopathic medical trainee-investigators in three university-based, osteopathic family practice clinics) Licciardone (Licciardone, Nelson, Glonek, Sleszynski, & des Anges Cruser, 2005) analyzed the records of 1,331 patient encounters among 424 adults. A somatic dysfunction was diagnosed for nearly one-third of the patients encounters. The authors composed a document called 'Burden of Somatic Dysfunction' which is based on the prevalence and severity of somatic dysfunctions in a specific anatomic region. They divided three anatomic regions into different levels:

Level I: High prevalence of somatic dysfunctions (thoracic T1–T4 and T5–T9, lumbar, sacrum/pelvis, and cervical).

Level II: Low prevalence of somatic dysfunctions (left and right upper extremities, left lower extremity, and ribs).

Level III: Low severity of somatic dysfunctions (right lower extremity, pelvis/innominate, head, and thoracic T10–T12).

Degenhardt (Degenhardt et al., 2007) examined various nociceptive pain-biomarkers that have been suggested as important mediators in the process of chronic pain. In a prospective, blinded assessment, blood was collected from 20 subjects (10 with chronic low back pain, 10 controls without chronic low back pain for 5 days). On day 4, OMT was administered to subjects 1 hour before blood collection. The researcher pointed out that concentration of several circulatory pain biomarkers were altered after OMT and that changes in biomarkers were greater in subjects with chronic LBP than in control subjects without the disorder.

The goal of the osteopathic treatment is to normalize the myofascial, ligamentous, and articular integrity of the body to restore normal body movement where possible (Rennie, 2006). In a study, Greenman (Greenman, 1996) identified frequently founded forms of somatic dysfunctions which are associated with low back pain. Licciardone (Licciardone, Brimhall, & King, 2005) assessed the efficacy of an Osteopathic Manipulative Treatment (OMT) as a complementary treatment for low back pain. The review included six trials, involving eight OMT vs. control-treatment comparisons between 1981 and 2003. A variety of osteopathic techniques (4 x), high-velocity, low-amplitude thrust (1x) and low-force techniques (1x) were applied in the included studies. The study came to the conclusion that OMT significantly reduces low back pain and that the pain reduction is greater than expected from placebo effects alone.

An osteopathic manipulative treatment may reduce costs for the management of acute LBP. This was the conclusion of Crow and Willis (2009), who estimated the cost of OMT and standard care compared with standard care alone for acute LBP in a study. In a retrospective review they assessed the data of 1,556 patients and 2,030 episodes of care. In comparison with the control group, individuals in the OMT group had 38% more office visits, but received 18.5% fewer prescriptions, had 74.2% fewer radiographs, 76.9% fewer referrals, and 90% fewer magnetic resonance imaging scans. In the OMT group, total average costs were $38.26 lower, and average

prescription costs were $19.53 lower. Patients in the OMT group also had $63.81 lower average radiologic costs. Contrary to this study, Sinay (Sinay, 2005) concluded that osteopathic hospitals are in general more costly and less productive in comparison to their allopathic counterparts.

Since most cases of back pain are not caused by precisely identified structural defects, the treatments chosen are prevalently those which emphasize the functional changes of structures and their synergy. The Muscle Energy Technique (MET) treats functional ailments of the motor system as a somatic dysfunction. Mitchell (2009b, p.51) defines the somatic dysfunction as ”a manipulable and amendable abnormal articular barrier”. Herein he focuses on a hypothetically impaired muscle function in order to treat the restricted joint mobility.

1.2 Muscle Energy Technique

The Muscle Energy Technique (MET) is one of the best known treatment techniques in osteopathy. It was developed 50 years ago by Fred Mitchell Sr. and was then refined and partially modified by his son Fred Mitchell Jr. The Muscle Energy Technique is ”a bio-scientifically based system of manual therapy for functional interference of the motor system“ (Mitchell 2009a, p.69). Greenman (2000, p.118) considers it ”within the framework of manual therapy one of the best and most effective techniques ever.” MET was first introduced to the curriculum of an osteopathic college in 1964 and is part of the courses at all important osteopathic schools today. According to a study by Johnston and Kurtz (2003), together with the soft-tissue technique and HVLA-thrusts, MET is one of the three most commonly used techniques applied by American osteopaths in a treatment. A web-based survey (Fryer, Morse, & Johnson, 2009) among members of the American Academy of Osteopathy reported that Muscle Energy Technique was most commonly used in treatments of the pelvis and sacroiliac joint.

1.2.1 The Model of Muscle Energy Technique

Several factors are responsible for a successful use of MET. These include an exact diagnosis, a precise positioning of the joint by the therapist, an active and appropriately regulated muscle contraction by the patient against a defined resistance of the therapist, and the accurate control of the therapeutic success.

All in all the model of MET is described very similarly by different authors (Goodridge, 1981; DiGiovanna, Schiowitz, & Dowling, 1997; Ehrenfeuchter, Heilig, & Nicholas, 2003; Graham, 1985; Kuchera & Kuchera, 1994). Significant differences to Mitchell's MET model can be found in Leon Chaitow's book about MET (Chaitow, 2008).

In MET, the restrictive barrier must be located precisely. If using an isometric technique, the therapist uses the first palpated barrier as the starting position. According to Fred Mitchell Jr, the analysis of the joint movements is the core of MET (Mitchell Jr & Mitchell, 2001). The diagnosis begins with the definition of the joint's neutral position. According to Fred Mitchell Jr it is defined as the position with the greatest possible range of passive movement.

The active mobility of the joint is judged by osseous markers (landmarks). They are either defined by comparing the sides from a static position or by comparing the chosen landmarks at the beginning and the end of the movement (dynamic test). In the dynamic tests the quality of the movement is of lesser interest. The focus lies on the osteologic measuring points at the beginning and end of the movement. Therefore, there are two coupled static tests. This is why Mitchell (Mitchell Jr & Mitchell, 2001, p.1) wrote: "MET diagnosis is based on bone, rather than soft tissue, anatomy. Even in Muscle Energy diagnostic procedures where it appears that movement is being observed, the information about the range or duration of movement depends on a comparison of the bone's static position before it moves and after it has stopped moving". An important criterion for the diagnosis is the palpation of the osseous markers and its visual judgment concerning possible asymmetries. Mitchell was eager to examine the positioning of the affected joint on three different planes. The described position of the measuring points gave him information about the functional restriction, which in turn resulted in the direction of therapeutic muscle contraction. This approach asks for clear definitions on which positions of the joint show a dysfunction and which show a physiological problem. In this context Fred Mitchell Jr goes back to spinal kinematics by Fryette (Fryette, 1954) and the pelvi-sacral model (Mitchell Jr & Mitchell, 1999), which was developed by his father and modified by himself.

Clearly defined descriptions of the positioning around clearly defined axes allow for a complete physiology-pathology scheme of sacrum and ilium. Fryettes categorization of dysfunctions in type I (neutral dysfunctions) and type II (nonneutral

dysfunctions) and the following positions (NSR, FRS, ERS) also form the biometric framework of examination as does Mitchell's model for the sacro-iliac joint.
In general, the muscle energy technique model is based on the following basic considerations:

1. There can be multiple causes for a mobility dysfunction, but the structure which is to be treated with MET is mainly the joint (arthro-kinematic fixation).
2. The reduction in joint mobility is accompanied or caused by neuroreflexive muscle reactions, e.g. there is a contraction mainly of tonic, monoarticular muscles (short restrictors, type II dysfunction). A contraction of the polyarticular muscles (long restrictors, type I dysfunction) is, even if rarer, also possible (simplified theoretic model of the "shortened muscle").
3. The joint blockade is not being diagnosed via the condition of the muscular system (soft tissue), provocation- and mobility tests, since they are unreliable for an evaluation, but via osseous points of orientation (landmarks), which are analyzed in static and dynamic tests (osteokinematic diagnosis).
4. For therapy, MET treatments are being used, which focus on a theoretically hypertonic muscle. If the muscle tension releases via a direct isometric or isotonic contraction, the joint becomes mobile.

1.2.2 Muscle Energy Technique and Post-Isometric Relaxation

Some years after Fred Mitchell's MET model, Karel Lewit developed an isometric method to stretch shorten muscles, which he named post-isometric relaxation (PIR) (Mitchell Jr & Mitchell, 1999). Over the years, both methods have undergone modification. But it would be wrong to assume that both methods are virtually identical, since there are important differences. They differ in their application variety, wherein MET is equipped with a broader repertoire of techniques, even though the most obvious difference lies in the diagnostic orientation (see table 10). "MET and PIR differ mainly in how they view the indications. PIR sees its primary application in muscle tightness, spasms, and myofascial trigger points, with joint mobilization as consequence of muscle relaxation. MET sees its primary application in mobilization of both active and passive joints, and regards muscle spasms and tightness, when they occur, as neurological consequence of postural and

locomotor adaptation to articular dysfunction usually located elsewhere in the body" (Mitchell Jr & Mitchell, 2004).

Table 10: Differences between MET and PIR

	MET	**PIR**
Variations	Isometric Isometric intermittend (Ruddys Rhythmic Resistive Duction) Isotonic concentric Isolytic (eccentric isotonic) Isolytic (vibratory) Isokinetic	Isometric Isometric in direction of the barrier Isotonic intermittend
Variables		
Definition of the barrier	Point of the first resistance during movement	Point of the first resistance during movement
Initial position	At the barrier	At the barrier
Force of the patient isometric isotonic	From light to moderate From moderate to maximum	Minimal force of the patient Notable force of the patient
Duration of contraction	2–3 seconds	About 10 seconds
Number of repetitions	Generally 3–5 times	Generally 3–5 times
Direction of patient's force	Away from the barrier	Away from the barrier In the direction of the barrier (variation)
Additional components	Breathing, visual direction	Breathing, visual direction
Type of counter force	Therapist	Therapist, gravitation, visual direction (Automobilization)
Diagnostic orientation	Concept of somatic dysfunction, Spinal kinematics according to Fryette, Mitchell model of the pelvis, Osteokinematic fixation	Undogmatic mobility tests including the soft tissue, Concept of muscular dysbalance, No osteokinematic fixation

(Franke, 2009)

1.2.3 Scientific Discussion about the Diagnostic Procedure of Muscle Energy Technique

A range of scientific studies shows that the diagnostic foundations in some areas of MET are not supported scientifically. Thus, the results of some biomechanical studies support the Fryette model of spinal kinematics (1st and 2nd law) for the cervical vertebrae and the upper thoracic spine, but not for the lumbar spine. After examining the lumbar spine, coupled movements can differ from segment to segment (Klein & Sommerfeld, 2007; Pearcy & Tibrewal, 1984; Vicenzino & Twomey, 1993). On the whole, there is growing evidence that the recording of the joint position or rather a categorized definition of a coupled movement for the determination of the (dys-) functionality, especially for the area of the lumbar spine, is

insufficient. The physiological position of the associated joints and their coupled movements can vary. According to studies, muscle tension, irritated ligaments, weight, back pain, inherent- or acquired changes of the facets are factors, which can be responsible for the altered movement patterns. Panjabi (Panjabi, Yamamoto, Oxland, & Crisco, 1989) conclude in their study, that coupled movements of the lumbar spine are far more complex than generally assumed and that the specific effect, which e.g. the muscular system has on the coupled movement, is still unknown. Gibbons and Tehan (1998) are of the opinion in their literature study that despite the poor results of some study designs "coupled motion occurs independently of muscular activity but muscular activity might influence the direction and magnitude of coupled movement". Apparently "there does not appear to be any simple and consistent relationship between conjunct rotation and the intervertebral motion segment level in the lumbar spine." (Gibbons & Tehan, 1998)

A further critique of the diagnostic concept of MET in the scientific literature is based on the question of whether the fixation on osteological points of reference in dynamic tests leads to valid and reliable results. One of the most important tests of the side of pelvic dysfunction, the standing flexion test (SFT), is, according to Vincent-Smith and Gibbons, questionable. In 1999, both of them came to this result during an examination of the inter- and intra-examiner reliability of SFT (Vincent-Smith & Gibbons, 1999). Additionally, a biomechanical study by Jacob and Kissling (1995) shows that during the flexion test, the sacrum does not necessarily nutate (flexion). A counternutation (extension) is also possible, which undermines the biomechanical principle on which the flexion tests are based. Holmgren and Wailing (2006) tested the „inter-examiner reliability" for the static palpation of the transverse processes of L5, the sacral sulcus and the inferior lateral angles of the sacrum. The tests were carried out by two experienced physiotherapists on 25 test subjects with pain in the lumbar spine or the sacroiliac joint. The concordance of the palpation was 44% indicating a correlation. The study supports the results of a pilot study (O'Haire & Gibbons, 2000) even though in 1,200 examinations by 10 therapists only minor "inter-examiner reliability" was found.

Gary Fryer, who has been trying to establish an evidence-based view of MET for many years, indicates that a focus on landmark asymmetry for diagnosis is problematic. Anatomic asymmetries alone can distort the result. For the diagnosis of a segmental dysfunction, additional mobility- and provocation tests are necessary

(Fryer, 2000; Fryer, 2009). In a literature study, Seffinger (Seffinger et al., 2004) examined the intra- and interexaminer reliability of spinal diagnostic palpation techniques via published test reports of the past 35 years. They concluded that pain provocation tests are the most reliable.

1.3 Objectives

The objective of this review is to determine the clinical effects of MET on nonspecific back pain. Therefore the main question should be answered:

Do MET treatments on subjects with nonspecific back pain lead to a reduction of subjective pain parameters and can this change be proven statistically significant in comparison with a control group?

As a second outcome, and only a minor aspect of the review, is to assess in a qualitative synthesis if MET applications on subjects without nonspecific back pain but with restriction in their active range of motion lead to an increased range of motion and respectively do MET interventions change the threshold of pressure pain in the back of asymptomatic subjects?

