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Effectiveness of the McKenzie Method of Mechanical Diagnosis and Therapy for Treating Low Back Pain: Literature Review With Meta-analysis

Low back pain (LBP) is the worldwide leading cause of years lived with disability, with an estimated point prevalence of 9.4% and a lifetime prevalence of up to 39%.[25,52,62] This negatively impacts the psychosocial health of those affected.[48] Moreover, with an aging population, LBP is expected to become more widespread.[26]

STUDY DESIGN: Literature review with meta-analysis.

BACKGROUND: The McKenzie Method of Mechanical Diagnosis and Therapy (MDT), a classification-based system, was designed to classify patients into homogeneous subgroups to direct treatment.

OBJECTIVES: To examine the effectiveness of MDT for improving pain and disability in patients with either acute (less than 12 weeks in duration) or chronic (greater than 12 weeks in duration) low back pain (LBP).

METHODS: Randomized controlled trials examining MDT in patients with LBP were identified from 6 databases. Independent investigators assessed the studies for exclusion, extracted data, and assessed risk of bias. The standardized mean difference (SMD) and 95% confidence interval were calculated to compare the effects of MDT to those of other interventions in patients with acute or chronic LBP.

RESULTS: Of the 17 studies that met the inclusion criteria, 11 yielded valid data for analysis. In patients with acute LBP, there was no significant difference in pain resolution (P = .11) and disability (P = .61) between MDT and other interventions. In patients with chronic LBP, there was a significant difference in disability (SMD, –0.45), with results favoring MDT compared to exercise alone. There were no significant differences between MDT and manual therapy plus exercise (P>.05) for pain and disability outcomes.

CONCLUSION: There is moderate- to high-quality evidence that MDT is not superior to other rehabilitation interventions for reducing pain and disability in patients with acute LBP. In patients with chronic LBP, there is moderate- to high-quality evidence that MDT is superior to other rehabilitation interventions for reducing pain and disability; however, this depends on the type of intervention being compared to MDT.

LEVEL OF EVIDENCE: Therapy, level 1a.
J Orthop Sports Phys Ther 2018;48(6):1-15. doi:10.2519/jospt.2018.7562

KEY WORDS: *centralization, classification, directional preference, lumbar spine, manual therapy*

A variety of clinical practice guidelines have been developed for the treatment of LBP.[6,29,43] These guidelines propose a shift away from treatment of LBP primarily based on pathoanatomical principles in favor of a classification-based approach. This suggestion is largely based on several studies reporting that classifying patients led to improved clinical results.[14,15,31] However, a recent review has questioned the clinical effectiveness of subgrouping claims, due to trials that were underpowered and the poor quality of reporting.[55]

The McKenzie Method of Mechanical Diagnosis and Therapy (MDT) is a well-studied classification system. This assessment and treatment model has demonstrated good interexaminer reliability when classifying patients with LBP; however, evidence of its treatment effectiveness continues to be challenged. The MDT was designed to classify patients into 3 mechanical subgroups (derangement, dysfunction, or postural syndrome) or an "other" subgroup, by which to direct treatment.[23,36] Derangement, the most common subgroup, is associated with a rapid change in symp-

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toms secondary to performance of a "directional-preference" exercise.[36] The directional preference of a patient is the direction in which a repeated movement and/or sustained position produces an improvement in symptoms. Those improvements may include centralization, a phenomenon in which symptoms down the lower extremity are progressively abolished in a distal to proximal direction.[64] The presence of centralization is associated with good prognosis in patients with LBP.[64] Furthermore, recent studies have shown that directional preference and centralization, when matched with adequate MDT treatment, result in better patient outcomes than treatment with general range-of-motion exercise.[31,47,50]

The latest meta-analysis to examine the effectiveness of MDT for LBP found limited evidence to support the use of MDT.[32] However, additional randomized controlled trials have since been published.[31,33,47] Moreover, the previous meta-analysis did not consider acute and chronic LBP separately. Because acute and chronic forms of LBP manifest differently, the treatment effect could be different.[19,44,51] A cutoff of 12 weeks to differentiate acute from chronic LBP has been used in previous systematic reviews and clinical practice guidelines.[4,37] Also, the previous meta-analysis compared MDT to passive therapy, which included a variety of interventions that might have different effects. Because the relative effectiveness of MDT could change based on the comparator intervention, MDT should be compared to each intervention type separately. The level of MDT training should also be considered, as it may impact interventions and risk-adjusted functional outcomes.[10] The objective of this meta-analysis was to determine the effectiveness of MDT provided by trained therapists compared to that of different types of comparator interventions for improving pain and disability in patients with acute and chronic LBP separately.

METHODS

The methodology for this review was based on the PRISMA statement,[39] and the data extraction form was informed by the Cochrane meta-analysis guidelines.[27]

Eligibility Criteria

Randomized controlled trials that examined the effectiveness of MDT for pain and disability in patients with LBP were included. There was no limit on publication date, and studies could be written in English or French. Exclusion criteria included duplicated data from other studies, other interventions combined with MDT where the effects could not be partitioned, and studies published in non–peer-reviewed journals. Only trials in which therapists were MDT trained were included. To be considered MDT trained, therapists were required to have participated in at least 1 course offered by the McKenzie Institute International focused on applying MDT to patients with LBP. This criterion was based on evidence that trained therapists are more reliable in classifying patients (κ = 0.7-0.9) than are therapists without certification (κ = 0.17-0.39).[28,49,65] Studies in which an MDT classification was not completed prior to the treatment were excluded, as a priori classification is an essential characteristic of the MDT approach.[36] Last, the comparator intervention had to be a typical rehabilitation intervention, such as manual therapy, exercise, or education. There was no review protocol published for this meta-analysis.

Information Sources

Six electronic databases (MEDLINE, Embase, CINAHL, Cochrane Database of Systematic Reviews, PsycINFO, and the Physiotherapy Evidence Database [PEDro]) were searched using 3 primary search strings: (1) MDT therapy, (2) low back/lumbar pain, and (3) randomized controlled trials. Related terms were included for each search string, and an example for the MEDLINE search is provided (**APPENDIX**, available at www.jospt.org). The first search was performed on November 12, 2015. A second search was performed on May 26, 2016, and a third search was performed on September 6, 2017 to provide an update of articles published since the first search. Additionally, references from the included studies and from previous systematic reviews/meta-analyses were searched manually, along with publications on the McKenzie Institute International website (www.mckenzieinstitute.org).

Study Selection

Titles and abstracts were screened independently by 2 reviewers (O.L., D.S.). When disagreements between reviewers occurred, they discussed the relevant abstract to reach a consensus. A third reviewer (S.R.) made the decision when a consensus could not be reached. The full articles were obtained for the selected abstracts and were reviewed again independently by 2 reviewers (O.L., D.S.). As before, a third reviewer (S.R.) made the decision to include the study in the analysis if a consensus could not be reached by the 2 initial reviewers.

Data Extraction

Data extraction was performed by 2 investigators (P.T.P., M.C.F.), who each independently extracted the data from all studies with the use of an extraction form. A customized data extraction form was developed for each of the 2 outcomes of interest, pain and disability. The data extraction form was a Microsoft Excel spreadsheet designed according to the Cochrane meta-analysis guidelines and adjusted to the needs of this meta-analysis.[27]

The following information was extracted from each study: (1) characteristics of the study (study duration, therapist MDT training, and the number of patients allocated to each group) and inclusion criteria, (2) type of intervention (including duration and frequency of the different interventions), and (3) type of outcome measures (including pain scores, disability scores, definitions and time of data collections). Where the study sample included a mix of individuals with chronic and acute LBP, the average duration of LBP symptoms was used to determine whether they were acute or chronic. The comparison interventions were classified into "other interventions," placebo, or a subdivision of other interventions. Other interventions were defined as nonsurgical and noninvasive interventions within the scope of physical therapy practice (eg, exercise, manual therapy, and education). These interventions could be performed by physical therapists or other health professions. Other interventions were further subdivided into manual therapy, exercise, a combination of manual therapy and exercise, or education. Chronic LBP was defined as pain in the lumbar spine lasting more than 12 weeks. Acute LBP was defined as having a duration of pain less than 12 weeks. After having completed the extraction process, the investigators compared results and reached consensus on any discrepancies. A third investigator (S.R.) resolved disagreements if a consensus could not be reached. Once the extraction form was completed, the 2 investigators independently tested the form with the first 3 included studies. The results were then compared to ensure uniformity of the extraction process. When relevant data were missing from a study, the authors and coauthors were contacted via e-mail to request the missing information. If the data could not be obtained, the study was excluded from the analyses. For each study, pain and disability measures were extracted immediately after the MDT intervention or the comparison intervention, when the intervention was assumed to have the largest treatment effect.

Risk of Bias and Strength of Evidence

To evaluate risk of bias in individual studies, the methodological quality of the included studies was rated on the PEDro scale.[34] The PEDro scale has demonstrated acceptable reliability for the overall score (intraclass correlation coefficient = 0.680)[34] and validity.[7] The ratings were obtained from the PEDro website when available. Articles not indexed in the PEDro database were assessed by 2 raters (O.L., D.S.) and a third reviewer (S.R.) made the final decision if a consensus could not be reached.

The Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach was used to assess the quality of the body of evidence for each outcome of this meta-analysis (pain and disability).[27] This evaluation was conducted by 2 raters (D.S., P.T.P.), and a third reviewer (O.L.) made the final decision if a consensus could not be reached. The quality of evidence was initially considered "high" and could be downgraded based on the following 5 factors: (1) limitation of design, (2) indirectness of evidence, (3) inconsistency of results, (4) imprecision of results, and (5) high probability of publication bias. Studies that did not reach a score of 5 on the PEDro scale could be downgraded for a limitation of design[41]; studies that possessed differences in populations, interventions, outcome measures, and indirect comparisons could be downgraded for indirectness; studies with effect estimates that were heterogeneous could be downgraded for inconsistency; and studies that had fewer than 400 participants could be downgraded for imprecision.