Chapter 2: Methods

2.1 Criteria for Considering Studies for this Review

2.1.1 Types of studies.

Only randomized clinical studies (RCT), controlled clinical studies (CCT) or clinical studies (CT) were included. The studies must have been published or at least been available as a complete study (e.g. via internet).

2.1.2 Types of participants.

For main question and meta-analysis (quantitative comparison) only those clinical studies were taken into account in which MET was used on those patients who complained about back pain. Studies which included subjects with specific back pain were excluded.

In addition and as an indirect evidence of the effects of MET, the review separately documents studies about MET on asymptomatic subjects with a restricted range of motion or trials which investigate the effect of MET on the pressure-pain threshold.

2.1.3 Types of intervention.

Only those studies were included in which the examiner or examiners described the applied technique as some form of MET. Techniques which were applied under a different name and which showed a similarity to some aspects of MET were not considered in this overview in order to avoid interpretation errors. The authors of the studies had to label their techniques as MET themselves and not the examiners who just interpreted the procedures as such.

Only those studies were taken into consideration whose effect size could be assigned to MET. Thus, if used, co-interventions also had to be carried out in the control group as a measure.

Studies which included similar techniques like proprioceptive neuromuscular facilitation (PNF) or post-isometric relaxation (PIR) instead of MET were excluded.

2.1.4 Types of outcome measure.

For the review only subjective pain parameters like visual analogue scale (VAS) or number rating scales (NRS-101) or the results of functional pain questionnaires were considered.

2.2 Search Methods for Identification of Studies

2.2.1 Electronic searches.

A systematic literature search on MET was done from March 2009 to January 2010 in the following electronic databases:

PUBMED,
EMBASE,
COCHRANE LIBRARY,
SCIENCE DIRECT,
PEDro,
OSTMED-DR,
OSTEOPATHIC WEBRESEARCH,
GOOGLE SCHOLAR,
SPRINGER VERLAGSDATENBANK
ISI WEB of KNOWLEDGE.
SCOPUS

In addition to the listed databases a query of data was made in the databases of ongoing trials.

The applied search strategy was sensitive and focused on the isometric form of MET (for the precise search strategy please see appendix A). The search strategy was not limited by language.

2.2.2 Searching other resources.

This search was supplemented by a citation tracking of the identified trials and a manual search in the reference lists of all relevant papers which are not listed in the electronic database. Personal communication was conducted with experts in the field of MET to identify additional studies.

2.3 Data Collection and Analysis

The reviewer conducted citation identification, study selection and data extraction. For the data extraction and the comparison process a standardized form was used which was also applied in Cochrane Reviews about back or neck pain (Gross et al., 2010; Assendelft, Morton, Yu, Suttorp, & Shekelle, 2004).

The outcomes of these studies were proof-read by a second researcher. The information about methodological procedures and outcomes in parts of some of the studies was not completed. Therefore the authors were contacted for additional information. Details are listed in Appendix E.

With Review Manager 5 (Cochrane collaboration) standardized mean differences with 95% confidence intervals (SMD; 95% CI) for continuous data were calculated. The standard mean difference is used as a statistical summary in meta-analysis, when the studies all assessed the same outcome but measured it in a variety of ways (Higgins & Green, 2008). The standard mean difference expresses the size of the intervention effect in each study relative to the variability observed in the study.

For the forest plots a random effect model was used. A random effect models emphasizes smaller studies in contrast to a fixed effects model. It is preferred when heterogeneity is identified among the included studies and the reasons of heterogeneity are unclear. Of course this is not a substitute for an investigation of heterogeneity (Higgins & Green, 2008).

If the data on “effect size” and “standard deviation” were missing in the studies they were calculated via the „baseline-“ and „after treatment-“ data (see appendix F).

2.4 Assessment of Risk of Bias in Included Studies

Checklists for the methodology of studies serve to provide transparency, in order to show how study design can possibly transform criteria so that the results will be attributed to whatever has been examined (internal validity). There are no strict guidelines for the use of risk of bias assessment in systematic reviews. The internal validity of the studies about nonspecific back pain in this review has been examined with two different tools. One is the examination according to the criteria recommended by the „Method Guidelines for Systematic Reviews“ of the Cochrane Back Review Group (CBRG), (Furlan, Pennick, Bombardier, & van Tulder, 2009).

This 12-point system is a compilation of former guidelines of the CBRG (van Tulder, Furlan, Bombardier, & Bouter, 2003), the evaluation checklist of nonpharmacological trials (CLEAR NPT) (Boutron et al., 2005) as well as comments from the „Cochrane Handbook of Reviews and Interventions“ (Higgins & Green, 2008). 11 of 12 criteria were used in 65% and 10 of 12 criteria were used in 18% of the CBRG reviews. The internal validity criteria are related to selection bias (criteria 1, 2, 9), performance bias (criteria 3, 4, 10, 11), attrition bias (criteria 6, 7), and detection bias (criteria 5, 12). Generally speaking, overview studies, which assign points for the fulfilment of single „quality criteria“ and conclude with a summarised scale, should be used with some caution (Kunz, Khan, Kleijnen, & Antes, 2009; McCarthy et al., 2008). This is why it is suggested to additionally use the Cochrane Collaboration's „risk of bias tool" for the methodical evaluation of the studies. The „risk of bias tool“ is suggested by the Cochrane Collaboration, which is eager to compose, update and circulate systematic overview studies in the medical field (Higgins & Green, 2008). It provides a clear illustration of essential markers on the methodology of the implemented study. The „risk of bias tool“ is therefore explicitly not to be mistaken for some kind of score list. The column „description“ promotes the transparency of the methodological evaluation as does the CBRG checklist, which lists the study according to their points.

A description of the evaluation with the „risk of bias tool“ by the Cochrane Collaboration as well as the criteria of the Cochrane Back Review Group are listed in Appendix C and D.

Chapter 3: Results

3.1 Results of the Search "MET and Nonspecific Back Pain"

The search strategy identified 15 studies form which 8 could be included in the qualitative synthesis and 5 in the quantitative synthesis (see figure 5). Table 11 shows the included studies and table 12 the excluded. Two of the excluded studies were no clinical trials, one study investigated specific back pain and in 4 studies the effect size could not be assigned to MET, because MET was mixed with other techniques.

3.2 Description of studies "MET and Nonspecific Back Pain"

Table 13 gives a synopsis of clinical trials with MET by subjects with back pain and reports about the most important characteristics (aim of the study, inclusion and exclusion criteria, drop outs, no. of treatments, measurement, number of patients, results and so on).

3.3 Risk of bias in included Studies "MET and Nonspecific Back Pain"

Table 14 comments on the assessment of the risk of bias in the included studies. The Cochrane Back Review Group recommends to classify studies with at least 6 of the 12 CBRG criteria as „low risk of bias" and studies with less than 6 criteria or with serious flaws as „high risk of bias" (Furlan et al., 2009). After that, the internal validity of the included studies varies from low (Brodin 1982, Hack 1999, Hack 2001) to high (Selkow 2009, Rana2009, Wilson 2003). Four of the 5 included studies in the meta-analysis have a high internal validity (which means a low risk of bias). One study (Salvador 2005) confirms 5 of the 12 CRBG criteria. In this study 3 of the criteria are unclear and it was not possible to get further information.

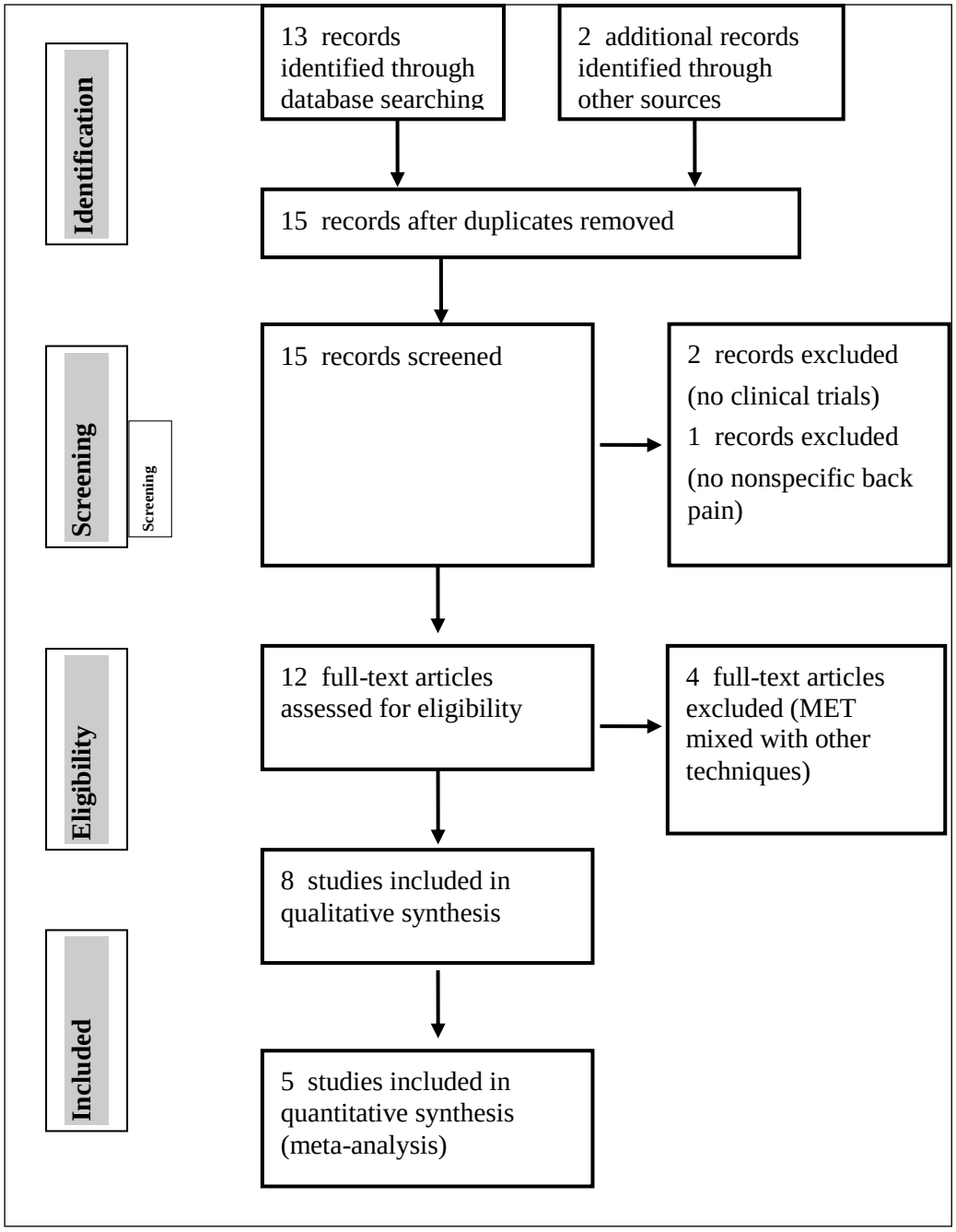


Figure 5: Flowchart study selection “MET and non-specific back pain”
The flow of information based on the recommended diagram of the PRISMA Statement ((Moher, Liberati, Tetzlaff, Altman, & The Prisma Group, 2009)

Table 11: Studies included in the qualitative synthesis (with * included in the quantitative synthesis)

***Rana 2009** *(published data and additional information)* Rana, K., Bansal, N., & Savita (2009). Comparative analysis of the efficacy of G.D. Maitland's concept of mobilization & muscle energy technique in treating sacroiliac joint dysfunction. ***Selkow 2009** *(published data and additional information)* Selkow, N., Grindstaff, T., Cross, K., Pugh, K., Hertel, J., & Saliba, S. (2009). Short-term effect of muscle energy technique on pain in individuals with non-specific lumbopelvic pain: A pilot study. ***Salvador 2005** *(published data only)* Salvador, D., Neto, P., & Ferrari, F. (2005). Application of muscle energy technique in garbage collectors with acute mechanical lumbar pain. ***Pillay 2005** *(published data and additional information)* Pillay, K (2005). The Relative Effectiveness of Muscle Energy Technique as Opposed to Specific Passive Mobilization in the Treatment of Acute and Sub-acute Mechanical Low Back Pain. ***Wilson 2003** *(published data only)* Wilson, E., Payton, O., Donegan-Shoaf, L., & Dec, K. (2003). Muscle energy technique in patients with acute low back pain: a pilot clinical trial. **Hack 2001** *(published data only)* Hack, A. (2001). Beschwerden der oberen Wirbelsäule. Teil 3: Behandlungsergebnisse mit Muscle Energy Technique nach Mitchel bei Beschwerden, die von der oberen Wirbelsäule ausgehen. **Hack 1999** *(published data only)* Hack, A. (1999). Therapeutischer Wert der Muscle energy technique nach Mitchel bei Wirbelsäulenbeschwerden. **Brodin 1982** *(published data only)* Brodin, H. (1982). Lumbar treatment using the Muscle Energy Technique.

Table 12: Excluded studies

(MET mixed with other techniques)
Geisser, M. E., Wiggert, E. A., Haig, A. J., & Colwell, M. O. (2005) *(published data and additional information)* A randomized, controlled trial of manual therapy and specific adjuvant exercise for chronic low back pain.
Lamberth, L., Hansen, K. L., Bloch-Thomsen, M., Silbye, P., & Remvig, L. (2005) *(published data only)* Muscle Energy Technique: a useful aid to manual treatment of Low Back Pain?
Riipinen, M., Niemisto, L., Lindgren, K. A., & Hurri, H. (2005) *(published data only)* Psychosocial differences as predictors for recovery from chronic low back pain following manipulation, stabilizing exercises and physician consultation or physician consultation alone.
Wreje, U., Nordgren, B., & Aberg, H. (1992) *(published data only)* Treatment of pelvic joint dysfunction in primary care--a controlled study.

(Specific low back pain)
Hack, A. (2002) *(published data only)*Therapeutische Ergebnisse mit der Muscle energy technique nach Mitchel beim Bandscheibenvorfall der Lendenwirbelsäule.

(No clinical trial)
Neumann, H. D. (1985) *(published data only)* Manuelle Diagnostik und Therapie von Blockierungen der Kreuzdarmbeingelenke nach F. Mitchell.
Neumann, H. D. (1996) *(published data only)* Diagnose und Therapie von reversiblen hypomobilen Funktionsstörungen an den Rippengelenken (nach Mitchell).

(For bibliographic data of included and excluded studies see References)

Table 13: Synopsis of clinical trials with MET by subjects with back pain
Part 1

Author / Year Country	**Rana 2009 India**	**Selkow 2009 USA**	**Salvador 2005 Brasil**
Study design	RCT	RCT	RCT
Aim of the Study	Comparative analysis on the efficacy of G.D. Maitland's concept of mobilization and muscle energy technique in treating sacroiliac joint dysfunctions.	Assessment the short-term effect of Muscle Energy Technique on pain in individuals with non-specific lumbopelvic pain	Assessment the efficacy of MET to reduce pain among garbage collectors with acute mechanical low back pain.
Reported Inclusion and Exclusion criteria, Dropouts	+ / + No dropouts reported	+ / + No dropouts reported	+ / + No dropouts reported
No. of treatments / Period	6 / 6 days	1 / After treatment	1 / After treatment
Measurement	Pain visual analogue scale, Oswestry disability Index, Hip range of motion	Pain visual analogue scale	Pain visual analogue scale, Muscle length test
Number of patients/ Age / Gender (mean)	45 / Ø 23 ?	20 / a. Ø24 b. Ø30 ♀ 4, ♂ 16	28 / ? ♂ 28
Number of patients Intervention / Control	a. 15 b. 15 c. 15	a. 10 b. 10	a. 14 b. 14
Randomized / Blind (Patients) / Pos. Diagnosis	+ / - / Unclear	+ /* + (also outcome ass.) No	+ /** + (also outcome ass.) No
Intervention A Intervention B Control C	a. MET and exercise b. Maitland and exercise c. Exercises	a. MET b. Sham Intervention	a. MET B. Tens
Reported Results	"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…"	"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."	"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."

Table 13: Synopsis of clinical trials with MET by subjects with back pain
Part 2

Author / Year Country	**Pillay 2005 South Africa**	**Wilson 2003 USA**	**Hack 2001 Germany**
Study design	RCT	RCT	CT
Aim of the Study	The relative effectiveness of MET as opposed to specific Passive Mobilization in the treatment of acute and sub-acute mechanical LBP	Examining the outcomes of MET in patients with acute low back pain	Effect of MET treatment in disorders of the upper spine
Reported inclusion / Exclusion criteria / Drop outs	+ / + / Dropouts existing	+ / + / Dropouts existing	+ / + / Dropouts existing
No. of treatments / Period	4 / 2 weeks Fol. up 1 week later	2-4 / 4 weeks	Ø 1,3 / Unclear
Measurement	NRS-101 Pain, Oswestry Disability Index, Lumbar range of motion, Pain pressure algometer	Oswestry Disability Index	Evaluation sheet with 1 question and 5 possibilities to answer
Number of patients/ Age / Gender (mean)	60 / a. Ø34 ♀ 21, ♂ 9 b. Ø32 ♀ 16 ♂ 14	16 / a. Ø31 b. Ø 32 ♀ 8, ♂ 8	367 Ø38 ♀ 71, ♂ 295
Number of pts Intervention / Control	a. 30 b. 30	a. 8 c. 8	a. 367 (analyzed 80% of 367)
Randomized / Blind (Patients) / Pos. Diagnosis	+ * / - / No (MD)	+ *** / - / Yes	- / - / Yes
Intervention A Intervention B Control C	a. MET b. Passive mobilization	a. MET , moist heat, supervised (home) exercise program b. Placebo Manual therapy , moist heat, supervised (home) exercise program	a. MET [(3)]
Reported Results	"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."	"MET combined with supervised motor control and resistance exercises may be superior to neuromuscular re-education and resistance training for decreasing disability and improving functions in patients with acute low back pain"	Strong improvement of the symptoms in 85% of the patients "A high percentage of patients with problems in the upper spine can be treated successfully with only a few sessions of MET."

Table 13: Synopsis of clinical trials with MET by subjects with back pain
Part 3

Author / Year Country	**Hack 1999 Germany**	**Brodin 1982 Sweden**	
Study design	CT	CCT	
Aim of the Study	Effect of MET treatment in disorders of the spine	Does a short-term study show MET to be more effective than no technique for low back pain	
Reported inclusion / Exclusion criteria / Drop outs	+ / + / Dropouts existing	+ / + / No dropouts reported	
No. of treatments / Period	Ø 1,1- 1,7 / Unclear	9 / 3 weeks [5]	
Measurement	Evaluation sheet with 1 question and 5 possibilities to answer	Nine step scale. Change of two steps was regarded as a significant change of pain	
Number of patients/ Age / Gender (mean)	580 / ♀ 99, ♂ 481	41 / ♀ 24, ♂ 17	
Number of pts Intervention / Control	580 (analyzed 82% of 580 = 478)	a. 21 c. 20	
Randomized / Blind (Patients) / Pos. Diagnosis	- / - / Yes	- / - / No	
Intervention A Intervention B Control C	a. MET	a. MET c. No treatment	
Reported results	"Nearly 80% of the patients had a strong improvement of their disorders after treatment with MET. In 3% of the cases were no alleviation of pain detectable".	"From this study we can conclude that in properly selected cases, the muscle energy technique is an effective treatment for lower back pain".	

* Random number generator ** Alternate allocation *** Coin toss [3] Referral for hot and cold applications. Patients with severe pain were permitted to take NSAIDs (Diclofenac)
[4] Referral for hot applications. It was also permitted for the patients with strong pain to take NSAIDs (Diclofenac) [5] If the patient was free of pain, treatment stopped earlier + = Yes - = No
MD= Motion diagnosis

Table 14: Risk of bias of the included studies

	Randomization?	Allocation concealed?	Patient blinding	Care provider blinding?	Outcome assessor blinding?	Drop-outs acceptable?	Analyzed in allo-cated group ?	Free of selective outcome report.?	Similar baseline?	Co-intervention avoided?	Compliance acceptable?	Similar timing?
Study	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Rana 2009	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Selkow 2009	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Salvador 2005	No	No	No	No	Yes	?	?	?	Yes	Yes	Yes	Yes
Pillay 2005	Yes	No	No	No	No	?	?	Yes	Yes	Yes	Yes	Yes
Wilson 2003	?	Yes	Yes	No	Yes	Yes	No	?	Yes	Yes	Yes	Yes
Hack 2001	Not a randomized clinical trial											
Hack 1999	Not a randomized clinical trial											
Brodin 1982	Not a randomized clinical trial											

Sources of Risk of Bias

1. Was the method of randomization adequate? Yes/No/Unsure
2. Was the treatment allocation concealed? Yes/No/Unsure
3. Was the patient blinded to the intervention? Yes/No/Unsure
4. Was the care provider blinded to the intervention? Yes/No/Unsure
5. Was the outcome assessor blinded to the intervention? Yes/No/Unsure
6. Was the drop-out rate described and acceptable? Yes/No/Unsure
7. Were all randomized participants analyzed in the in the group to which they were allocated? Yes/No/Unsure
8. Are reports of the study free of suggestion of selective outcome reporting? Yes/No/Unsure
9. Were the groups similar at baseline regarding the most important prognostic indicators? Yes/No/Unsure
10. Were co-interventions avoided or similar? Yes/No/Unsure
11. Was the compliance acceptable in all groups? Yes/No/Unsure
12. Was the timing of outcome assessment similar in all groups? Yes/No/Unsure

(According to (Furlan et al., 2009)

3.4 Effects of interventions

The quantitative evaluation included five studies. The study design exclusively included randomized clinical trials (RCTs). Table 15 shows mean, standard deviation and total of the 5 studies based on the outcomes VAS, NRS-101 and ODI. Figure 6 illustrates the standard mean difference and the overall effect size in a random effects model. Table 16 shows mean, standard deviation and total from 4 of the 5 studies based only on the outcomes VAS and NRS-101. Figure 7 illustrates the standard mean difference and the overall effect size in a random effects model. If we compare overall effect size and confidence interval in the forest plots between the 5 studies in figure 6 and the 4 studies in figure 7, the results are nearly the same. Both forest plots show a significant improvement in the MET intervention group (effect size -1.54, 95% confidence interval -2.62 - -0.46 to effect size -1.64, 95% confidence interval -2.92 - -0.36).

Two studies investigated the therapeutic effect with the measurement of VAS (respectively NRS-101) and ODI. The study of Wilson (2003) deals only with ODI. Table 17 shows the data for this whereas figure 8 compares the effect size of the 3 studies in a forest plot. Although overall effect size shows an improvement in the MET group, the result is not statistically significant (effect size -1.08, 95% confidence interval -2.55 - -0.39). The reason for this is that the intervention in the control groups is not the same. Pillay (2005) used specific passive mobilizations whereas Rana (2009) worked with exercises and Wilson (2003) with placebo manual treatments. On the basis of the studies of Wilson 2003 and Rana 2009 the effect size is -1.77 with a confidence interval of -2.65 - -0.89.

Two studies, in which MET interventions were compared to passive mobilization, i.e., Maitland techniques, conclude that MET treatments bring no improvement in pain relief or functional pain scores in contrast to the control treatments. Measurements in the 2 studies were both VAS (NRS-101) and ODI (see table 18, figure 9 and 10).

The sensitivity analysis shows that the heterogeneity is a result of the studies by Pillay (2005) and Rana (2009). If the studies by Pillay (2005) and Rana (2009) are not taken into consideration, the I2 value is 0% (see figure 11).

Table 15 : Mean, standard deviation, and total of the included studies in the quantitative synthesis

Study ID	MET			Control		
	Mean	SD	Total	Mean	SD	Total
Wilson 2003	-37.5	7.62	8	-28.75	5.23	8
Salvador 2005	-30.1	28.50	28	-7.1	5.40	28
Pillay 2005	-19.21	15.43	30	-18.58	10.7	30
Selkow 2009	-4.3	19.9	20	17.10	21.0	20
Rana 2009	-3.33	0.62	15	0.07	0.59	15

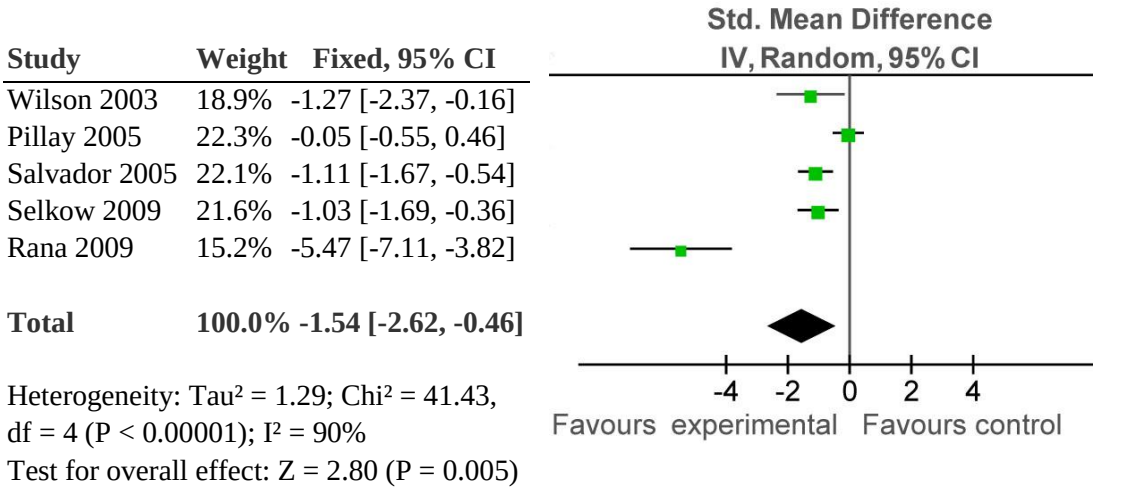


Figure 6: Forest plot (random effects model) of the included studies in the meta-analyses

Table 16: Data of the included studies based on Visual Analogue Scale (VAS) and Number Rating Scale (NRS 101)

Study ID	MET			Control		
	Mean	SD	Total	Mean	SD	Total
Salvador 2005	-30.1	28.5	28	-7.1	5.40	28
Pillay 2005	-19.21	15.43	30	-18.58	10.7	30
Rana 2009	-3.33	0.62	15	0.07	0.59	15
Selkow 2009	-4.3	19.9	20	17.10	21.0	20