Statistical Analysis

Analyses were completed separately for patients with acute and chronic LBP. The effectiveness of MDT compared to other interventions, subdivisions of other interventions, or placebo were examined using random-effects models with statistical significance set at $P<.05$.[8,67] The standardized mean difference (SMD) and 95% confidence interval (CI) were calculated for each analysis. Random-effects models were utilized, because it was expected that there would be heterogeneity of the comparator interventions. The heterogeneity among studies was determined using the chi-square statistic with significance set at $P<.10$ and I^2. These analyses proceeded even if statistical heterogeneity was present. RevMan 5.3 (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark) was used for all statistical analyses.

When a study had 2 intervention groups that were compared to MDT (eg, manual therapy and education), the intervention that was considered to contribute most (eg, manual therapy) was included in the primary analysis. However, in these cases, a sensitivity analysis was completed where the comparator groups were substituted. Both comparator groups could not be included in the same analysis to avoid artificially inflating the sample size. When medians and interquartile ranges (first and third) were provided, means were calculated by summing the median, first interquartile range, and third interquartile range and then dividing by 3. Standard deviation estimates were calculated from interquartile values and consideration of the study sample size.[63]

RESULTS

The literature search resulted in the identification of 758 publications, 678 from databases and 80 from reference lists (**FIGURE 1**). After removing duplicates, 2 independent reviewers screened 354 abstracts and selected 51 articles for full-text review. After review, 17 articles were retained for the meta-analysis; however, of these 17 studies, 4 did not provide sufficient data to be included in the statistical analyses. These 4 studies are summarized in **TABLE 1**.[1,20,46,53] No significant between-group differences were observed in pain and disability in 3 and 4, respectively, of the 4 studies excluded from the meta-analysis.[1,20,46,53] Attempts to contact the authors to provide additional data were not successful. One study that met the inclusion criteria was excluded from data analysis, because participants who were noncentralizers post randomization were only excluded from the intervention group.[41] This could have biased the treatment effect toward the MDT group, as a greater effect has been shown when a directional-preference exercise is given to centralizers.[66] Also, because the modification occurred following allocation, the study could not be considered a randomized controlled trial. In this study, the findings of a significant between-group difference in improvement in pain and disability favoring MDT should be interpreted with caution.[41] One study with a mix of individuals with acute and chronic LBP[45] was included in the data analyses for chronic LBP, because most participants had recurrent episodes of LBP. For 1 study, medians and interquartile ranges were converted to means and standard deviations, respectively, as described in the Methods.[63] A summary of the meta-analysis is shown in **TABLE 2**.

Acute LBP: Primary Analysis of MDT Versus Other Interventions

Four studies compared MDT to other interventions in participants with acute LBP.[3,33,54,55] The other interventions included spinal manipulative thrusts, lumbar range-of-motion exercise,[54] joint mobilizations,[55] and first-line care (eg, advice to remain active and take acetaminophen, and assurance of a favorable prognosis).[33] Another study compared MDT to 2 other interventions: manipulations with strength and stretching home exercises, and an education booklet.[3]

Only 3 of 4 studies were included in the analysis of pain intensity.[33,54,55] The fourth study examined the bothersomeness of pain, numbness, and tingling, which was considered a different construct.[3] For the 3 included studies, tests of heterogeneity were not significant (**FIGURE 2A**). There was moderate-quality evidence of no significant (P = .11) difference in pain after the intervention period (SMD, –0.45; 95% CI: –0.99, 0.10) between MDT and the other interventions. Ratings were downgraded because of imprecision of results.

For the disability analysis, all 4 studies were included and tests of heterogeneity were not significant (**FIGURE 3A**).[3,33,54,55] There was high-quality evidence of no significant difference (P = .61) in disability after the intervention period between MDT and other physical therapy interventions (SMD, –0.07; 95% CI: –0.34, 0.20). The analysis included manipulations, with home exercises as the comparator intervention from the study that included 2 comparator interventions.[3] When the education booklet was included instead, no significant differences remained (P = .16).

Acute LBP: Subgroup Analysis

MDT Versus Manual Therapy Plus Exercise Three studies compared MDT to manual therapy plus exercise.[3,54,55] Comparator interventions included spinal manipulative thrusts with lumbar range-of-motion exercises,[54] joint mobilizations,[55] and manipulations with home exercises.[3] Only 2 of 3 studies were included in the pain intensity analysis.[54,55]

Tests of heterogeneity were not significant (**FIGURE 2B**). There was moderate evidence of a significant (P = .04) difference in pain after the intervention period, with results favoring MDT (SMD, –0.74; 95% CI: –1.45, –0.03). Ratings were downgraded because of imprecision of results. For the disability analysis, all 3 studies were included and tests of heterogeneity were not significant (**FIGURE 3B**).[3,54,55] There was moderate evidence of no significant difference (P = .36) in disability after the intervention period between MDT and manual therapy plus exercise (SMD, –0.24; 95% CI: –0.77, 0.28). Ratings were also downgraded because of imprecision of results.

MDT Versus Exercise None of the included studies compared MDT to exercise alone in participants with acute LBP.

MDT Versus Education Two studies compared MDT to an intervention that included only education in participants with acute LBP.[3,33] In 1 study, education was described as "first line care," and included advice to avoid bed rest and to remain active, assurance of a favorable prognosis, and advice to take acetaminophen.[33] This first-line care was provided

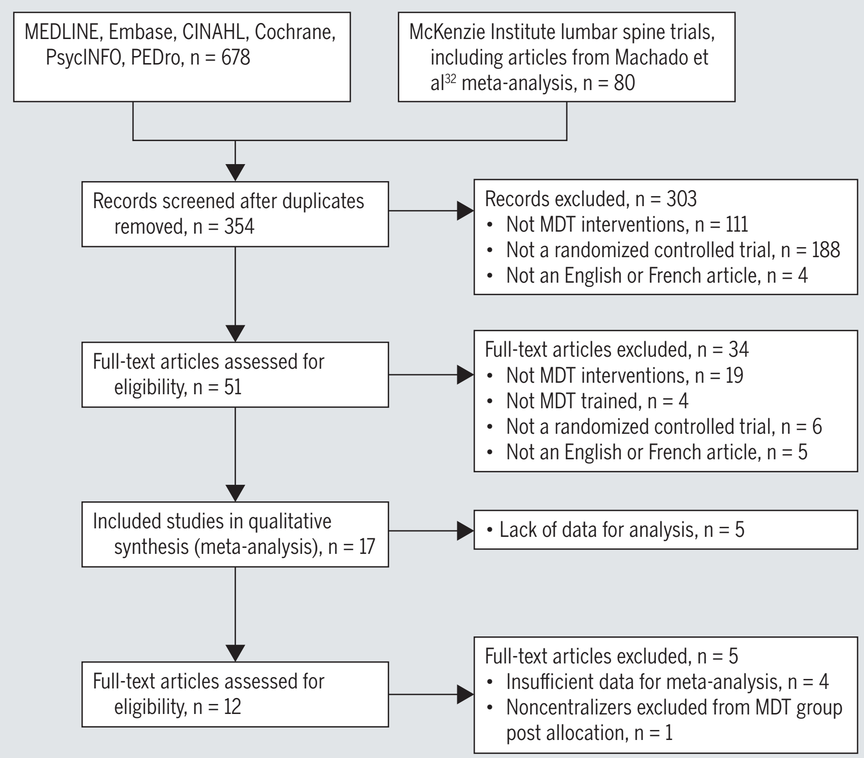


FIGURE 1. Flow diagram of search strategy and results. Abbreviation: MDT, Mechanical Diagnosis and Therapy.

to both the MDT group and the comparison group, who received no other treatments. The outcome variables for this study included both pain intensity and disability. The second study used an education booklet as the comparison intervention,[3] and had disability as an outcome measure, but not pain intensity.

As only 1 study assessed pain intensity,[33] no meta-analysis was performed. This study found that MDT plus first-line care resulted in a significant (P = .02), but small, improvement (0.7 on an 11-point numeric pain-rating scale; adjusted values) in pain intensity compared to first-line care only.

For the disability analysis, based on 2 studies,[3,33] tests of heterogeneity were not significant (**FIGURE 3C**). There was

TABLE 1 Summary of Inclusion and Exclusion Criteria, Intervention Groups, and Outcome Measures