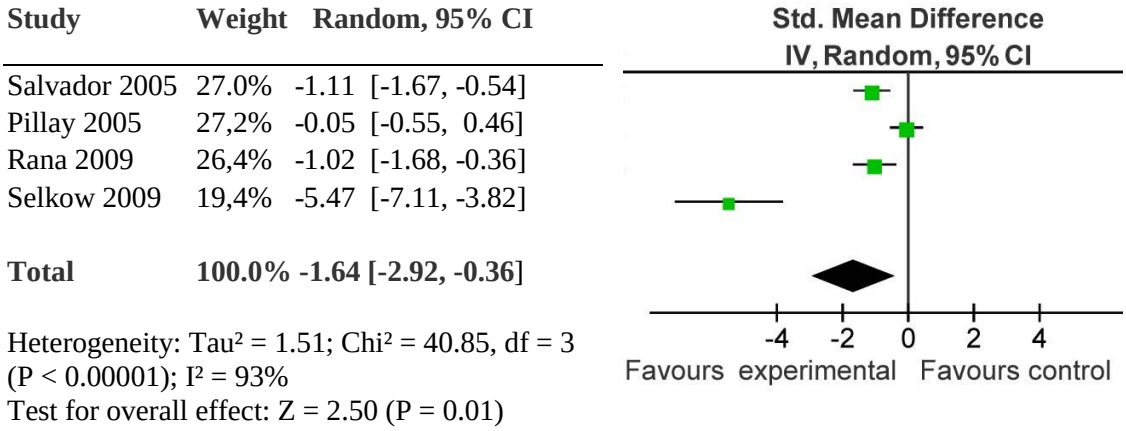


Figure 7: Forest plot (random effects model) of the included studies based on VAS and NRS 101

Table 17: Data of the included studies based on Oswestry Disability Index (ODI)

Study ID	MET			Control		
	Mean	SD	Total	Mean	SD	Total
Wilson 2003	-37.5	7.62	8	-28.75	5.23	8
Pillay 2005	-16.05	12.05	30	-16.92	16.05	30
Rana 2009	-25.06	8.81	15	-5.13	9.07	15

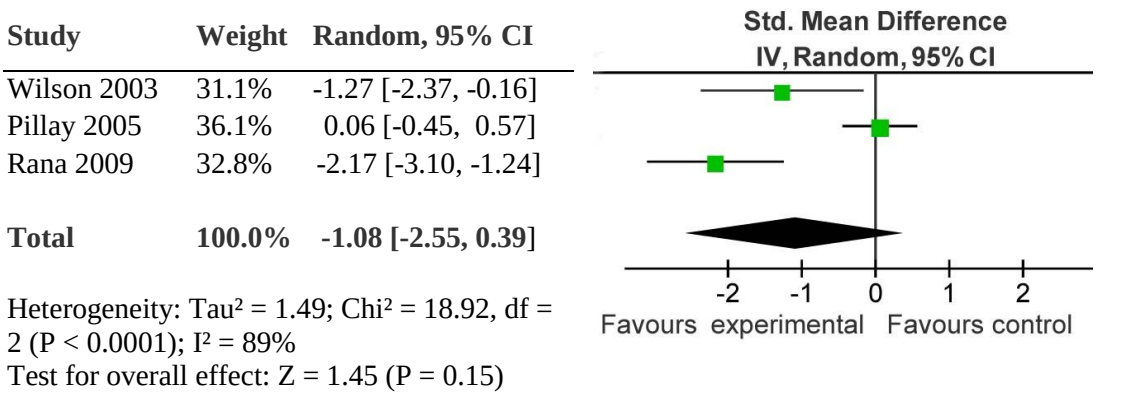


Figure 8: Forest plot (random effects model) of the included studies based on ODI

Table 18: Data of the studies which compared MET with Mobilization

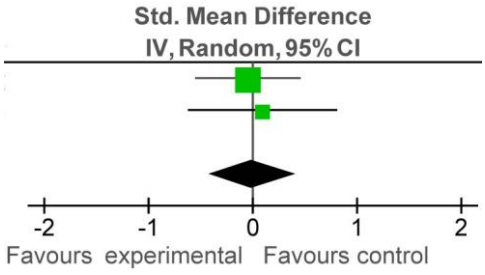
Based on VAS and NRS-101 pain

Study ID	MET Mean	MET SD	MET Total	Control Mean	Control SD	Control Total
Pillay 2005	-19.21	15.43	30	-18.58	10.7	30
Rana 2009	-3.33	0.62	15	-3.40	0.83	15

Based on ODI

Study ID	MET Mean	MET SD	MET Total	Control Mean	Control SD	Control Total
Pillay 2005	-16.05	12.05	30	-16.92	16.05	30
Rana 2009	-25.06	8.81	15	-22.07	6.77	15

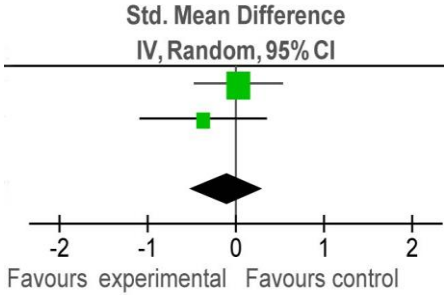
Study	Weight	Random, 95% CI
Pillay 2005	66.7%	-0.05 [-0.55, 0.53]
Rana 2009	33.3%	0.09 [-0.62, 0.81]
Total	**100.0%**	**-0.00 [-0.41, 0.41]**



Heterogeneity: Tau² = 0.00; Chi² = 0.10, df = 1 (P = 0.75); I² = 0%
Test for overall effect: Z = 0.00 (P = 1.00)

Figure10: Forest plot (random effects model) of comparison: MET versus Passive Mobilization / Maitland Mobilization (based on VAS and NRS-101)

Study	Weight	Random, 95% CI
Pillay 2005	67.1%	0.03 [-0.48, 0.53]
Rana 2009	32.9%	-0.37 [-1.09, 0.35]
Total	**100.0%**	**-0.10 [-0.52, 0.31]**



Heterogeneity: Tau² = 0.00; Chi² = 0.79, df = 1 (P = 0.38); I² = 0%
Test for overall effect: Z = 0.48 (P = 0.63)

Figure11: Forest plot (random effects model) of comparison: MET versus Passive Mobilization / Maitland Mobilization (based on ODI)

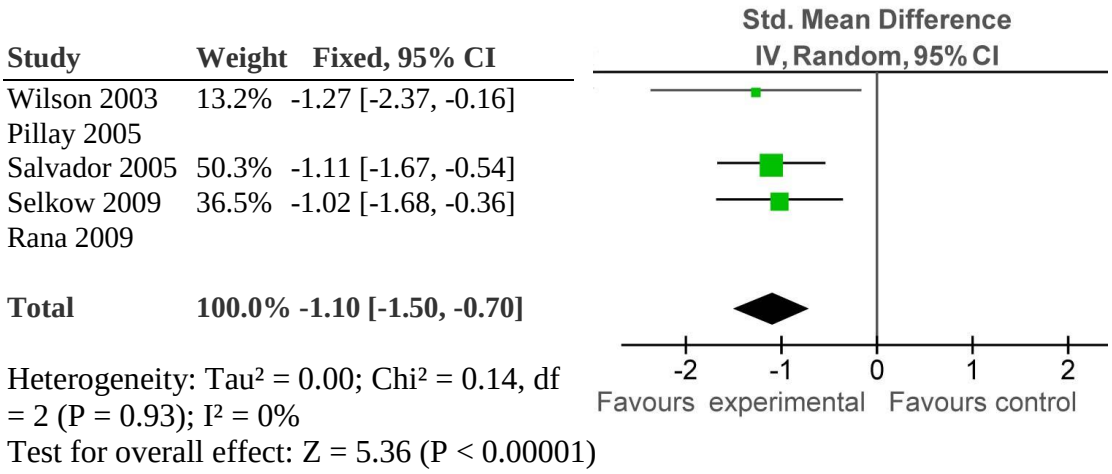


Figure 11: Forest plot (random effects model) of the included studies in the meta-analyses without Pillay 2005 and Selkow 2009.

3.5 Results of the search "MET for Range of Motion or Pressure Pain Threshold in the Back in Asymptomatic Subjects

Table 19 shows the clinical trials with MET for range of motion or pressure pain threshold in the back in asymptomatic subjects which are included in the additional qualitative synthesis. The literature search identified 7 randomized clinical trials with MET interventions for the back in asymptomatic subjects.

Table 19: Clinical trials with MET for range of motion or pressure pain threshold in the back in asymptomatic subjects included in the additional qualitative synthesis

Gabin, M. (2009) *(thesis data only)* An investigation into the effects of manual technique targeted towards psoas major muscle on lumbar range of motion.
Dearing, J. & Hamilton, F. (2008) *(published data only)* An examination of pressure-pain thresholds (PPT's) at myofascial trigger points (MTrP's), following muscle energy technique or ischaemic compression treatment.
Rogers, T. (2005) *(thesis data only)* The effect of a single application of muscle energy technique on pressure pain thresholds in the lumbar spine.
Nawrocki, S. (2004) *(thesis data only)* A comparison between muscle energy technique and high velocity low amplitude thrust technique on gross trunk rotation range of motion.
Daly, M. (2004) *(thesis data only)* The Short Term Effects of Muscle Energy Technique on Thoracic Range of Motion.
Lenehan, K. L., Fryer, G., & McLaughlin, P. (2003) *(published data only)* The effect of muscle energy technique on gross trunk range of motion.
Schenk, R., MacDiarmid, A., & Rousselle, J. (1997) *(published data only)* The Effects of Muscle Energy Technique on Lumbar Range of Motion.

3.6 Description of the studies "MET for Range of Motion or Pressure Pain Threshold in the Back in Asymptomatic Subjects

Five studies focused on range of motion, Two studies researched the threshold of pressure pain pre- and post-treatment. Six of seven studies are each based on an intervention, but only one of them shows eight treatments (see table 20). In four studies the values were obtained immediately after the intervention, in two of the studies they were obtained right after the treatment and again 30 minutes later but in one of the studies the input and output values were four weeks apart (see table 21).

Table 20: Synopsis of clinical trials with MET for range of motion or pressure pain threshold in the back in aysmptomatic subjects
Part 1

Author / Year Country	**Gabin 2009 New Zealand**	**Dearing 2008 Great Britain**	**Rogers 2006 Australia**
Study design	RCT	RCT	RCT
Aim of the Study	An investigation into the effects of manual technique targeted towards psoas major muscle on lumbar range of motion	Sensitivity of pressure-pain thresholds at myo-fascial trigger points (MTrP) following MET or ischaemic compression treat-ment in asympto-matic subjects	The effect of a single application of MET on Pressure pain thresholds in the lumbar spine
Reported inclusion / Exclusion criteria /	+* +	+ +	+ +
No. of treatments / Period	1 / After treatment	1 / After treatment	1 / After treatment
Measurement	Lumbar range of motion	Pressure-pain thres-holds at a myofaszial trigger point in the left upper trapezius muscle after treatment	Pressure-pain threshold at the lumbar processus spinosus
Number of patients/ Age / Gender (mean)	25 / Ø 38 ♀ 9, ♂ 16	50 / Ø ? ♀ ?, ♂ ?	59 / Ø 23 ♀ 40, ♂ 19
Number of patients Intervention / Control	a. 12 b. 13	Not specified	Not specified
Randomized /	+	+	+
Intervention A Intervention B Control C	a. MET b. Sham treatment	a. MET b. Ischaemic compression c. No treatment (3 mins relaxing music)	a. MET b. Sham “functional” treatment
Reported results	“The results indicate that treatment of the psoas… does not influence lumbar range of motion in flexion, extension, and right- and left-sidebending in subjects with mild dysfunction of the psoas muscle.”	„Ischaemic com-pression and muscle energy technique produce a significant reduction in pain sensitivity at MTrP’s… Ischaemic compression appeared to be more effective than muscle energy technique at these trigger points in asymptomatic subjects”.	“A single application of rotational MET to the lumbar spine did produce a significant increase in PPT in this asymptomatic population. Caution must be used when interpreting this result because the change in PPT was small and with in the error range of the testing equipment.”

Table 20: Synopsis of published clinical trials with MET for range of motion or pressure pain threshold in the back in asymptomatic subjects.
Part 2

Author / Year Country	**Nawrocki 2004 Australia**	**Daly 2004 Australia**	**Lenehan 2003 Australia**
Study design	RCT	RCT	RCT
Aim of the study	To compare the immediate and lasting effects (30 min) of a single application of thoracolumbar MET and HVLA technique on gross trunk rotation ROM in asymptomatic volunteers with no fixed asymmetry	To determine the test-retest reliability of a thoracic ROM measurement device and investigate the immediate and short-term effects of MET on ROM of the thoracic spine	Determine whether a single application of thoracic MET could significantly increase range of motion (ROM) in asymptomatic volunteers with restricted active trunk rotation
Reported Inclusion and Exclusion criteria	+* +	+ +	+ +
No. of treatments / Period	1 / After / 30 min later	1 / After / 30 min later	1 / After treatment
Measurement	Trunk range of motion measured by a axial rotation measuring device (ARMDno3)	Trunk range of motion measured by a axial rotation measuring device (ARMDno3	Trunk range of motion measured by a axial rotation measuring device (ARMDno2)
Number of pts/ Age / Gender (mean)	90 / Ø 22 ♀ 58, ♂ 32	60 / Ø 22 ♀ 37, ♂ 23	48 / 19-33 ♀ ?, ♂ ?
Number of pts Intervention / Control	a. 30 b. 30 c. 30	a. 30 b. 30	a. 30 b. 18
Randomized /	+	+	+
Intervention A Intervention B Control C	a. MET b. HVLA c. Sham "counter-strain" treatment	a. MET B. Sham treatment	a. MET c. No treatment
Reported results	"Although demonstrating a statistically significant difference in gross trunk ROM immediately and 30 minutes following a single application of MET or HVLA, this was meaningless as it was within the error range of the test equipment."	"The effect of Muscle Energy Technique was not signifycantly different from the sham treatment in increasing thoracic range of motion into a restricted direction within a asymptomatic sample population, either directly after MET application or at approximately thirty minutes post-MET".	„Muscle energy technique was demonstrated to be effective in increasing the restricted range of trunk rotation and ameliorating asymmetry in asymptomatic subjects. The restricted direction in the treatment group demonstrated a significant increase in gross trunk rotation".