Study (PEDro Score)	Participants (MDT Intervention)*	Participants (Other Interventions)*	Inclusion Criteria	Acute Pain (<12 wk) or Chronic Pain (>12 wk)	Intervention	MDT Level of Training	Outcomes
Bonnet et al[1] (7/10)[†]	n = 28; men, n = 17; women, n = 11; age, 48.8 ± 4.75 y; mean symptom duration, 46.1 mo	n = 26 men, n = 12; women, n = 14; age, 45.9 ± 5.1 y; mean symptom duration, 49.2 mo	Nonspecific LBP with or without radiation to lower extremity, ≥18 y of age	Mix	MDT: directional-preference exercises, can modify positions and/or add manual techniques Manual therapy plus exercise: active mobilizations in weight bearing and non–weight bearing, lower extremity stretching, proprioception in weight bearing, massage, TENS	Parts A and B	Pain: visual analog scale Disability: Oswestry Disability Questionnaire Outcomes evaluated after 1 wk
Cherkin et al[3] (8/10)	n = 133; men, n = 71; women, n = 62; age, 41.8 ± 11.5 y; mean symptom duration, 77% <6 wk	Education: n = 66; men, n = 38; women, n = 28; age, 40.1 ± 11.2 y; mean symptom duration, 72% <6 wk Manual therapy plus exercise: n = 122; men, n = 57; women, n = 65; age, 39.7 ± 9.4 y; mean symptom duration, 83% <6 wk	LBP with pain 7 d after initial physician visit, 20-64 y of age	Acute	MDT: directional-preference exercises, avoid symptom peripheralizing movements, home exercise program, education book, lumbar-support cushion Manual therapy plus exercise: chiropractic high-velocity, low-amplitude thrust manipulation; stretching and strengthening exercises; home exercise program Education: Educational booklet	Credentialed	Bothersomeness of back/leg pain, numbness/tingling: numeric rating scale Disability: modified Roland-Morris Disability Questionnaire Outcomes evaluated at 1, 4, and 12 wk
Garcia et al[17] (8/10)	n = 74; men, n = 16; women, n = 58; age, 53.7 ± 1.53 y; mean symptom duration, median of 21 mo (IQR, 28)	n = 74; men, n = 23; women, n = 51; age, 54.16 ± 1.57 y; mean symptom duration, median of 24 mo (IQR, 83)	Nonspecific LBP of ≥3 mo duration, 18-80 y of age	Chronic	MDT: directional-preference exercises, postural training, home exercise program, education Exercise: exercises aimed to improve mobility, flexibility, and strength; home exercise program; education	Credentialed	Pain: numeric rating scale Disability: Roland-Morris Disability Questionnaire Outcomes evaluated after 1, 3, and 6 mo
Gillan et al[20] (4/10)[†]	n = 19; sex, NA; age, NA; symptom duration, NA	n = 21; sex, NA; age, NA; symptom duration, NA	Acute LBP, <12 wk in duration, and a lateral shift of the lumbosacral spine	Acute	MDT: MDT approach, no further details given Education: nonspecific back massage and standard back care advice	Diploma	Disability: Oswestry Disability Questionnaire Outcomes evaluated after 1 and 3 mo
Long et al[31] (8/10)	n = 80; men, n = 39; women, n = 41; age, 42.86 ± 9.55 y; symptom duration, 13.7 ± 19.84 wk	Exercise: n = 80; men, n = 39; women, n = 41; age, 41.51 ± 10.76 y; symptom duration, 14.55 ± 17.6 wk Opposite MDT (experimental): n = 69; men, n = 35; women, n = 34; age, 42.19 ± 10.34 y; symptom duration, 17.65 ± 21.82 wk	LBP, with or without leg symptoms, with or without 1 neurological sign, directional preference, 18-65 y of age	Chronic	MDT: directional-preference exercise, avoid activities and positions that increase or radiate symptoms Exercise opposite MDT: unidirectional end-range lumbar exercises in opposite direction of directional preference and education Exercise: multidirectional, midrange lumbar exercises and stretches for the hip and thigh muscles, education	Credentialed and diploma	Back pain and leg pain: visual analog scale Disability: Roland-Morris Disability Questionnaire Outcomes evaluated after 2 wk

Table continues on page 6.

TABLE 1 — Summary of Inclusion and Exclusion Criteria, Intervention Groups, and Outcome Measures (continued)

Study (PEDro Score)	Participants (MDT Intervention)*	Participants (Other Interventions)*	Inclusion Criteria	Acute Pain (<12 wk) or Chronic Pain (>12 wk)	Intervention	MDT Level of Training	Outcomes
Machado et al[33] (8/10)	n = 73; men, n = 35; women, n = 38; age, 47.5 ± 14.4 y; mean symptom duration, 66% <2 wk, 34% 2-6 wk	n = 73; men, n = 38; women, n = 35; age, 45.9 ± 14.9 y; mean symptom duration, 67% <2 wk, 33% 2-6 wk	Acute nonspecific LBP, pain between the 12th rib and buttock crease, with or without leg pain, <6 wk in duration, preceded by at least 1 mo without LBP in which the patient did not consult a health care practitioner, 18-80 y of age	Acute	MDT: first-line care, directional-preference exercises, postural correction and education, *Treat Your Own Back* book, lumbar roll, home exercise program Education: physician advice, acetaminophen; follow-up visit in 3 wk, earlier if necessary	Credentialed	Pain: numeric rating scale Disability: Roland-Morris Disability Questionnaire Function: Patient-Specific Functional Scale Outcomes evaluated after 1 and 3 wk
Moncelon and Otero[40] (5/10)	n = 7; men, n = 4; women, n = 3; age, NA; symptom duration, NA; age of both groups, 47 ± 11 y	n = 7; men, n = 5; women, n = 2; age, NA; symptom duration, NA	Chronic nonspecific LBP, directional preference, 18-70 y of age	Chronic	MDT: directional-preference exercises, home exercise program, pool therapy Manual therapy plus exercise: diaphragmatic breathing, lumbopelvic and coxofemoral mobilizations, paravertebral muscle strengthening, pool therapy	Parts A and B	Disability: Oswestry Disability Questionnaire Outcome evaluated after 1 wk
Murtezani et al[41] (8/10)[†]	n = 111; men, n = 83; women, n = 28; age, 48.8 ± 8.9 y; symptom duration, NA	n = 109; men, n = 42; women, n = 67; age, 47.5 ± 8.8 y; symptom duration, NA	Nonspecific LBP, pain between lower angle of scapulae and above the buttocks, with or without leg pain or neurological signs, >3 mo duration, 18-65 y of age	Chronic	MDT: directional-preference exercises, can add manual techniques, avoid motions that peripheralize symptoms, home exercise program Modalities: interferential current, ultrasound, heat	50 h of training, equivalent to 2 courses	Pain: visual analog scale Disability: Oswestry Disability Questionnaire Outcomes evaluated at 2 and 3 mo
Paatelma et al[45] (7/10)	n = 52; men, n = 37; women, n = 15; age, 44 ± 9 y; symptom duration, NA	Education: n = 37; men, n = 24; women, n = 13; age, 44 ± 15 y; symptom duration, NA Manual therapy: n = 45; men, n = 26; women, n = 19; age, 44 ± 10 y; symptom duration, NA	Nonspecific LBP with or without radiation to one or both lower extremities, employed, acute or chronic duration, 18-65 y of age	Mix	MDT: exercises with or without sustained end-range positions, manual techniques, education, *Treat Your Own Back* book, home exercise program Manual therapy plus exercise: high-velocity, low-amplitude thrust manipulation; specific mobilizations; stretching; spinal stabilization exercises; home exercise program Education: good prognosis of LBP, pain tolerance and remaining active, medication, early return to work, booklet	Credentialed	Pain: back and leg pain, visual analog scale Disability: Roland-Morris Disability Questionnaire Outcomes evaluated after 3, 6, and 12 mo

Table continues on page 7.

TABLE 1 Summary of Inclusion and Exclusion Criteria, Intervention Groups, and Outcome Measures (continued)

Study (PEDro Score)	Participants (MDT Intervention)*	Participants (Other Interventions)*	Inclusion Criteria	Acute Pain (<12 wk) or Chronic Pain (>12 wk)	Intervention	MDT Level of Training	Outcomes
Petersen et al[46] (7/10)†	n = 132; men, n = 70; women, n = 62; median (10th, 90th percentiles) age, 34.5 y (23.0, 52.1 y); median (10th, 90th percentiles) symptom duration, 8 mo (2.0, 95.7 mo)	n = 128; men, n = 72; women, n = 56; median (10th, 90th percentiles) age, 35 y (24.0, 51.6 y); median symptom duration (10th, 90th percentiles), 14 mo (2.7, 113.5 mo)	LBP with or without leg pain of >8 wk; radiograph, CT scan, or MRI taken within the preceding 2 y; 18-60 y of age	Mix	MDT: directional-preference exercises, can modify positions and/or add manual techniques Exercise: stationary bike and low-resistance exercises for lumbopelvic muscles, dynamic back strengthening exercises, stretching trunk and hip muscles Both groups: asked to continue exercising for a minimum of 2 mo after intervention	Credentialed, parts A-D	Pain: back and leg pain, Low Back Pain Rating Scale Disability: Low Back Pain Rating Scale Outcomes evaluated after 2, 4 , and 12 mo
Petersen et al[47] (7/10)	n = 175; men, n= 72; women, n = 103; age, 38 ± 10.4 y; symptom duration, 97 ± 230 wk	n = 175; men, n = 83; women, n = 92; age, 37 ± 9.4 y; symptom duration, 94 ± 181 wk	LBP, with or without leg pain, >6 wk; able to speak and understand Danish; clinical signs of disc-related symptoms; 18-60 y of age	Chronic	MDT: directional-preference exercise, no manual vertebral mobilizations, educational booklet and/or lumbar roll at therapist discretion Manual therapy plus exercise: manual techniques at therapist discretion (eg, vertebral mobilization/manipulation), self-manipulation, flexion/extension exercises and stretching, educational booklet Both groups: given stabilization/strengthening exercises at therapist discretion, given home exercise plan and encouraged to continue post intervention	Screening prerandomization: diploma Treatment: credentialed	Pain: numeric rating scale Disability: Roland-Morris Disability Questionnaire SF-36 Outcomes evaluated after 3, 5, and 12 mo
Sakai et al[53] (4/10)†	n = 25; men, n = 25; women, n = 0; age, 47.9 ± 13.1 y; symptom duration, 25.3 ± 17.5 mo	Control: n = 25; men, n = 25; women, n = 0; age, 44.4 ± 13.9 y; symptom duration, 20.3 ± 18.7 mo Medication: n = 24; men, n = 24; women, n = 0; age, 44.2 ± 12.2 y; symptom duration, 23.9 ± 20.4 mo	LBP, without radiating leg pain or numbness in lower extremity, of >6 mo; male >20 y of age	Chronic	MDT: MDT approach, no further details given Control: compress, no exercise Medication: 50 mg eperisone hydrochloride, 3 times a day after meals for 4 wk All groups: educational booklet, heat therapy, ultrasound, electrical muscle stimulation, traction, no use of NSAID or anti-inflammatory agent	Credentialed	Pain: visual analog scale, Faces Pain Scale-Revised Disability: SF-36 Outcomes evaluated after 2 and 4 wk
Schenk et al[54] (5/10)	n = 19; men, n = 7; women, n = 12; mean age, 39 y; mean symptom duration, 18 d	n = 12; men, n = 5; women, n = 7; mean age, 46 y; mean symptom duration, 15 d	LBP, at least 3 of 5 selection criteria from clinical prediction rules, ≥18 y of age	Acute	MDT: directional-preference exercises, home exercise program Manual therapy plus exercise: regional lumbopelvic thrust technique, hand-heel rock range-of-motion exercise Both groups: as of third session, directional-preference exercises at home on an hourly basis, exercise log	Credentialed	Pain: numeric rating scale Disability: Oswestry Disability Index Outcomes evaluated after 2 and 4 wk

Table continues on page 8.

high-quality evidence of no significant (P = .45) difference in disability after the intervention period between participants treated with MDT or education (SMD, −0.09; 95% CI: −0.31, 0.14).

One study included in the review, despite lacking data for analysis, compared MDT to education[20] and found no significant between-group differences for changes in disability.

Chronic LBP: Primary Analysis of MDT Versus Other Interventions

Seven studies compared MDT to other interventions in participants with chronic LBP.[17,22,31,38,40,45,47] Exercise, combined

TABLE 1 — Summary of Inclusion and Exclusion Criteria, Intervention Groups, and Outcome Measures (continued)

Study (PEDro Score)	Participants (MDT Intervention)*	Participants (Other Interventions)*	Inclusion Criteria	Acute Pain (<12 wk) or Chronic Pain (>12 wk)	Intervention	MDT Level of Training	Outcomes
Schenk et al[55] (5/10)	n = 15; men, n = 7; women, n = 8; mean age, 40.1 y; symptom duration, 7 d to 7 wk	n = 10; men, n = 8; women, n = 2; mean age, 44.8 y; symptom duration, 7 d to 7 wk	Lumbar radiculopathy: symptoms originating in disc, peripheral to lumbar region, with or without neurological symptoms; posterior derangement	Acute	MDT: directional-preference exercises Manual therapy plus exercise: mobilization: passive movement to spinal segments Both groups: postural correction, ambulation on treadmill	Credentialed	Pain: visual analog scale Disability: Oswestry Disability Questionnaire Outcomes evaluated after third visit
Miller et al[38] (5/10)	n = 14; men, n = 7; women, n = 7; age, 44 ± 16 y; symptom duration, 20 ± 30 mo	n = 15; men, n = 8; women, n = 7; age, 54 ± 15 y; symptom duration, 32 ± 58 mo	Chronic LBP for >7 wk, 18 y of age or older	Chronic	MDT: postural correction, directional-preference exercises, and manual techniques Exercise: spine stabilization exercises (transversus abdominis and lumbar multifidus) Both groups: home exercise program according to grouping	Credentialed	Pain: short-form McGill Pain Questionnaire Disability: Functional Status Questionnaire Outcomes evaluated after 6 wk
Halliday et al[22] (7/10)	n = 35; men, n = 7; women, n = 28; age, 48.8 ± 12.1 y; median symptom duration, 26.6 wk (IQR, 22.3)	n = 35; men, n = 7; women, n = 28; age, 48.3 ± 14.2 y; median symptom duration, 37.7 wk (IQR, 28.8)	LBP localized between the 12th rib and the buttock crease, with or without referred pain into one or both legs and with or without sensory and or motor changes, for >3 mo; directional preference	Chronic	MDT: directional-preference exercises, postural education and lumbar roll, *Treat Your Own Back* book Exercise: motor control exercises of deep lumbar stabilizers, home exercise program	Credentialed	Pain: visual analog scale Disability: Patient-Specific Functional Scale Outcomes evaluated after 8 wk
Garcia et al[18] (8/10)[†]	n = 74; men, n = 16; women, n = 58; age, 57.5 ± 12.2 y; symptom duration, 36 ± 102 mo	n = 73; men, n = 19; women, n = 54; age, 55.5 ± 13.7 y; symptom duration, 48 ± 96 mo	Chronic nonspecific LBP, pain intensity of 3/10 on a numeric pain-rating scale, 18-80 y of age, and able to read Portuguese	Chronic	MDT: directional-preference exercises, specific end-range motion exercise, postural education, home exercise program, and *Treat Your Own Back* book Placebo: detuned pulsed ultrasound, detuned shortwave diathermy Both groups: given educational booklet *The Back Book*	Part A	Pain: numeric pain-rating scale Disability: modified Roland-Morris Disability Questionnaire Outcomes evaluated after 5 wk and 3, 6, and 12 mo

Abbreviations: CT, computed tomography; IQR, interquartile range; LBP, low back pain; MDT, Mechanical Diagnosis and Therapy; MRI, magnetic resonance imaging; NA, not available; NSAID, nonsteroidal anti-inflammatory drug; PEDro, Physiotherapy Evidence Database; SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey; TENS, transcutaneous electrical nerve stimulation.
**Values are mean ± SD unless otherwise indicated.*
[†]Not included in meta-analysis.

manual therapy and exercise, and education were the comparator interventions. One of the studies compared combined MDT and balneotherapy to combined exercise, manual therapy, and balneotherapy.[40] Another study had 2 comparator groups, manual therapy with exercise and education.[45]

Six of the 7 studies measured pain intensity.[17,22,31,38,45,47] Tests of heterogeneity were significant (**FIGURE 4A**). There was moderate evidence of a significant (P = .03) difference in pain after the intervention period, with the results favoring MDT (SMD, −0.33; 95% CI: −0.63, −0.03). The GRADE ratings were downgraded due to unexplained heterogeneity. This analysis included manual therapy with exercise as the comparator intervention from the study that included 2 comparator groups.[45] When education was included instead, significant differences remained (P = .03).

Disability was measured in all 7 studies.[17,22,31,38,40,45,47] Tests for heterogeneity were not significant (**FIGURE 5A**). There was high-quality evidence of a significant (P<.01) difference in disability after the intervention period, with the results favoring MDT (SMD, −0.28; 95% CI: −0.44, −0.12). This analysis included manual therapy, with exercise as the comparator intervention from the study that included 2 comparator groups.[45] When education was included instead, significant differences remained (P = .04).

Two studies included in the review, which lacked sufficient data to be included in the meta-analysis comparing MDT to modalities (heat, ultrasound, electrical muscle stimulation, and interferential current),[42,53] found significant between-group differences for changes in pain, with results favoring MDT; only 1 of these studies[42] found a significant difference in change in disability, with results favoring MDT.

TABLE 2 SUMMARY OF META-ANALYSIS RESULTS

	Number of Studies	Mean Difference (95% CI)	*P* Value
Acute LBP			
MDT versus other interventions			
Pain	3	−0.45 (−0.99, 0.10)	.11
Disability	4	−0.07 (−0.34, 0.20)	.61
MDT versus manual therapy and exercise			
Pain	2	−0.74 (−1.45, −0.03)	.04
Disability	3	−0.24 (−0.77, 0.28)	.36
MDT versus education	2	−0.09 (−0.31, 0.14)	.45
Chronic LBP			
MDT versus other interventions			
Pain*	6	−0.33 (−0.63, −0.03)	.03
Disability	7	−0.28 (−0.44, −0.12)	<.01
MDT versus manual therapy and exercise			
Pain*	2	−0.26 (−0.73, 0.22)	.30
Disability	3	−0.11 (−0.29, 0.07)	.23
MDT versus exercise			
Pain*	4	−0.38 (−0.82, 0.05)	.08
Disability	4	−0.45 (−0.64, −0.25)	<.01
MDT versus education			
Pain (unable to calculate)	1		
Disability (unable to calculate)	1		
MDT versus placebo			
Pain (unable to calculate)	1		
Disability (unable to calculate)	1		

Abbreviations: CI, confidence interval; LBP, low back pain; MDT, Mechanical Diagnosis and Therapy.
**Significant heterogeneity.*

Chronic LBP: Subgroup Analysis

MDT Versus Manual Therapy Plus Exercise Three studies compared the effects of MDT to combined manual therapy plus exercise in participants with chronic LBP.[40,45,47] Manual therapy plus exercise interventions consisted of manipulation, mobilization, and lumbar range of motion/stretching exercises. Of the 3 studies, 2 measured pain intensity, and tests of heterogeneity were significant (**FIGURE 4B**).[45,47] There was moderate evidence of no significant (P = .30) difference in pain after the intervention period between interventions (SMD, −0.26; 95% CI: −0.73, 0.22). Ratings were downgraded because of unexplained heterogeneity. All 3 studies measured disability, and tests of heterogeneity were not significant (**FIGURE 5B**).[40,45,47] There was high-quality evidence of no significant (P = .23) difference in disability after the intervention period between interventions (SMD, −0.11; 95% CI: −0.29, 0.07).

One study that did not provide sufficient data to be included in the meta-analysis[2] compared MDT to manual therapy and exercise. The study found no significant between-group differences for change in pain intensity and disability after a 1-week intervention.

MDT Versus Exercise Four studies compared the effects of MDT and exercise on pain intensity in participants with chronic LBP.[17,22,31,38] Exercise programs consisted of group exercises,[17] midrange lumbar/stretching exercises,[31] or stabilization/motor control exercises.[22,38] One study had 2 comparison intervention groups consisting of either MDT exercise in the opposite direction as the directional preference or midrange lumbar/stretching exercises.[31] Only this latter group was included as the comparison to MDT in the current analysis. All 4 studies measured pain intensity, and tests of heterogeneity were significant (**FIGURE 4C**).[17,22,31,38] There was moderate evidence of no significant difference in pain after the intervention period between interventions (SMD, –0.38; 95% CI: –0.82, 0.05). Ratings were downgraded because of imprecision of results. These 4 studies also examined disability. Tests of heterogeneity were not significant (**FIGURE 5C**). There was high-quality evidence of a significant difference (P<.01) in disability after the intervention period, with the results favoring MDT (SMD, –0.45; 95% CI: –0.64, –0.25).

One of the included studies did not provide sufficient data to be included in the meta-analysis; the authors found no significant between-group differences in change in pain and disability between patients treated with MDT versus exercise.[47]

MDT Versus Education Only 1 study compared MDT to an education intervention in participants with chronic LBP, and thus a meta-analysis could not be completed.[45] Education included advice to remain active. There was no significant difference in change in pain intensity or disability between MDT and education 3 months after initiating treatment.