Table 20: Synopsis of published clinical trials with MET for range of motion or pressure pain threshold in the back in asymptomatic subjects.
Part 3

Author / Year Country	**Schenk 1997 USA**		
Study design	RCT		
Aim of the study	Examination whether the application of MET to the lumbar spine could significantly influence lumbar extension range of motion in an asymptomatic population.		
Reported inclusion / Exclusion criteria /	+ +		
No. of treatments / Period	8 / About 4 weeks		
Measurement	Lumbar extension measured by a bubble inclinometer		
Number of patients/ Age / Gender (mean)	26 / Ø 25 ♀ 13, ♂ 13		
Number of patients Intervention / Control	a. 13 c. 13		
Randomized /	+		
Intervention A Intervention B Control C	a. MET c. No treatment		
Reported results	„The result of this study indicates that MET may have an influence of increasing lumbar extension range of motion“.		

ROM = Range of motion HVLA = High velocity low amplitude (thrust technique)
* To be eligible for inclusion in the study, subjects were required to have a history of either mild low back pain (not greater than 30/100 on a visual analogue scale) for the three month period prior to the study, or had current groin pain, or demonstrated a clinical limitation of hip extension (as measured by the Thomas Test).

Table 21: Period between MET intervention and measurement on asymptomatic subjects

Study	Measurement	Time
Gabin 2009	Lumbar range of motion	After treatment
Dearing 2008	Pressure pain threshold upper trapezius muscle	After treatment
Rogers 2006	Pressure pain threshold lumbar processus spinosus	After treatment
Nawrocki 2004	Trunk range of motion	After treatment / 30 Min after treatment
Daly 2004	Trunk range of motion	After treatment / 30 Min after treatment
Lenehan 2003	Trunk range of motion	After treatment
Schenk 1997	Lumbar extension range of motion	After 4 weeks

Chapter 4: Discussion

4.1 Summary of MET Studies on Subjects with Nonspecific Back Pain.

The primary outcome of the studies was pain, which was either measured via the visual analogue scale (VAS) or a number rating scale (NRS-101). In three studies, the functional pain status was acquired via the validated Oswestry disability index (ODI). In three other studies, self-developed pain questionnaires were used to evaluate the pain status. These questionnaires were only made up of a few questions and were not validated. They were only applied in low-internal-validity studies which did not qualify for the quantitative evaluation for this review due to its study design. All in all it is unadvisable to use self-designed, non-validated questionnaires, since they are lacking proof that they really measure what they pretend to be measuring. Thus the evaluation of the study results and its comparison with the results of other study questionnaires is even more difficult.

Four of the five included studies in the meta-analysis have a high internal validity (which means a low risk of bias). One study (Salvador 2005) confirms 5 of the 12 CRBG criteria. In this study 3 of the criteria are unclear and it was not possible to get further information. It is to be mentioned that in small studies with limited funds (in which the therapist covers the classic tasks of the care attendants for the study setting) point 4 on the CBRG checklist (was the care provider blinded to the intervention?) has to be answered with “no”. Larger studies with more funds can otherwise easily obtain a positive evaluation of this criterion.

The included studies examine the short-term effect of the applied treatment techniques. The time span covered various time intervals, from less than an hour after confirmed findings to 24 hours and 3 days right up to 3 to 4 weeks (see table 22). For studies in the future it would be desirable to integrate a follow up in the study design in order to prove the process of improvement. As we have seen in the background chapter (see 1.12 Prevalence and Recurrence of Back Pain) recurrence of symptoms often occurs after a pain-free period.

Table 22: Period between treatment and measurement

Study	Measurement	Time
Rana 2009	VAS in pain ODI (functional pain status)	6 days after baseline 6 days after baseline
Selkow 2009	VAS in pain	24 hours after baseline
Pillay 2005	NRS-101 in pain ODI (functional pain status)	3 weeks after baseline 3 weeks after baseline
Salvador 2005	VAS in pain	< 1 hour after baseline
Wilson 2003	ODI (functional pain status	4 weeks after baseline
Hack 2001	Pain questionnaire	=< 3 days after baseline
Hack 1999	Pain questionnaire	=< 3 days after baseline
Brodin 1982	Pain questionnaire	=< 3 weeks after baseline

VAS = Visual analogue scale NRS-101 = Number rating scale ODI = Oswestry Disability Index

Two of the studies included mobilization techniques (passive mobilization, Maitland techniques) besides MET as comparison-intervention, while the control groups on the other hand did exercises or received sham- (placebo) or tens treatments. In one of the studies the control group was not treated (see table 23)

Table 23: Intervention and type of control groups

Study	Intervention	Control	2. Intervention
Rana 2009	MET and exercises	exercises	Maitland + exercises
Selkow 2009	MET	sham	-
Pillay 2005	MET	-	passive mobilization
Salvador 2005	MET	tens	-
Wilson 2003	MET and heat	placebo manual treatment	-
	and exercises	and heat and exercises	-
Hack 2001	MET	-	-
Hack 1999	MET	-	-
Brodin 1982	MET	no treatment	-

VAS = Visual analogue scale NRS-101 = Number rating scale ODI = Oswestry Disability Index.

The forest-plots presented in the meta analysis show that MET significantly reduces nonspecific back pain. In comparison to Passive Mobilization or Maitland's Mobilization no greater benefit in pain relief or results in functional pain questionnaires were detected.

The quantitative synthesis shows signs of heterogeneity. This is true as well for the forest plot of 5 studies with the outcomes VAS, NRS-101 and ODI (I^2 = 90%, see figure 6) as for the 4 studies with the outcomes VAS and NRS-101 (I^2 = 86%, see figure 7) and for the forest plot with 3 studies based on ODI (I^2 = 95%, see figure 8).

Higgins (Higgins & Green, 2008) gives in the *Cochrane Handbook for Systematic Reviews of Intervention* a rough guide for interpretation of I^2:

0% to 40%: might not be important;

30% to 60%: may represent moderate heterogeneity

50% to 90%: may represent substantial heterogeneity

75% to 100: considerable heterogeneity

The sensitivity analysis shows that the heterogeneity is a result of the studies by Pillay (2005) and Rana (2009). Pillay's study compares the MET intervention to another form of treatment (passive mobilization) and comes to the conclusion that there is no significant therapeutic effect between the two treatment methods. Rana's study on the other hand compares MET plus exercises to exercises alone in the control group. This study shows a clearly positive therapeutic effect of the MET intervention (see table 16 and 17). If the studies by Pillay (2005) and Rana (2009) are not taken into consideration, the I2 value is 0% (see figure 9 and 10).

4.2 Annotations about the Diagnostic Procedure

When assessing the studies, it is not possible to say which concrete diagnoses MET treatments are based on. Non-specific back pain is a general term, which – as already explained in this study – is defined by the exclusion criteria of the specific structural damage, but not necessarily based on the same cause. This difficult-to-grasp inhomogeneous general term „non-specific back pain" is exactly why a listing of the diagnosis or the frequency of diagnostic results would be very helpful for the manually working therapist. After all, the patient consults a therapist because of his back pain; the therapist however doesn't treat the patient's back pain but treats on the basis of his findings that are responsible for the back pain. More than 10 years ago, van Tulder (van Tulder, Koes, & Bouter, 1997) and Anderson (Anderson, 1999) pointed out that back pain is more a category of disease than a firm diagnosis. If one evaluates the available studies according to their diagnostic approach, a different pattern of diagnoses emerge. While the approach in Hack's and Wilson's studies are based on a postural diagnosis used by Fred Mitchell Jr, Selkow focuses on a pelvic malposition of at least 2 degrees between the left and the right side. Salvador however concentrates on the contraction of at least one of the following muscles (M. erector spinae longissimus, M. biceps femoris, M. semimembranosus, M.

semitendinosus, M. piriformis or M. quadratus lumborum). Pillay does not consider the posture diagnosis at all and uses the range of motion as a criterion. Rana and Brodin give no statement on their diagnostic approach.

All in all, the remarks about diagnostic findings in each of the studies are sparse and leave too much space for interpretation. It would be important for future studies on MET to have clear statements on the diagnostic approach and the results. This seems even more important, since the discussion, which has been going on for several years now, on the diagnostic approach of the MET concept according to Mitchell, does not include any data from the MET studies, but rather draws its conclusion via analogies from other studies. In the long run, however, this level of reasoning is unrewarding. In this case, studies are needed which compare different diagnostic but same therapeutic MET approaches directly to find out which diagnostic procedure gets the best results. As long as there is no concrete data for this question, the Mitchell's MET model can neither be proven nor can parts of it be disproven – a development which will eventually result in methodical stagnation and which can hardly be desirable. Finally there is a concern that what the MET studies mirror in the review is exactly what will happen: That each therapist will use his own diagnostic procedure according to his own concept. It should be clear that such diagnostic freedom will result in the loss of a consistent MET model. If this is the price for an improved approach with improved therapeutic results, this change would be gratifying as well as ultimately necessary. If there is no improvement in results, at least the diagnostic approach will become an individual mindset within MET treatment. Besides results on the therapeutic efficacy, clinical studies should also produce data on the methodical considerations.

4.3 Summary of Studies about MET for Range of Motion or Pressure Pain Threshold in the Back in Asymptomatic Subjects.

Outcomes of the MET-studies with asymptomatic subjects are not consistent. The results of 2 studies (Lenehan 2003, Schenk 1997) indicate that MET has an influence of increasing range of motion. One study (Nawrocki 2004) reports that MET demonstrates a significant improvement in trunk range of motion but the measured value was within the error range of the test equipment. Rogers (2006) comes to the same result regarding the pressure pain threshold whereas Dearing

(2008) finds a significant reduction in pain sensitivity. Gabin (2009) reports that the MET treatment of M. psoas does not influence lumbar range of motion and Daly (2004) writes that MET was not significantly different from the sham treatment.

Indirect evidence is not direct evidence and every analogy includes a broad range of speculation. Unfortunately, six of the seven studies include only one intervention and measure the effect immediately after treatment (two of the studies also measured 30 minutes later). Thus, an ultra-short-term effect can be measured but the question remains, whether it can be used to draw a therapeutic conclusion. The measured effect could be different only one hour later. Immediate changes in tissue lead to no conclusion about the sustainability of an intervention. Additionally, a study design with only one intervention and only one single measure recording is subject to measurement errors. Last but not least, comparisons between pain-free and pain-stricken persons, even if all other symptomatic effects are similar or the same, are only possible with certain reservations. The inconsistency of the results – except for Schenk's study (1997) - as well as the vulnerable study design draw a questionable picture of the indirect evidence of the mentioned studies for the therapeutic efficacy of MET.

4.4 Potential Biases in the Review Process

For a systematic review about an osteopathic technique it is desirable that at least two authors with expertise in osteopathy, statistics and clinical epidemiology independently conducted citation identification, study selection, and data extraction. In this review the author performed alone study identification, study selection and the statistic analysis. Only the data extraction was proof read by a second person. Working alone at a review is always a potential source of bias in the review process.

4.5 Conclusion

4.5.1 MET and Nonspecific Back Pain

MET significantly reduces nonspecific back pain. In comparison to Passive Mobilization or Maitland's Mobilization no greater benefit in pain relief or results in functional pain questionnaires were detected. The included studies focus on the short time effect (up to 4 weeks). Details about diagnostic procedures and findings were

insufficient and leave too much room for interpretation. Back pain is more a category of disease than a diagnosis of MET or Manual Therapy. It would be important for future studies on MET to give clear information on the manual diagnostic approach. For the assessment of longterm effects in clinical studies on MET, a follow up of at least 12 months after treatment is necessary.

4.5.2 MET for range of motion or pressure pain threshold in the back in asymptomatic subjects

Comparisons between pain-free and pain-stricken persons, even if all other symptomatic effects are similar or the same, are only possible with certain reservations. The inconsistency of the results as well as the vulnerable study design draw a questionable picture of the indirect evidence of the mentioned studies for the therapeutic efficacy of MET.