MDT Versus Placebo One study compared MDT to a placebo intervention in participants with chronic LBP, and thus a meta-analysis could not be completed.[18] Both groups received a copy of *The Back Book* (Baltimore, MD: Johns Hopkins University Press) and 5 weeks of treatments that included 10 sessions in total. The placebo group was treated with detuned pulsed ultrasound for 5 minutes and detuned shortwave diathermy in pulse mode for 25 minutes, which did not provide any therapeutic benefit. There was a statistically significant difference between groups for change in pain intensity at the end of treatment, with results favoring the MDT group (adjusted mean difference, –1.00; 95% CI: –2.09, –0.01); however, the difference was only 1 point on a 0-to-10 visual analog scale, and likely not clinically significant.

Risk-of-Bias Assessment and Strength of Evidence

The articles' scores on the PEDro scale were all obtained through the PEDro database and ranged from 4 to 8 out of 10. There were 15 studies with a PEDro score of at least 5, and 2 studies with a score of less than 5. Due to the nature of the interventions, the providers could not be blinded to the interventions in any of the studies, which lowered the PEDro scores of the included articles. Blinding of the patients was reported in only 1 study.[18] Blinding of the assessor was reported in 9 of the studies.[1,17,20,22,31,33,41,47,55] The mean PEDro scale score for all studies was 6/10 (**TABLE 1**).

DISCUSSION

In patients with acute LBP, (1) MDT was no more effective than other interventions, (2) MDT yielded statistically and clinically significant better improvements in pain intensity compared to manual therapy plus exercise (though only 2 studies with small sample sizes were included in the analysis), and (3) no difference in improvement in disability was found between MDT and either manual therapy plus exercise or education. In those with acute LBP, the quality of evidence assessed with the GRADE ratings was moderate and high for the outcome of pain and disability, respectively; therefore, there is good-quality evidence showing that MDT is not clinically superior to other interventions in acute LBP to improve pain or disability.

In patients with chronic LBP, (1) MDT was more effective at reducing pain and disability than other rehabilitation interventions, (2) MDT was superior to exercise for reducing disability but not pain, and (3) MDT was not superior to combined manual therapy and exercise, or to education. Although superior, the effect size was small to moderate, indicating at least minimal clinical significance. The strength of evidence of these findings was moderate to high and was downgraded mainly due to significant heterogeneity between the included studies. The strength of evidence is further demonstrated by the PEDro scale scores higher than 5 for all studies contrib-

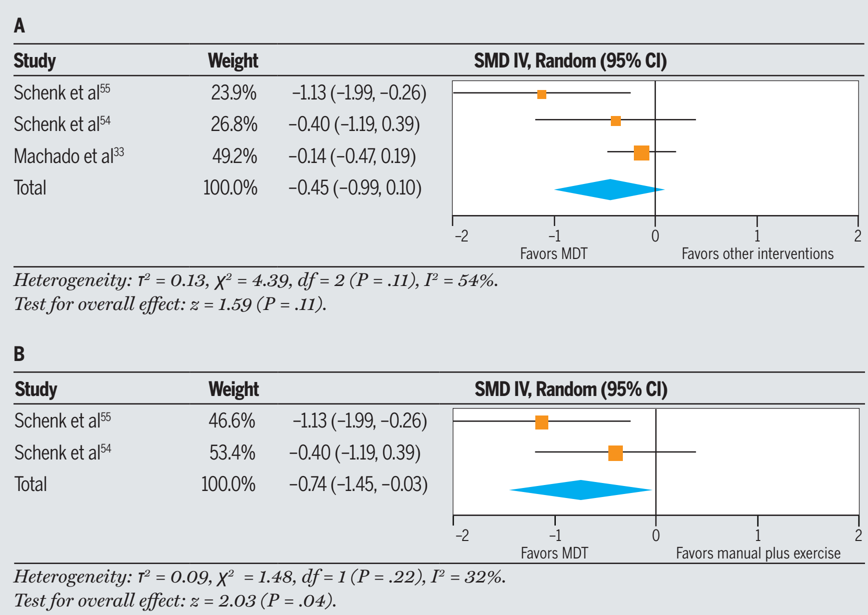


FIGURE 2. Forest plot of the effectiveness of MDT for improving pain in patients with acute low back pain in comparison to (A) other physical therapy interventions, and (B) a combination of manual therapy with exercise. The other physical therapy interventions included a combination of manual therapy with exercise or education. Abbreviations: CI, confidence interval; IV, independent variable; MDT, Mechanical Diagnosis and Therapy; SMD, standardized mean difference.

uting to statistical analysis. A PEDro scale score of 5 or higher is used as a common cutoff to evaluate the quality of a study.[7]

The current findings were different from those of the previous meta-analysis, which concluded that the MDT approach did not produce clinically significant differences in pain and disability in patients with LBP. Nine studies included in the current study were published after the last meta-analysis,[32] published in 2006 (**TABLE 1**).[1,18,22,33,40,45,47,53,54] There are 4 main differences between the previous and current meta-analyses. First, in the current meta-analysis, acute and chronic LBP were investigated separately. Chronic pain and acute pain manifest differently, because psychosocial factors are potentially more dominant in patients with chronic pain.[68] Second, the current meta-analysis only included studies in which therapists received MDT standardized training. When providing care based on MDT principles, trained therapists obtained better treatment outcomes than untrained therapists.[10] From the previous meta-analysis, 2 studies included therapists who were not trained in MDT.[5,12] Third, only studies in which classification was conducted a priori were included in the current meta-analysis. The basis of the MDT approach relies on the classification of a patient before providing treatment, such as directional-preference exercises. Thus, patients should be classified into 1 of the subgroups (derangement, dysfunction, postural, or other) prior to receiving a specific treatment to be considered an MDT treatment. The classification process was omitted in 5 of the included studies in the previous systematic review.[9,11,35,57,60] Thus, the current findings provided an updated meta-analysis of the effectiveness of MDT, and ensured that the included studies more closely followed the MDT program as intended.

In patients with acute LBP, we observed statistically significantly greater improvement in pain intensity when utilizing the MDT approach compared to the combination of manual therapy and exercise. Two studies in which directional-preference exercises were the primary means of treatment in the MDT group were analyzed.[54,55] Directional preference implies a rapid improvement in patient symptoms in response to a specific exercise.[36] This could explain the differences observed when comparing a symptom-based approach to a nonspecific exercise regimen, such as range-of-motion exercises, which may not address pain immediately. Analysis of the 2 included studies showed statistically significant differences in pain favoring MDT (**FIGURE 2**), with an SMD of 0.74 and a nonstandardized difference of 1.86 on the visual analog scale (analysis not presented), which would be considered clinically meaningful.[21] For acute LBP, no difference was observed for change in disability across the different methods of intervention, including education (**FIGURE 3**). This could be explained by the nature of acute LBP, in that most patients have a favorable prognosis, and that rapid reductions in both pain and disability are noted within 6 weeks of symptom onset.[37] For patients with acute LBP, MDT seemed to be more effective at reducing pain than manual therapy plus exercise; however,

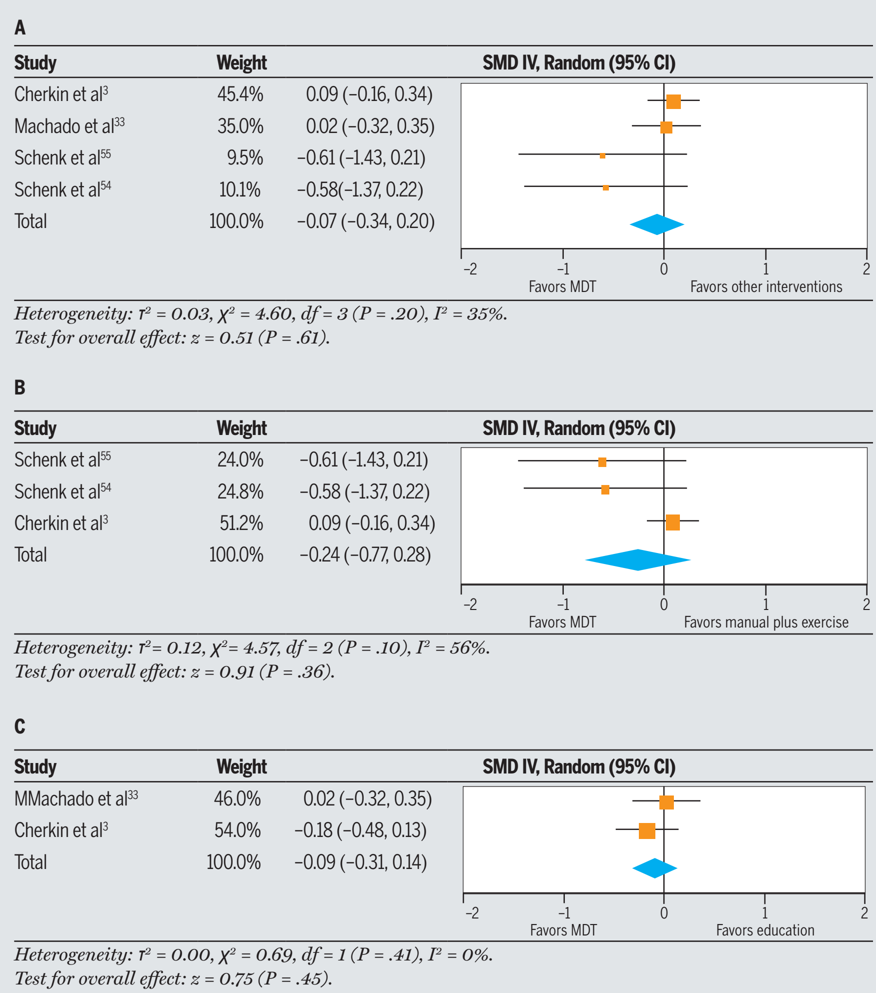


FIGURE 3. Forest plot of the effectiveness of MDT for improving disability in patients with acute low back pain in comparison to (A) other physical therapy interventions, (B) a combination of manual therapy with exercise, and (C) education. The other physical therapy interventions included a combination of manual therapy with exercise or education. Abbreviations: CI, confidence interval; IV, independent variable; MDT, Mechanical Diagnosis and Therapy; SMD, standardized mean difference.

therapists should be careful when using MDT exclusively, as the effect size was moderate for a small sample size, and other treatment approaches could yield similar results for disability in this population.

For patients with chronic LBP, MDT provided greater improvements in pain and disability compared to other interventions and exercise alone, but had similar outcomes compared to the combination of manual therapy and exercise. The SMD values represented a small treatment effect for the comparison of MDT to other interventions for pain (SMD, −0.33) and disability (SMD, −0.28); therefore, despite statistical significance, the clinical significance of the difference may be less meaningful. Other symptom-matched approaches have also demonstrated similar findings in patients with chronic LBP.[2,56]

Although effective in treating chronic LBP, MDT might not be any better than combined manual therapy plus exercise. It has been shown in treatment-based classification that patients who may benefit from specific exercise may also benefit from spinal manipulation.[58] Also, small treatment effects could be credited to the fact that a large group of patients may not fall into a distinct subgrouping and may benefit from a more generalized exercise program.[59] These patients are likely to be classified into the "chronic pain" category of the MDT classification. Because the meta-analysis did not evaluate each MDT subgroup separately, definite conclusions regarding the different treatment effectiveness outcomes are unknown. This latter subgroup is largely based on the presence of psychological factors and on patients not responding to mechanical-type treatments.[36] Also, MDT does not explicitly account for pain systems theory, specifically differentiating between pain that is central or peripheral in origin, and for a wider spectrum of psychological factors that could be present in patients with chronic LBP.[44,51] Regardless, although the treatment effects are small to moderate, MDT remains a viable option in reducing pain and disability in patients with chronic LBP.

However, there were some methodological issues in the included studies. Lower PEDro scale scores were often due to the nature of the studies: not allowing for blinding of the therapists and patients. The intention to treat was not met for 4 studies, and it was not clear how participants who dropped out were accounted for statistically.[1,20,22,38] Also, some studies included only the derangement subgroup for the MDT intervention, whereas others included all 3 mechanical syndromes. The fact that the 3 different subgroups had different prognoses could have impacted MDT's effectiveness. Furthermore, MDT was not compared to other classification approaches that tailor treatments based on clinical characteristics rather than pathoanatomical diagnoses, such as treatment-based classification and movement system impairments.[13,27]

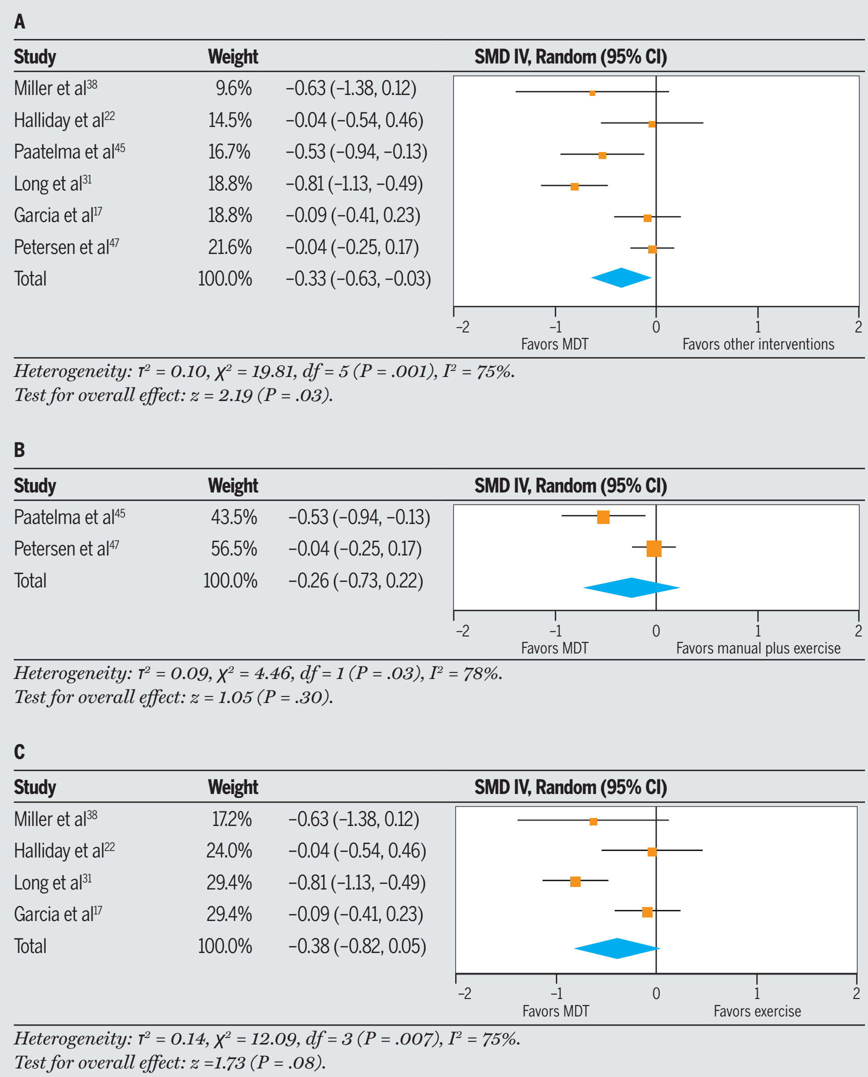


FIGURE 4. Forest plot of the effectiveness of MDT for improving pain in patients with chronic low back pain in comparison to (A) other physical therapy interventions, (B) a combination of manual therapy with exercise, and (C) exercise. The other physical therapy interventions included either a combination of manual therapy with exercise or exercise alone. Abbreviations: CI, confidence interval; IV, independent variable; MDT, Mechanical Diagnosis and Therapy; SMD, standardized mean difference.

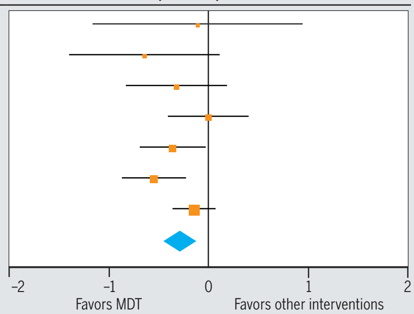
These approaches have yielded similarly modest results, finding statistically insignificant improvements in outcome measures for both the classification-specific and the non–classification-specific groups.[24,61] However, this current review did find a significant difference between patient-matched treatment and generic exercise for disability in the short term for chronic LBP, albeit moderate.

CONCLUSION

There is moderate- to high-quality evidence that MDT is not superior to other rehabilitation interventions for reducing pain and disability in patients with acute LBP. In patients with chronic LBP, there is moderate- to high-quality evidence that MDT is superior to other rehabilitation interventions for reducing pain and disability; however, this depends on the type of intervention being compared to MDT, and the effect sizes were generally considered small to moderate, which means clinical significance needs to be determined. Although some evidence supported the use of MDT for assessing and treating LBP, therapists should be careful when using this approach exclusively, because other treatments have shown similar effectiveness, and a patient's values and preferences should be considered. ◉

A

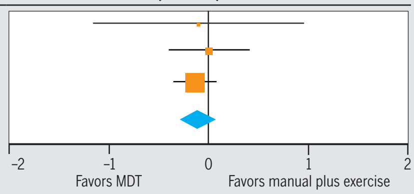
Study	Weight	SMD IV, Random (95% CI)
Moncelon and Otero[40]	2.3%	−0.11 (−1.16, 0.94)
Miller et al[38]	4.4%	−0.64 (−1.39, 0.11)
Halliday et al[22]	9.1%	−0.32 (−0.82, 0.18)
Paatelma et al[45]	13.4%	0.00 (−0.40, 0.40)
Garcia et al[17]	18.5%	−0.36 (−0.68, −0.03)
Long et al[31]	19.3%	−0.55 (−0.86, −0.23)
Petersen et al[47]	33.0%	−0.14 (−0.35, 0.07)
Total	100.0%	−0.28 (−0.44, −0.12)



Heterogeneity: τ^2 = 0.01, χ^2 = 7.44, df = 6 (P = .28), I^2 = 19%.
Test for overall effect: z = 3.38 (P = .0007).

B

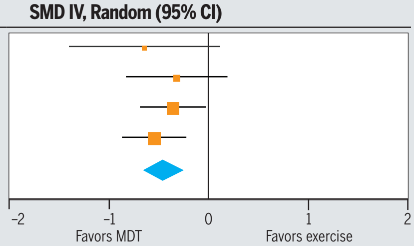
Study	Weight	SMD IV, Random (95% CI)
Moncelon and Otero[40]	3.0%	−0.11 (−1.16, 0.94)
Paatelma et al[45]	21.0%	0.00 (−0.40, 0.40)
Petersen et al[47]	76.0%	−0.14 (−0.35, 0.07)
Total	100.0%	−0.11 (−0.29, 0.07)



Heterogeneity: τ^2 = 0.00, χ^2 = 0.38, df = 3 (P = .83), I^2 = 0%.
Test for overall effect: z = 1.20 (P = .23).

C

Study	Weight	SMD IV, Random (95% CI)
Miller et al[38]	7.0%	−0.64 (−1.39, 0.11)
Halliday et al[22]	15.7%	−0.32 (−0.82, 0.18)
Garcia et al[17]	37.5%	−0.36 (−0.68, −0.03)
Long et al[31]	39.7%	−0.55 (−0.64, −0.25)
Total	100.0%	−0.45 (−0.86, −0.23)



Heterogeneity: τ^2 = 0.00, χ^2 = 1.18, df = 3 (P = .76), I^2 = 0%.
Test for overall effect: z = 4.39 (P<.0001).