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Chapter 6: Appendix

Appendix A

Applied Search Strategy

Database	Results of potential interest (duplications not listed)	
	MET for back pain	**MET for ROM and PPT back**
PubMed www.ncbi.nlm.nih.gov/pubmed/ Date: 01.06.2010 (randomized controlled trial[pt] OR controlled clinical trial[pt] OR randomized[tiab] OR randomly[tiab] OR trial[tiab]) AND ("Back Pain"[Mesh] OR "Low Back Pain"[Mesh] OR back OR "nonspecific back pain") OR "nonspecific low back pain") AND ("muscle energy technique" OR "MET" OR isometric contraction OR Mitchell technique OR "Mitchell technique") 258 results Date: 16.11.2009 Search strategy: muscle energy technique and CT or RCT 84 results OMT and CT or RCT 58 results Osteopathic medicine and CT or RCT 108 results muscle energy techni* 13 results	Wilson 2003 Wilson 2003 Selkow 2009 = 2	-
Embase and Embase alert via www.dimdi.de Date: 06.12.2009 Search strategy: “muscle energy technique” 29 result	Neumann 1985 Neumann 1996 = 2	Schenk, 1997 = 1
The Cochrane Library www.cochrane.de/de/browse.htm Date: 06.01.2009 Search strategy: muscle energy technique 53 results	Salvador 2004 = 1	Lenehan 2003 = 1

Science Direct www.sciencedirect.com Date: 20.11.2009 Search strategy: "muscle energy technique" and journals and medicine/dentistry 168 results	-	Dearing, 2008 = 1
Osteopathic Research Web www.osteopathic-research.com Date: 20.12.2009 Search strategy: "muscle energy technique" 13 results	-	-
PEDro www.pedro.org.au Date: 06.01.2010 Search strategy: muscle energy technique and clinical trial 12 results	-	-
Ostmed.Dr www.ostmed-dr.com Date: 20.11.2009 Search strategy: "muscle energy technique" 82 results muscle energy technique and clinical trial 115 results	-	-
Google scholar www.scholar.google.de Date: 05.01.2010 Search strategy: "muscle energy technique" 431 results	Rana 2009 Pillay 2005 Geisser 2005 Riipinen 2005 Wreje 1992 = 5	Gabin 2009 Rogers 2006 Nawrocki 2004 Daly 2004 = 4
Springer Verlagsdatenbank www.springerlink.de/home/main.mpx Date: 07.01.2010 Search strategy: "muscle energy technique" 10 results	Hack 1999 Hack 2001 Hack 2002 = 3	-

ISI Web of Knowledge Via server of the library of the University of Siegen Date: 07.01.2010 Search strategy: muscle energy technique 569 results	-	-
Handsearch in reference lists of articles in journals and books until Dec 2009	Brodin 1982 Lamberth 2005 = 2	-
Scopus Via server of the library of the University of Düsseldorf Date: 13.02.2010 Search strategy: "muscle energy technique" 46 results	-	-
Total	15	7

ROM = Range of motion PPT = Pain pressure threshold

Appendix B

Characteristics of Included Studies

(Ordered by Date)

Rana 2009

Aim of the study:	Comparative analysis on the efficacy of G.D. Maitland's concept of mobilization and muscle energy technique in treating sacroiliac joint dysfunctions.
Method:	Type of study: RCT Nr. Analyzed/Rand.: 15/15/15
Participants:	Patients (mean age 22.82 ± 2.9) with chronic low back pain not associated with any neurological symptoms, without traumatic or infectious conditions. Age between 18-30 years and a scoring on the Oswestry disability index between 20% and 80%.
Interventions:	INDEX TREATMENT I MET, 6 treatments for the type of dysfunction the subject was diagnosed for. Additional exercises to gently move the sacroiliac joint. INDEX TREATMENT II Maitland mobilization technique, 6 treatments for the particular diagnosed sacroiliac dysfunction. Additional exercises to gently move the sacroiliac joint COMPARISON TREATMENT Exercises to gently move the sacroiliac joint CO-INTERVENTION: None Duration of Therapy Period: One treatment per day on six consecutive days Follow-up: No follow up.
Outcomes:	<u>Visual analog thermometer for pain:</u> Baseline mean: MET 3.53 (± 0.51), Maitland (3.73 (± 0.70), Control 3.53 (±) After 6 treatments mean: MET 0.20 (± 0.41), Maitland 0.33 (± 0.48), Control: 3.67 (± 0.516), Effect size mean: MET 3.33 (±0.62), Maitland 3.40 (±0.83), Control: -0.07 (±0.59) <u>Oswestry disability index:</u> Baseline mean: MET 0.296 (± 0.05mm), Maitland 0.27 (± 0.05mm), Control 0.28 (± 0.05). After 6 treatments mean: MET 0.25 (± 0.09), Maitland 0.22 (±0.07), Control: 0.05 (±0.09), <u>Hip range of motion:</u> Significant changes in flexion, medial and lateral rotation in the MET and Maitland group. Data was only shown in a table. PATIENT SATISFACTION: NR SIDE EFFECTS: Not reported COST OF CARE: NR
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 table: Rana 2009

Item	Judgment	Description
Adequate of sequence Generation	Yes	The patient was asked to pick up a chit and was assigned to that particular group
Allocation concealment?	No	The assignment was not generated by an independent person.
Blinding?	Yes	Patients were blinded to the treatment
Incomplete outcome data addressed?	Yes	No drop outs
Free of selective reporting?	Yes	All pre-specified outcomes were published
Free of other bias?	Yes	The study appears to be free of other sources of bias.

Selkow 2009

Aim of the study:	Determine the effectiveness of a single treatment of MET immediately and 24 hours after treatment when used on subjects with lumbopelvic pain.
Method:	Type of study: RCT Nr. Analyzed/Rand.: 20/20
Participants:	Subjects with an acute episode of lumbopelvic pain within the previous 6 weeks and an anterior innominate rotation by a bilateral difference of 2° or greater. Subjects were excluded if an acute episode of low back pain lasted longer than 6 weeks or pain radiated past the knee or if they had a history of previous back surgery or if they had been diagnosed by a physician with a specific cause of lumbopelvic pain.
Interventions:	INDEX TREATMENT MET, 4 isometric contractions of the "hamstrings" and the M. iliopsoas against resistance for 5 seconds with 5 seconds rest between each contraction. COMPARISON TREATMENT Sham treatment. The examiner placed the palms of the hands over both Spina iliaca anterior superior (ASIS) with no pressure for 30 seconds. CO-INTERVENTION: None Duration of Therapy Period: One session Follow-up: After 24 hours
Outcomes:	Visual analog scale (VAS) 100 mm for current pain, worst pain and pain provocation test baseline, immediately and 24 hours after intervention. Current pain: Baseline mean: MET 18.2mm (± 9,0mm), Control 36,6mm (± 26,2mm) After 24 hours Mean: MET 17,2mm (± 14,3mm), Control: 21,4mm (± 24,7mm), Worst pain: Baseline mean: MET 29,3mm (± 19,1mm), Control: 18,1mm (± 14,3mm) After 24 hours mean: MET 25,0mm (± 20,6), Control: 35,2mm (± 28 mm) Absolute Benefit: MET 4,3mm (± 19,9mm), (p=.03) Control – 17.1 (± 21,2mm), (p=.03) Pain with provocation test: Baseline mean: MET 21,8mm (± 23,5mm), Control: 31,3mm (± 25,6mm), After 24 hours mean: MET 15,7mm (± 20,5mm), Control 29,2mm (± 27,4mm), Reported Results: Current pain: not significant (p=.06) Worst pain: significant (p=.03) Pain provocation test: significant (p=.001) PATIENT SATISFACTION: NR SIDE EFFECTS: None COST OF CARE: NR

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 table: Selkow 2009

Item	Judgment	Description
Adequate of sequence Generation	Yes	Random number generator
Allocation concealment?	Yes	Participants were randomly assigned by a third party unknown to the Examiners.
Blinding?	Yes	Participants, Examiner
Incomplete outcome data addressed?	Yes	No missing outcome data
Free of selective reporting?	Yes	The study was submitted to the Institution Review Board for the Social and Behavioral Sciences. All pre-specified outcomes were published.
Free of other bias?	Unclear	The control group had higher VAS pain scores for current pain than worst pain over the past 24 hours. Lumbopelvic pain could have more reasons than an anterior innominate rotation. Intervention was used on subjects who had low levels of pain (floor effects).

Salvador 2005

Aim of the study:	Assessment the efficacy of MET to reduce pain among garbage collectors with acute mechanical low back pain.
Method	Type of study: RCT Nr. Analyzed/Rand.: 28/28
Participants:	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, no chronic back pain, no rheumatoid arthritis, osteoporosis or fracture and no positive Laseque and Valsalva test. The participants must have also one shorten muscle (M. erector spinae longissimus, M. biceps femoris, M. semimembranosus, M. semitendinosus, M. piriformis or M. quadratus lumborum). Participants was arranged in 3 groups of pain intensity (low, medium, strong)
Interventions:	INDEX TREATMENT MET, 3 isometric contractions with 30-50% of the patients force for 10, 15 and 20 seconds with 10 seconds rest after each contraction and before each passive extension of the muscles. COMPARISON TREATMENT Sham treatment. TENS in a minimal dose for 5 minutes. CO-INTERVENTION: None Duration of Therapy Period: One session Follow-up: No follow up
Outcomes:	Visual analog scale (VAS) 100 mm for current pain and muscle length test after treatment. Current pain: Baseline Mean: MET 43,9mm (± 20,2mm), Control: 32,1mm (± 27,0mm), (p=0.12) After Intervention Mean: MET 17,4mm (± 15,0mm), Control: Not specified Absolute Benefit: MET 30,1mm (± 28,5mm), Control: 7,1 mm (± 5,4mm), (p=0.0008) Reported Results: Current pain: significant (p=.0015) PATIENT SATISFACTION: NR SIDE EFFECTS: Not specified COST OF CARE: NR
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 table: Salvador 2005

Item	Judgment	Description
Adequate of sequence Generation	No	Sequence generated by some rule based on date of admission
Allocation concealment?	Unclear	Insufficient information to permit judgment
Blinding?	Yes	Observer, blinded outcome measurement.
Incomplete outcome data addressed?	Yes	No missing outcome data reported
Free of selective reporting?	Unclear	Insufficient information to permit judgment.
Free of other bias?	Unclear	Mechanic low back pain could have more reasons than the tested shorten muscles.

Pillay 2005

Aim of the study:	The Relative Effectiveness of Muscle Energy Technique as Opposed to Specific Passive Mobilization in the Treatment of Acute and Sub-acute Mechanical Low Back Pain.
Method:	Type of study: RCT Nr. Analyzed/Rand.: 30/30
Participants:	Patients with low back pain of two months or less duration and pain confined to the lumbar region without radiation to the buttock and lower extremities. Patients aged from 18 to 45 years with decreased lumbar range of motion and an initial pain rating score of 5-10 on the numerical pain rating scale. Exclusion criteria: Patients who presented with paresthesias and numbness, motor weakness, absent or diminished muscle reflexes. Patients with spondylolisthesis, previous back surgery or a history of trauma to the lower back or any organic pathology that may have contributed to low back pain. Patients who received other forms of treatment for low back pain
Interventions:	INDEX TREATMENT I MET, 4 treatments INDEX TREATMENT II Passive Mobilization, 4 treatments CO-INTERVENTION: None Duration of Therapy Period: Two weeks Follow-up: In the third week.
Outcomes:	NRS 101 pain (average of pain when it was at its least and when it was at its worst) After 3 weeks effect size: Mean: MET -19.22 mm (± 15.43mm), Control: -18.59mm (± 10.70mm), Oswestry Disability Index (ODI) After 3 weeks effect size: Mean: MET -16.05 (± 12.05), Control: -16.92 (± 16.05), Algometer pain pressure threshold: After 3 weeks effect size: Mean: MET -1.17 (± 1.04), Control: -1.25 (± 1.13), PATIENT SATISFACTION: NR SIDE EFFECTS: Not specified COST OF CARE: NR
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."

Risk of bias table: Pillay 2005

Item	Judgment	Description
Adequate of sequence Generation	Yes	Sixty pieces of paper were put into a hat. Thirty pieces with the letter A on them and thirty with the letter B. Each patient was required to draw out one piece of paper, which then determined which treatment group they would be allocated to.
Allocation concealment?	No	The assignment was not generated by an independent person.
Blinding?	No	Patients in both groups knew what treatment they received
Incomplete outcome data addressed?	No	Drop outs in the study were eliminated and only results of those patients that completed the 5 treatments were considered.
Free of selective reporting?	Yes	All pre-specified outcomes were published in the study.
Free of other bias?	Yes	The study appears to be free of other sources of bias.

Wilson 2003

Aim of the study:	Examining the outcomes of MET in patients with acute low back pain.
Method:	Type of study: RCT Nr. Analyzed/Rand.: 16/19
Participants:	Low back pain of no more than 12 weeks duration at the time of examination and without radiating symptoms, motor weakness, absent or diminished muscle stretch reflexes or spondylolisthesis. Inclusion criteria were also a subject range of 18 to 65 years old, an initial ODI score of 20-60% and a lumbar flexion restriction (ERS dysfunction in the osteopathic model).
Interventions:	INDEX TREATMENT: Muscle energy technique described by Greenman with the patient side lying on the side opposite on their flexion and side-bending restriction. MET specific home exercise program. COMPARISON TREATMENT: Randomized placebo manual therapy. CO-INTERVENTION: All patients received moist heat and a standardized set of supervised neuromuscular re-education and resistance training exercises. Duration of Therapy Period: 2, 3 or 4 MET-treatments in 8 sessions over 4 weeks. Follow up: No follow up
Outcomes:	Oswestry Disability Index Baseline mean: MET 45% (± 7%), Control: 44% (± 5%), After all treatments mean: MET 7% (± 3%), Control 15% (± 4%), Changes in Scores: MET 83% (± 7%), Control 65% (± 8%, Reported Results: Significant PATIENT SATISFACTION: NR SIDE EFFECTS: Not specified COST OF CARE: NR
Conclusion:	"MET combined with supervised motor control and resistance exercises may be superior to neuromuscular re-education and resistance training for decreasing disability and improving functions in patients with acute low back pain."

Risk of bias table: Wilson 2003

Item	Judgment	Description
Adequate of sequence Generation	Unclear	Coin toss determined the group placement only of the first patient. Further patient were either randomly assigned or matched to patients already participating in the study.
Allocation concealment?	Yes	Placebo manual treatment closely mirrored the MET intervention, only the first therapist knew the group assignment.
Blinding?	Yes	Patients, 2. therapist
Incomplete outcome data addressed?	Unclear	Three subjects were removed from the study and potentially introduced an element of bias.
Free of selective reporting?	Unclear	Insufficient information to permit judgment.
Free of other bias?	Yes	The study appears to be free of other sources of bias

Hack 2001

Aim of the study:	Effect of MET treatment in disorders of the upper spine
Method:	Type of study: Clinical Trial Nr. Analyzed/Rand.: 80% of 367 patients / -
Participants:	Patients with pain in the upper spine (neck and thoracic spine) with or without breathing difficulties, with or without radiation in the arm and without herniated disc.
Interventions:	INDEX TREATMENT: Muscle energy technique (no further description). COMPARISON TREATMENT: No comparison treatment / No control group. CO-INTERVENTION: Cold and hot applications were also permitted like the use of Diclofenac. Duration of Therapy Period: One to three sessions (mean 1,3) Follow-up: No follow up
Outcomes:	5-point Pain Questionnaire" Decreasing of pain in 85% of the patients PATIENT SATISFACTION: NR SIDE EFFECTS: Not specified COST OF CARE: NR
Conclusion:	"Strong improvement of the symptoms in 85% of the patients… A high percentage of patients with problems in the upper spine can be treated successfully with only a few sessions of MET."