FIGURE 5. Forest plot of the effectiveness of MDT for improving disability in patients with chronic low back pain in comparison to (A) other physical therapy interventions, (B) a combination of manual therapy with exercise, and (C) exercise. The other physical therapy interventions included either a combination of manual therapy with exercise or exercise alone. Abbreviations: CI, confidence interval; IV, independent variable; MDT, Mechanical Diagnosis and Therapy; SMD, standardized mean difference.

KEY POINTS

FINDINGS: For reducing pain and disability in patients with acute low back pain (LBP), the McKenzie Method of Mechanical Diagnosis and Therapy (MDT) is not superior to other rehabilitation interventions. In patients with chronic LBP, however, MDT is superior to other rehabilitation interventions for reducing pain and disability; however, this depends on the type of intervention being compared to MDT. The treatment effect for MDT was generally small to moderate.

IMPLICATIONS: To treat patients with LBP, MDT may be used, although other intervention methods might offer a similar benefit.

CAUTION: Although statistically significant, clinical significance of MDT effects needs to be determined because the effect sizes found were small to moderate.

ACKNOWLEDGMENTS: *Jose Correa and Joe Ornelas provided advice on statistics. Jill Boruff provided assistance with developing the literature search.*

REFERENCES

1. Bonnet F, Monnet S, Otero J. Short-term effects of treatment according to "directional preference" of low back pain: a randomized controlled trial. *Kinésithér Rev*. 2011;11:51-59. https://doi.org/10.1016/S1779-0123(11)75100-2
2. Browder DA, Childs JD, Cleland JA, Fritz JM. Effectiveness of an extension-oriented treatment

approach in a subgroup of subjects with low back pain: a randomized clinical trial. *Phys Ther*. 2007;87:1608-1618. https://doi.org/10.2522/ptj.20060297

3. Cherkin DC, Deyo RA, Battie M, Street J, Barlow W. A comparison of physical therapy, chiropractic manipulation, and provision of an educational booklet for the treatment of patients with low back pain. *N Engl J Med*. 1998;339:1021-1029. https://doi.org/10.1056/NEJM199810083391502
4. Chou R, Qaseem A, Snow V, et al. Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. *Ann Intern Med*. 2007;147:478-491. https://doi.org/10.7326/0003-4819-147-7-200710020-00006
5. Delitto A, Cibulka MT, Erhard RE, Bowling RW, Tenhula JA. Evidence for use of an extension-mobilization category in acute low back syndrome: a prescriptive validation pilot study. *Phys Ther*. 1993;73:216-222. https://doi.org/10.1093/ptj/73.4.216
6. Delitto A, George SZ, Van Dillen LR, et al. Low back pain. *J Orthop Sports Phys Ther*. 2012;42:A1-A57. https://doi.org/10.2519/jospt.2012.0301
7. de Morton NA. The PEDro scale is a valid measure of the methodological quality of clinical trials: a demographic study. *Aust J Physiother*. 2009;55:129-133. https://doi.org/10.1016/S0004-9514(09)70043-1
8. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7:177-188. https://doi.org/10.1016/0197-2456(86)90046-2
9. Dettori JR, Bullock SH, Sutlive TG, Franklin RJ, Patience T. The effects of spinal flexion and extension exercises and their associated postures in patients with acute low back pain. *Spine (Phila Pa 1976)*. 1995;20:2303-2312.
10. Deutscher D, Werneke MW, Gottlieb D, Fritz JM, Resnik L. Physical therapists' level of McKenzie education, functional outcomes, and utilization in patients with low back pain. *J Orthop Sports Phys Ther*. 2014;44:925-936. https://doi.org/10.2519/jospt.2014.5272
11. Elnaggar IM, Nordin M, Sheikhzadeh A, Parnianpour M, Kahanovitz N. Effects of spinal flexion and extension exercises on low-back pain and spinal mobility in chronic mechanical low-back pain patients. *Spine (Phila Pa 1976)*. 1991;16:967-972. https://doi.org/10.1097/00007632-199108000-00018
12. Erhard RE, Delitto A, Cibulka MT. Relative effectiveness of an extension program and a combined program of manipulation and flexion and extension exercises in patients with acute low back syndrome. *Phys Ther*. 1994;74:1093-1100. https://doi.org/10.1093/ptj/74.12.1093
13. Fritz J. Disentangling classification systems from their individual categories and the category-specific criteria: an essential consideration to evaluate clinical utility. *J Man Manip Ther*. 2010;18:205-208. https://doi.org/10.1179/106698110X12804993427162
14. Fritz JM, Brennan GP. Preliminary examination of a proposed treatment-based classification system for patients receiving physical therapy interventions for neck pain. *Phys Ther*. 2007;87:513-524. https://doi.org/10.2522/ptj.20060192
15. Fritz JM, Delitto A, Erhard RE. Comparison of classification-based physical therapy with therapy based on clinical practice guidelines for patients with acute low back pain: a randomized clinical trial. *Spine (Phila Pa 1976)*. 2003;28:1363-1371; discussion 1372. https://doi.org/10.1097/01.BRS.0000067115.61673.FF
16. Furlan AD, Pennick V, Bombardier C, van Tulder M. 2009 updated method guidelines for systematic reviews in the Cochrane Back Review Group. *Spine (Phila Pa 1976)*. 2009;34:1929-1941. https://doi.org/10.1097/BRS.0b013e3181b1c99f
17. Garcia AN, Costa LC, da Silva TM, et al. Effectiveness of back school versus McKenzie exercises in patients with chronic nonspecific low back pain: a randomized controlled trial. *Phys Ther*. 2013;93:729-747. https://doi.org/10.2522/ptj.20120414
18. Garcia AN, Costa LC, Hancock MJ, et al. McKenzie Method of Mechanical Diagnosis and Therapy was slightly more effective than placebo for pain, but not for disability, in patients with chronic non-specific low back pain: a randomised placebo controlled trial with short and longer term follow-up. *Br J Sports Med*. In press. https://doi.org/10.1136/bjsports-2016-097327
19. Giesecke T, Gracely RH, Grant MA, et al. Evidence of augmented central pain processing in idiopathic chronic low back pain. *Arthritis Rheum*. 2004;50:613-623. https://doi.org/10.1002/art.20063
20. Gillan MG, Ross JC, McLean IP, Porter RW. The natural history of trunk list, its associated disability and the influence of McKenzie management. *Eur Spine J*. 1998;7:480-483. https://doi.org/10.1007/s005860050111
21. Hagg O, Fritzell P, Nordwall A. The clinical importance of changes in outcome scores after treatment for chronic low back pain. *Eur Spine J*. 2003;12:12-20. https://doi.org/10.1007/s00586-002-0464-0
22. Halliday MH, Pappas E, Hancock MJ, et al. A randomized controlled trial comparing the McKenzie method to motor control exercises in people with chronic low back pain and a directional preference. *J Orthop Sports Phys Ther*. 2016;46:514-522. https://doi.org/10.2519/jospt.2016.6379
23. Hefford C. McKenzie classification of mechanical spinal pain: profile of syndromes and directions of preference. *Man Ther*. 2008;13:75-81. https://doi.org/10.1016/j.math.2006.08.005
24. Henry SM, Van Dillen LR, Ouellette-Morton RH, et al. Outcomes are not different for patient-matched versus nonmatched treatment in subjects with chronic recurrent low back pain: a randomized clinical trial. *Spine J*. 2014;14:2799-2810. https://doi.org/10.1016/j.spinee.2014.03.024
25. Hoy D, Bain C, Williams G, et al. A systematic review of the global prevalence of low back pain. *Arthritis Rheum*. 2012;64:2028-2037. https://doi.org/10.1002/art.34347
26. Hoy D, March L, Brooks P, et al. The global burden of low back pain: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis*. 2014;73:968-974. https://doi.org/10.1136/annrheumdis-2013-204428
27. Karayannis NV, Jull GA, Hodges PW. Physiotherapy movement based classification approaches to low back pain: comparison of subgroups through review and developer/expert survey. *BMC Musculoskelet Disord*. 2012;13:24. https://doi.org/10.1186/1471-2474-13-24
28. Kilpikoski S, Airaksinen O, Kankaanpaa M, Leminen P, Videman T, Alen M. Interexaminer reliability of low back pain assessment using the McKenzie method. *Spine (Phila Pa 1976)*. 2002;27:E207-E214. https://doi.org/10.1097/00007632-200204150-00016
29. Koes BW, van Tulder MW, Ostelo R, Kim Burton A, Waddell G. Clinical guidelines for the management of low back pain in primary care: an international comparison. *Spine (Phila Pa 1976)*. 2001;26:2504-2513. https://doi.org/10.1097/00007632-200111150-00022
30. Krause P, Forderreuther S, Straube A. TMS motor cortical brain mapping in patients with complex regional pain syndrome type I. *Clin Neurophysiol*. 2006;117:169-176. https://doi.org/10.1016/j.clinph.2005.09.012
31. Long A, Donelson R, Fung T. Does it matter which exercise? A randomized control trial of exercise for low back pain. *Spine (Phila Pa 1976)*. 2004;29:2593-2602. https://doi.org/10.1097/01.brs.0000146464.23007.2a
32. Machado LA, de Souza M, Ferreira PH, Ferreira ML. The McKenzie method for low back pain: a systematic review of the literature with a meta-analysis approach. *Spine (Phila Pa 1976)*. 2006;31:E254-E262. https://doi.org/10.1097/01.brs.0000214884.18502.93
33. Machado LA, Maher CG, Herbert RD, Clare H, McAuley JH. The effectiveness of the McKenzie method in addition to first-line care for acute low back pain: a randomized controlled trial. *BMC Med*. 2010;8:10. https://doi.org/10.1186/1741-7015-8-10
34. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. *Phys Ther*. 2003;83:713-721. https://doi.org/10.1093/ptj/83.8.713
35. Malmivaara A, Häkkinen U, Aro T, et al. The treatment of acute low back pain—bed rest, exercises, or ordinary activity? *N Engl J Med*. 1995;332:351-355. https://doi.org/10.1056/NEJM199502093320602
36. McKenzie R, May S. *The Lumbar Spine: Mechanical Diagnosis and Therapy*. 2nd ed. Wellington, New Zealand: Spinal Publications; 2003.
37. Menezes Costa LC, Maher CG, Hancock MJ, McAuley JH, Herbert RD, Costa LO. The prognosis of acute and persistent low-back pain: a meta-