Risk of bias table: Hack 2001

Item	Judgment	Description
Adequate of sequence Generation	_	-
Allocation concealment?	-	-
Blinding?	-	-
Incomplete outcome data addressed?	-	-
Free of selective reporting?	Unclear	Insufficient information to permit judgment.
Free of other bias?	No	Referral for hot and cold applications. It was also permitted for the patients with strong pain to take NSAIDs (Diclofenac) . So it's not possible to assign the outcomes of the study to MET, heat or cold applications or to NSAID.

Hack 1999

Aim of the study:	Effect of MET treatment in disorders of the spine
Method:	Type of study: Clinical Trial Nr. Analyzed/Rand.: 82% of 580 patients (= 478) / -
Participants:	Patients with pain in the upper spine (neck and thoracic spine) with or without breathing difficulties, low back pain, sciatic pain and paresthesia without herniated disc or spondylolisthesis
Interventions:	INDEX TREATMENT: Muscle energy technique (no further description). COMPARISON TREATMENT: No comparison treatment / No control group. CO-INTERVENTION: Hot applications were also permitted like the use of Diclofenac. Duration of Therapy Period: One to three sessions, in 1% more than three sessions (mean 1.4) Follow-up: No follow up
Outcomes:	5-point Pain Questionnaire" Decreasing of pain in 79% of the patients. No change in pain intensity in 3% of the patients. PATIENT SATISFACTION: NR SIDE EFFECTS: Not specified COST OF CARE: NR
Conclusion:	"Nearly 80% of the patients had a strong improvement of their disorders after treatment with MET. In 3% of the cases were no alleviation of pain detectable".

Risk of bias table: Hack 1999

Item	Judgment	Description
Adequate of sequence Generation	No	-
Allocation concealment?	No	-
Blinding?	No	-
Incomplete outcome data addressed?	No	-
Free of selective reporting?	Unclear	Insufficient information to permit judgment.
Free of other bias?	No	Referral for hot applications. It was also permitted for the patients with strong pain to take NSAIDs (Diclofenac). So it's not possible to assign the outcomes of the study to MET, heat applications or to NSAID.

Brodin 1982

Aim of the study:	Does a short-term study show MET to be more effective than no technique for low back pain
Method:	Type of study: Controlled Clinical Trial Nr. Analyzed/Rand.: 41 / -
Participants:	Patients with lower back pain histories of more than two month and no radicular symptoms. Pain could be located in one or more or several mobile segments of the lumbar spine. Patients with lumbar pain from the lower part of the thoracic spine were also excluded. Patients had no abnormalities or signs of rheumatoid spondylitis (roentgenographic examination).
Interventions:	INDEX TREATMENT: Muscle energy technique (no further description). COMPARISON TREATMENT: Untreated CO-INTERVENTION: None Duration of Therapy Period: Nine sessions during 3 weeks were planned; if the patient was free of pain, treatment was stopped earlier. Follow-up: No follow up
Outcomes:	9 step scale Pain Questionnaire. A change of 2 steps was regarded as a significant change of pain level. In the treated group 7 patients were free of pain, in the control group one. 17 patients of the treated had a reduction of at least two steps of the nine steps, 4 patients in the control group. Mobility was tested using the distance between L1 and S1 and sidebending by analyzing photographs of the patients in sidebending position. No distinct tendency of the mobility tests was recorded, the impression was a slightly better mobility in treated than in control patients. PATIENT SATISFACTION: NR SIDE EFFECTS: Not specified COST OF CARE: NR
Conclusion:	“From this study we can conclude that in properly selected cases, the muscle energy technique is an effective treatment for lower back pain”.

Risk of bias table: Brodin 1982

Item	Judgment	Description
Adequate of sequence Generation	_	-
Allocation concealment?	-	-
Blinding?	-	-
Incomplete outcome data addressed?	-	-
Free of selective reporting?	Unclear	Insufficient information to permit judgment.
Free of other bias?	Unclear	Insufficient information to permit judgment.

Appendix C

Criteria for a Judgment of "Yes" for the Sources of Risk of Bias

(Furlan et al., 2009)

1	Was the method of randomization adequate? A random (unpredictable) assignment sequence. Examples of adequate methods are coin toss (for studies with 2 groups), rolling a dice (for studies with 2 or more groups), drawing of balls of different colors, drawing of ballots with the study group labels from a dark bag, computer-generated random sequence, pre-ordered sealed envelops, sequentially-ordered vials, telephone call to a central office, and pre-ordered list of treatment assignments Examples of inadequate methods are: alternation, birth date, social insurance/ security number, date in which they are invited to participate in the study, and hospital registration number.
2	Was the treatment allocation concealed? Assignment generated by an independent person not responsible for determining the eligibility of the patients. This person has no information about the persons included in the trial and has no influence on the assignment sequence or on the decision about eligibility of the patient.
3	Was the patient blinded to the intervention? This item should be scored "yes" if the index and control groups are indistinguishable for the patients or if the success of blinding wastested among the patients and it was successful.
4	Was the care provider blinded to the intervention? This item should be scored "yes" if the index and control groups are indistinguishable for the care providers or if the success of blinding was tested among the care providers and it was successful
5	Was the outcome assessor blinded to the intervention? Adequacy of blinding should be assessed for the primary outcomes. This item should be scored "yes" if the success of blinding was tested among the outcome assessors and it was successful or: –for patient-reported outcomes in which the patient is the outcome assessor (e.g., pain, disability): the blinding procedure is adequate for outcome assessors if participant blinding is scored "yes" –for outcome criteria assessed during scheduled visit and that supposes a contact between participants and outcome assessors (e.g., clinical examination): the blinding procedure is adequate if patients are blinded, and the treatment or adverse effects of the treatment cannot be noticed during clinical examination –for outcome criteria that do not suppose a contact with participants (e.g., radiography, magnetic resonance imaging): the blinding procedure is adequate if the treatment or adverse effects of the treatment cannot be noticed when assessing the main outcome –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, hospitalization length, treatment failure), in which the care provider is the outcome assessor: the blinding procedure is adequate for outcome assessors if item "4" (caregivers) is scored "yes" –for outcome criteria that are assessed from data of the medical forms: the blinding procedure is adequate if the treatment or adverse effects of the treatment cannot be noticed on the extracted data
6	Was the drop-out rate described and acceptable? The number of participants who were included in the study but did not complete the observation period or were not included in the analysis must be described and reasons given. If the percentage of withdrawals and drop-outs does not exceed 20% for short-term follow-up and 30% for long-term follow-up and does not lead to substantial bias a "yes" is scored. (N.B. these percentages are arbitrary, not supported by literature).
7	Were all randomized participants analyzed in the in the group to which they were

	allocated? All randomized patients are reported/analyzed in the group they were allocated to by randomization for the most important moments of effect measurement (minus missing values) irrespective of non-compliance and co-interventions.
8	Are reports of the study free of suggestion of selective outcome reporting? In order to receive a "yes", the review author determines if all the results from all pre-specified outcomes have been adequately reported in the published report of the trial. This information is either obtained by comparing the protocol and the report, or in the absence of the protocol, assessing that the published report includes enough information to make this judgment.
9	Were the groups similar at baseline regarding the most important prognostic indicators? In order to receive a "yes", groups have to be similar at baseline regarding demographic factors, duration and severity of complaints, percentage of patients with neurological symptoms, and value of main outcome measure(s).
10	Were co-interventions avoided or similar? This item should be scored "yes" if there were no co-interventions or they were similar between the index and control groups.
11	Was the compliance acceptable in all groups? The reviewer determines if the compliance with the interventions is acceptable, based on the reported intensity, duration, number and frequency of sessions for both the index intervention and control intervention(s). For example, physiotherapy treatment is usually administered over several sessions; therefore it is necessary to assess how many sessions each patient attended. For single-session interventions (e.g., surgery), this item is irrelevant.
12	Was the timing of outcome assessment similar in all groups? Timing of outcome assessment should be identical for all intervention groups and for all important outcome assessments.

Appendix D

The Cochrane Collaboration's Tool for Assessing Risk of Bias

(http://www.ohg.cochrane.org/form/Risk%20of%20bias%20assessment%20tool.pdf)

Possible approach for summary assessments outcome (across domains) within and across studies

Domain	Description	Review authors' judgement
Sequence generation	Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups.	Was the allocation sequence adequately generated?
Allocation concealment	Describe the method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocations could have been foreseen in advance of, or during, enrolment.	Was allocation adequately concealed?
Blinding of participants, personnel and outcome assessors *Assessments should be made for each main outcome (or class of outcomes)*	Describe all measures used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Was knowledge of the allocated intervention adequately prevented during the study?
Incomplete outcome data *Assessments should be made for each main outcome (or class of outcomes)*	Describe the completeness of outcome data for each main outcome, including attrition and exclusions from the analysis. State whether attrition and exclusions were reported, the numbers in each intervention group (compared with total randomized participants), reasons for attrition/exclusions where reported, and any re-inclusions in analyses performed by the review authors.	Were incomplete outcome data adequately addressed?
Selective outcome reporting	State how the possibility of selective outcome reporting was examined by the review authors, and what was found.	Are reports of the study free of suggestion of selective outcome reporting?
Other sources of bias	State any important concerns about bias not addressed in the other domains in the tool. If particular questions/entries were pre-specified in the review's protocol, responses should be provided for each question/entry.	Was the study apparently free of other problems that could put it at a high risk of bias?

	Interpretation	Within a study	Across studies
Low risk of bias	Plausible bias unlikely to seriously alter the results.	Low risk of bias for all key domains.	Most information is from studies at low risk of bias.
Unclear risk of bias	Plausible bias that raises some doubt about the results	Unclear risk of bias for one or more key domains.	Most information is from studies at low or unclear risk of bias.
High risk of bias	Plausible bias that seriously weakens confidence in the results.	High risk of bias for one or more key domains.	The proportion of information from studies at high risk of bias is sufficient to affect the interpretation of the results.

Criteria for judging risk of bias in the 'Risk of bias' assessment tool	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	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; Minimization*. *Minimization may be implemented without a random element, and this is considered to be equivalent to being random.
Criteria for the judgement of 'NO' (i.e. high risk of bias).	The investigators describe a non-random component in the sequence generation process. Usually, the description would involve some systematic, non-random approach, for example: ° Sequence generated by odd or even date of birth; ° Sequence generated by some rule based on date (or day) of admission; ° Sequence generated by some rule based on hospital or clinic record number. Other non-random approaches happen much less frequently than the systematic approaches mentioned above and tend to be obvious. They usually involve judgement or some method of non-random categorization of participants, for example: ° Allocation by judgement of the clinician; ° Allocation by preference of the participant; ° Allocation based on the results of a laboratory test or a series of tests; ° Allocation by availability of the intervention.
Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	Insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.

ALLOCATION CONCEALMENT Was allocation adequately concealed? [Short form: Allocation concealment?]	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	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, randomization); ° Sequentially numbered drug containers of identical appearance; ° Sequentially numbered, opaque, sealed envelopes
Criteria for the judgement of 'NO' (i.e. high risk of bias).	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; ° Any other explicitly unconcealed procedure.
Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	Insufficient information to permit judgement of 'Yes' or 'No'. This is usually the case if the method of concealment is not described or not described in sufficient detail to allow a definite judgement – for example if the use of assignment envelopes is described, but it remains unclear whether envelopes were sequentially numbered, opaque and sealed.

BLINDING OF PARTICIPANTS, PERSONNEL AND OUTCOME ASSESSORS Was knowledge of the allocated interventions adequately prevented during the study? [Short form: Blinding?]	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	Any one of the following: ° No blinding, but the review authors judge that the outcome and the outcome measurement are not likely to be influenced by lack of blinding; ° Blinding of participants and key study personnel ensured, and unlikely that the blinding could have been broken; ° Either participants or some key study personnel were not blinded, but outcome assessment was blinded and the non-blinding of others unlikely to introduce bias.
Criteria for the judgement of 'NO' (i.e. high risk of bias).	Any one of the following: ° No blinding or incomplete blinding, and the outcome or outcome measurement is likely to be influenced by lack of blinding; ° Blinding of key study participants and personnel attempted, but likely that the blinding could have been broken; ° Either participants or some key study personnel were not blinded, and the non-blinding of others likely to introduce bias.
Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	Any one of the following: ° Insufficient information to permit judgement of 'Yes' or 'No'; ° The study did not address this outcome.

INCOMPLETE OUTCOME DATA Were incomplete outcome data adequately addressed? [Short form: Incomplete outcome data addressed?]	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	Any one of the following: ° No missing outcome data; ° Reasons for missing outcome data unlikely to be related to true outcome (for survival data, censoring unlikely to be introducing bias); ° Missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups; ° For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate; ° For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size; ° Missing data have been imputed using appropriate methods.
Criteria for the judgement of 'NO' (i.e. high risk of bias).	Any one of the following: ° Reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups; ° For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk enough to induce clinically relevant bias in intervention effect estimate; ° For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes enough to induce clinically relevant bias in observed effect size; ° 'As-treated' analysis done with substantial departure of the intervention received from that assigned at randomization; ° Potentially inappropriate application of simple imputation.
Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	Any one of the following: ° Insufficient reporting of attrition/exclusions to permit judgement of 'Yes' or 'No' (e.g. number randomized not stated, no reasons for missing data provided); ° The study did not address this outcome.