analysis. *CMAJ*. 2012;184:E613-E624. https://doi.org/10.1503/cmaj.111271

38. Miller ER, Schnek RJ, Karnes JL, Rousselle J. A comparison of the McKenzie approach to a specific spine stabilization program for chronic low back pain. *J Man Manip Ther*. 2005;13:103-112. https://doi.org/10.1179/106698105790824996
39. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med*. 2009;151:264-269. https://doi.org/10.1371/journal.pmed.1000097
40. Moncelon S, Otero J. The McKenzie Method of Mechanical Diagnosis and Therapy in chronic low back pain with directional preference. *Kinésithér Rev*. 2015;15:31-37. https://doi.org/10.1016/j.kine.2014.11.086
41. Murtezani A, Govori V, Meka VS, Ibraimi Z, Rrecaj S, Gashi S. A comparison of McKenzie therapy with electrophysical agents for the treatment of work related low back pain: a randomized controlled trial. *J Back Musculoskelet Rehabil*. 2015;28:247-253. https://doi.org/10.3233/BMR-140511
42. Murtezani A, Hundozi H, Orovcanec N, Sllamniku S, Osmani T. A comparison of high intensity aerobic exercise and passive modalities for the treatment of workers with chronic low back pain: a randomized, controlled trial. *Eur J Phys Rehabil Med*. 2011;47:359-366.
43. NICE-Guidelines. Managing low back pain and sciatica - NICE Pathways. *Br Med J*. 2004;329:571.
44. Nijs J, Torres-Cueco R, van Wilgen CP, et al. Applying modern pain neuroscience in clinical practice: criteria for the classification of central sensitization pain. *Pain Physician*. 2014;17:447-457.
45. Paatelma M, Kilpikoski S, Simonen R, Heinonen A, Alen M, Videman T. Orthopaedic manual therapy, McKenzie method or advice only for low back pain in working adults: a randomized controlled trial with one year follow-up. *J Rehabil Med*. 2008;40:858-863. https://doi.org/10.2340/16501977-0262
46. Petersen T, Kryger P, Ekdahl C, Olsen S, Jacobsen S. The effect of McKenzie therapy as compared with that of intensive strengthening training for the treatment of patients with subacute or chronic low back pain: a randomized controlled trial. *Spine (Phila Pa 1976)*. 2002;27:1702-1709. https://doi.org/10.1097/00007632-200208150-00004
47. Petersen T, Larsen K, Nordsteen J, Olsen S, Fournier G, Jacobsen S. The McKenzie method compared with manipulation when used adjunctive to information and advice in low back pain patients presenting with centralization or peripheralization: a randomized controlled trial. *Spine (Phila Pa 1976)*. 2011;36:1999-2010. https://doi.org/10.1097/BRS.0b013e318201ee8e
48. Rahimi A, Vazini H, Alhani F, Anoosheh M. Relationship between low back pain with quality of life, depression, anxiety and stress among emergency medical technicians. *Trauma Mon*. 2015;20:e18686. https://doi.org/10.5812/traumamon.18686
49. Razmjou H, Kramer JF, Yamada R. Intertester reliability of the McKenzie evaluation in assessing patients with mechanical low-back pain. *J Orthop Sports Phys Ther*. 2000;30:368-383; discussion 384-389. https://doi.org/10.2519/jospt.2000.30.7.368
50. Rosedale R, Rastogi R, May S, et al. Efficacy of exercise intervention as determined by the McKenzie system of Mechanical Diagnosis and Therapy for knee osteoarthritis: a randomized controlled trial. *J Orthop Sports Phys Ther*. 2014;44:173-181. https://doi.org/10.2519/jospt.2014.4791
51. Roussel NA, Nijs J, Meeus M, Mylius V, Fayt C, Oostendorp R. Central sensitization and altered central pain processing in chronic low back pain: fact or myth? *Clin J Pain*. 2013;29:625-638. https://doi.org/10.1097/AJP.0b013e31826f9a71
52. Rubin DI. Epidemiology and risk factors for spine pain. *Neurol Clin*. 2007;25:353-371. https://doi.org/10.1016/j.ncl.2007.01.004
53. Sakai Y, Matsuyama Y, Nakamura H, et al. The effect of muscle relaxant on the paraspinal muscle blood flow: a randomized controlled trial in patients with chronic low back pain. *Spine (Phila Pa 1976)*. 2008;33:581-587. https://doi.org/10.1097/BRS.0b013e318166e051
54. Schenk R, Dionne C, Simon C, Johnson R. Effectiveness of mechanical diagnosis and therapy in patients with back pain who meet a clinical prediction rule for spinal manipulation. *J Man Manip Ther*. 2012;20:43-49. https://doi.org/10.1179/2042618611Y.0000000017
55. Schenk R, Jozefczyk C, Kopf A. A randomized trial comparing interventions in patients with lumbar posterior derangement. *J Man Manip Ther*. 2013;11:95-102. https://doi.org/10.1179/106698103790826455
56. Sheeran L, van Deursen R, Caterson B, Sparkes V. Classification-guided versus generalized postural intervention in subgroups of nonspecific chronic low back pain: a pragmatic randomized controlled study. *Spine (Phila Pa 1976)*. 2013;38:1613-1625. https://doi.org/10.1097/BRS.0b013e31829e049b
57. Stankovic R, Johnell O. Conservative treatment of acute low-back pain. A prospective randomized trial: McKenzie method of treatment versus patient education in "mini back school". *Spine (Phila Pa 1976)*. 1990;15:120-123.
58. Stanton TR, Fritz JM, Hancock MJ, et al. Evaluation of a treatment-based classification algorithm for low back pain: a cross-sectional study. *Phys Ther*. 2011;91:496-509. https://doi.org/10.2522/ptj.20100272
59. Stanton TR, Hancock MJ, Apeldoorn AT, Wand BM, Fritz JM. What characterizes people who have an unclear classification using a treatment-based classification algorithm for low back pain? A cross-sectional study. *Phys Ther*. 2013;93:345-355. https://doi.org/10.2522/ptj.20120263
60. Underwood MR, Morgan J. The use of a back class teaching extension exercises in the treatment of acute low back pain in primary care. *Fam Pract*. 1998;15:9-15. https://doi.org/10.1093/fampra/15.1.9
61. Van Dillen LR, Norton BJ, Sahrmann SA, et al. Efficacy of classification-specific treatment and adherence on outcomes in people with chronic low back pain. A one-year follow-up, prospective, randomized, controlled clinical trial. *Man Ther*. 2016;24:52-64. https://doi.org/10.1016/j.math.2016.04.003
62. Vos T, Allen C, Arora M, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet*. 2016;388:1545-1602. https://doi.org/10.1016/S0140-6736(16)31678-6
63. Wan X, Wang W, Liu J, Tong T. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. *BMC Med Res Methodol*. 2014;14:135. https://doi.org/10.1186/1471-2288-14-135
64. Werneke M, Hart DL, Cook D. A descriptive study of the centralization phenomenon. A prospective analysis. *Spine (Phila Pa 1976)*. 1999;24:676-683. https://doi.org/10.1097/00007632-199904010-00012
65. Werneke MW, Deutscher D, Hart DL, et al. McKenzie lumbar classification: inter-rater agreement by physical therapists with different levels of formal McKenzie postgraduate training. *Spine (Phila Pa 1976)*. 2014;39:E182-E190. https://doi.org/10.1097/BRS.0000000000000117
66. Werneke MW, Hart DL, Resnik L, Stratford PW, Reyes A. Centralization: prevalence and effect on treatment outcomes using a standardized operational definition and measurement method. *J Orthop Sports Phys Ther*. 2008;38:116-125. https://doi.org/10.2519/jospt.2008.2596
67. Whitehead A. *Meta-Analysis of Controlled Clinical Trials*. Chichester, UK: John Wiley; 2002.
68. Yamada K, Matsudaira K, Imano H, Kitamura A, Iso H. Influence of work-related psychosocial factors on the prevalence of chronic pain and quality of life in patients with chronic pain. *BMJ Open*. 2016;6:e010356. https://doi.org/10.1136/bmjopen-2015-010356

APPENDIX

EXAMPLE OF A SEARCH CONDUCTED ON MEDLINE

Search String 1	Search String 2	Search String 3
1. McKenzie therap*.mp.	13. Low Back Pain/	34. randomized controlled trial.pt.
2. McKenzie method*.mp.	14. (low* back adj2 pain*).mp.	35. controlled clinical trial.pt.
3. McKenzie treatment*.mp.	15. lumbar pain.mp.	36. RCT.ti,ab.
4. McKenzie exerci*.mp.	16. lumbar strain.ti,ab.	37. random*.ti,ab.
5. centralization.mp.	17. lumbar sprain.ti,ab.	38. placebo.ti,ab.
6. extension exercise*.mp.	18. Back Pain/	39. trial.ti,ab.
7. flexion exercise*.mp.	19. (backache* or back ache*).ti,ab.	40. groups.ti,ab.
8. "mechanical diagnosis and therapy".mp.	20. discogenic pain.ti,ab.	41. or/34-40
9. MDT.mp.	21. dorsalgia.ti,ab.	
10. directional preference*.mp.	22. coccydynia.ti,ab.	
11. active therap*.mp.	23. Sciatica/	
12. or/1-11	24. sciatica.ti,ab.	
	25. Sciatic Neuropathy/	
	26. sciatic neuropath*.ti,ab.	
	27. Spondylosis/	
	28. spondylosis.ti,ab.	
	29. Spondylolysis/	
	30. spondylolysis.ti,ab.	
	31. Spondylolysthesis.ti,ab.	
	32. lumbago.ti,ab.	
	33. or/13-32	