SELECTIVE OUTCOME REPORTING Are reports of the study free of suggestion of selective outcome reporting? [Short form: Free of selective reporting?]	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	Any of the following: ° 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; ° 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).
Criteria for the judgement of 'NO' (i.e. high risk of bias).	Any one of the following: ° 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.
Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	Insufficient information to permit judgement of 'Yes' or 'No'. It is likely that the majority of studies will fall into this category.

OTHER POTENTIAL THREATS TO VALIDITY Was the study apparently free of other problems that could put it at a risk of bias? [Short form: Free of other bias?]	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	The study appears to be free of other sources of bias.
Criteria for the judgement of 'NO' (i.e. high risk of bias).	There is at least one important risk of bias. For example, the study: ° Had a potential source of bias related to the specific study design used; or ° Stopped early due to some data-dependent process (including a formal-stopping rule); or ° Had extreme baseline imbalance; or ° Has been claimed to have been fraudulent; or ° Had some other problem.
Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	There may be a risk of bias, but there is either: ° Insufficient information to assess whether an important risk of bias exists; or ° Insufficient rationale or evidence that an identified problem will introduce bias.

Appendix E

Documentation of the Correspondence with Authors Regarding Additional Information

In a part of the studies the information about methodological procedures and outcomes were not completed. Appendix E documents the efforts to get the missing information in direct contact with the authors.

Rana 2009

E-Mail to Kanchan Rana 22.12.2009, 03.01.2010
E-Mail to Nitesh Bansal 13.01.2010
Answer 14.01.2010
Answer Kanchan Rana 03.02.2010

"1.How were the groups randomized?
Alternate Subject was assigned in the groups (A,B and C) after diagnosis was made.
2.Do the subjects know which kind of treatment they got (MET or Maitland)?
No.
3.Who has measured the hip range of motion and were the examiner blinded to the treatment in the groups?
The physical therapist that is me only measured the ROM, no the examiner was not blinded to the treatment groups.
4.Do you have drop-outs in the study?
No, all the patients completed the study.
5.Are all outcomes that are of interest in the study and which are pre-specified in the study protocol are published in the article?
Yes. "

Kanchan Rana sent the following tables as an attachment:

GROUP		VAT-Pain(Thermometer Pain rating Scale)-Base Line	VAT-Pain(Thermometer Pain rating Scale)-After 6 sitting
Experimental Group - Muscle Energy Technique + Exercise	N	15	15
	Minimum	3	0
	Maximum	4	1
	Range	1	1
	Mean	3.53	.20
	Std. Deviation	.516	.414
	Median	4.00	.00
	Std. Error of Mean	.133	.107
Experimental Group – G.D. Maitland's Mobilisation +Exercise	N	15	15
	Minimum	3	0
	Maximum	5	1
	Range	2	1
	Mean	3.73	.33
	Std. Deviation	.704	.488
	Median	4.00	.00
	Std. Error of Mean	.182	.126
Control Group-Exercise	N	15	15
	Minimum	3	3
	Maximum	4	4
	Range	1	1
	Mean	3.53	3.67
	Std. Deviation	.516	.488
	Median	4.00	4.00
	Std. Error of Mean	.133	.126
Total	N	45	45
	Minimum	3	0
	Maximum	5	4
	Range	2	4
	Mean	3.60	1.40
	Std. Deviation	.580	1.684
	Median	4.00	1.00
	Std. Error of Mean	.086	.251

"The Table 3 represents the descriptive statistics of the **visual analogue thermometer** of the 3 groups,the mean of the Experimental Group(1)- 3.53 , Experimental Group(2)- 3.73, Control Group(3)- 3.53, at the baseline.
Post 6 sittings the mean of all three groups are .20, .33, 3.67 respectively.
The total mean of all three groups for visual analogue thermometer was 3.60 at base line and 1.40 after 6 sittings."

GROUP		ODI- Functional Ability(Oswestry Disability Index)- Base Line	ODI- Functional Ability(Oswestry Disability Index)- After 6 sitting
Experimental Group - Muscle Energy Technique +Exercise	N	15	15
	Minimum	.23	.00
	Maximum	.38	.20
	Range	.15	.20
	Mean	.2960	.0241
	Std. Deviation	.05166	.05173
	Median	.2800	.0000
	Std. Error of Mean	.01334	.01336
Experimental Group – G.D. Maitland's Mobilisation +Exercise	N	15	15
	Minimum	.20	.00
	Maximum	.38	.18
	Range	.18	.18
	Mean	.2780	.0673
	Std. Deviation	.05003	.05982
	Median	.2600	.0500
	Std. Error of Mean	.01292	.01544
Control Group- Exercise	N	15	15
	Minimum	.22	.07
	Maximum	.38	.35
	Range	.16	.28
	Mean	.2847	.2333
	Std. Deviation	.05290	.07594
	Median	.2800	.2200
	Std. Error of Mean	.01366	.01961
Total	N	45	45
	Minimum	.20	.00
	Maximum	.38	.35
	Range	.18	.35
	Mean	.2862	.1083
	Std. Deviation	.05091	.11019
	Median	.2800	.0700
	Std. Error of Mean	.00759	.01643

“The mean of the oswestry disability index within the three groups at the base line are as following;
Experimental group(1): .2960
Experimental group(2): .2780
Control group(3): .2800
The mean changes after the 6 sittings are: .0241, .0673, .2333 respectively.”

Selkow 2009
E-Mail to Noelle Selkow 06.05.2009
Answer 07.05.2009
E-Mail to Noelle Selkow 08.05.2009
Answer 08.05.2009
"Measurements of pain:
Day 1 Baseline current pain:
Control 36.6 +/- 26.2mm, MET 18.2 +/- 9.0 mm
Day 2 (24 hours after treatment) current pain:
Control 21.4 +/- 24.7, MET 17.2 +/- 14.3
Day 1 Baseline worst pain over the past 24 hours
Control 18.1 +/- 14.3mm, MET 29.3 +/- 19.1 mm
Day 2 (24 hours after treatment) worst pain over past 24 hours
Control 35.2 +/- 28.0 mm, MET 25.0 +/- 20.6 mm
Day 1 Pain resulting during provocation test before treatment
Control 34.0 +/- 27.7 mm, MET 25.9 +/- 20.0 mm
Immediately after treatment pain with provocation test
Control 31.3 +/- 25.6mm, MET 21.8 +/- 23.5mm
Day 2 (24 hours after treatment) pain with provocation test
Control 29.2 +/- 27.4mm, MET 15.7 +/- 20.5mm

There were no side effects to those who received MET. The study was submitted to the Institution Review Board for the Social and Behavioral Sciences prior to starting data collection. The study is free of selective outcome reporting. Our pre-specified outcomes were:

–VAS (mm)
-Current pain
-Worst pain over past 24 hours
-Worst pain with pain provocation test
–Innominate rotation (degrees)
–True Leg length discrepancy (mm)
–Apparent leg length discrepancy (mm)
–SI joint pain provocation tests (yes/no)"

Pillay 2005
E-Mail to Charmaine Korporaal 01.12.2009
Answer 02.12.2009
E-Mail to Keshnee Pillay 04.12.2009, 14.12.2009
"Therefore I need the following data:
Mean and standard deviation (SD) of the MET group (intervention group) before treatment and the measure points after treatment for the outcomes
NRS-101 pain score and the Oswestry Disability Index
Mean and standard deviation (SD) of the mobilization (control group) before treatment and the measure points after treatment for the outcomes NRS-101 pain score and the Oswestry Disability Index".
E-Mail to Keshnee Pillay 17.01.2010, 18.01.2010
"Do the subjects know which kind of treatment they got (MET or Mobilization)?
Do you have drop-outs in the study?
Are all outcomes that are of interest in the study and which are pre-specified in the study protocol are published in the study?"
Answer Keshnee Pillay 15.12.2009, 29.01.2010
"Yes patients in both groups knew what treatment they received, *the drop outs in the study were eliminated and only results of those patients that completed the 5 treatments were considered… all statistical data was included in the study, no additional data was excluded."

E-Mail to Laura Wilson 18.01.2010
Answer Laura Wilson 18.01.2010
"Mean, Std. Deviation and Number of the 2 intervention groups"

group		Change in flexion	Change in extension	Change in right lateral flexion	Change in left lateral flexion
A-passive	Mean	8.3000	2.9000	5.3333	3.3667
	N	30	30	30	30
	Std. Deviation	17.12057	7.31248	5.89174	8.14728
B-muscle energy	Mean	9.5333	3.3793	3.1000	1.4000
	N	30	29	30	30
	Std. Deviation	13.11418	7.95260	7.00419	6.78538
Total	Mean	8.9167	3.1356	4.2167	2.3833
	N	30	59	30	29
	Std. Deviation	15.13251	7.57140	6.51489	7.49936

group		Change in right rotation	Change in left rotation	Change in algometer	Change in ODI	Change in NRS
A-passive	Mean	2.5333	2.6333	1.2497	-16.9167	-18.5833
	N	30	30	30	30	30
	Std. Deviation	4.59935	3.85499	1.12684	16.04631	10.70134
B-muscle energy	Mean	3.8333	3.1333	1.1678	-16.0500	-19.2167
	N	30	30	29	30	30
	Std. Deviation	4.64671	5.50068	1.04220	12.04614	15.43210
Total	Mean	3.1833	2.8833	1.2094	-16.4833	-18.9000
	N	60	60	59	60	60
	Std. Deviation	4.63038	4.71597	1.07748	14.07395	13.16995

Salvador 2005
E-Mail to Daniel Salvador 08.05.2009
E-Mail to Fernando Pierette Ferrari 08.05.2009
E-Mail failed

Geisser 2005
E-Mail to Michael Geisser 30.11.2009
„Do you work only with MET or do you mix MET with other therapy procedures. Have every patient got a MET treatment or only some of the patients?"
Answer Michael Geisser 02.12.2009
„Subjects in the manual therapy arm received muscle energy techniques. Some subjects received other types of mobilization as appropriate."
Answer Beth Wiggert 03.12.2009
"All of the patients in the two specific therapy groups received Muscle Energy Technique as part of their therapy. They may also have gotten hip capsule mobilizations."

Lamberth 2005
E-Mail to Lars Remvig 08.05.2009
"Would it be possible to send me the participant's data of RMQ-score, RS-score and average pain (VAS)? You published them in Figure 3, 4 and 5 but for the review I need the exact data. Have you assess in the MET group any side effects? Could you please inform me if all in the study pre-specified primary and secondary outcomes that are of interest have been reported in the article? Have you registered the study before starting or have you given the study protocol to an ethic commission?"
Answer Lasse Lamberth 24.05.2009
"Lars Remvig has forewarded your e-mail to me, and I will try to answer your questions the best I can. It will follow in a later mail though. This mail is just to inform you, that we haven´t forgotten about your request. I hope you understand".
Answer Lars Remvig
"I forwarded your mail to the physio's who made the analyses. They have received my mail, but I haven't heard from them, and I am afraid that they have been unable to locate the results you ask for."

Appendix F

Calculation of Effect size, Mean and Standard Deviation

Study Rana 2005. Outcome: Visual analogue scale (VAS)

GROUP	N	Effect size VAS
Experimental Group - Muscle Energy Technique+Exercise	1	4
	2	4
	3	4
	4	3
	5	3
	6	3
	7	3
	8	2
	9	4
	10	3
	11	3
	12	4
	13	4
	14	3
	15	3
	Mean	3.3333333
	Std. Deviation	0.6172134
Experimental Group - G.D. Maitland's Mobilisation+Exercise	1	3
	2	3
	3	4
	4	4
	5	5
	6	2
	7	4
	8	4
	9	3
	10	4
	11	2
	12	3
	13	3
	14	4
	15	3
	Mean	3.4
	Std. Deviation	0.8280786
Control Group – Exercise	1	1
	2	0
	3	0
	4	0
	5	0
	6	0
	7	0
	8	0
	9	-1
	10	-1
	11	1
	12	0
	13	0
	14	-1
	15	0
	Mean	-0.0666666
	Std. Deviation	0.5936168

Study Rana 2005. Outcome: Oswestry Disability Index (ODI)

GROUP	N	Effect size ODI
Experimental group - Muscle Energy Technique+Exercise	1	0.32
	2	0.23
	3	0.35
	4	0.18
	5	0.25
	6	0.24
	7	0.28
	8	0.23
	9	0.21
	10	0.24
	11	0.34
	12	0
	13	0.36
	14	0.23
	15	0.3
	Mean	0.25066667
	Std. Deviation	0.08819351
Experimental group -G.D. Maitland's Mobilisation+Exercise	1	0.32
	2	0.21
	3	0.22
	4	0.2
	5	0.12
	6	0.05
	7	0.22
	8	0.22
	9	0.2
	10	0.25
	11	0.28
	12	0.25
	13	0.31
	14	0.25
	15	0.21
	Mean	0.22066667
	Std. Deviation	0.06776711
Control group – Exercise	1	0.25
	2	0.02
	3	0.03
	4	0.03
	5	0.1
	6	0.02
	7	0.02
	8	0.07
	9	-0.03
	10	0.23
	11	0
	12	0.01
	13	-0.1
	14	0.02
	15	0.1
	Mean	0.05133333
	Std. Deviation	0.09070097

StudyWilson 2003. Outcome: Oswestry Disability Index (ODI)

GROUP	N	Effect size ODI
Experimental group - Muscle Energy Technique + moist heat + supervised (home) exercise program	1	44
	2	36
	3	36
	4	22
	5	40
	6	48
	7	38
	8	36
	Mean	37.5
	Std. Deviation	7.61577311
Control group - Placebo manual therapy + moist heat, + supervised (home) exercise program	1	32
	2	30
	3	30
	4	22
	5	22
	6	28
	7	38
	8	28
	Mean	28.75
	Std. Deviation	5.23040561