SUPPLEMENTARY APPENDICES

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Pourahmadi M, *et al. Br J Sports Med* 2022;0:1–13. doi: 10.1136/bjsports-2021-104926

APPENDIX I: Search terms and strategies, and list of excluded articles

Search strategy for PubMed/Medline (NLM)

Last searched April 30, 2021

((("Radiculopathy"[Mesh] OR Radiculopathy[TIAB] OR Radiculitis[TIAB] OR Radiculitides[TIAB] OR nerve[TIAB] OR neutral[TIAB] OR nervi[tiab]) AND (root[tiab] OR radix[tiab]) AND (disorder*[tiab] OR Inflammation[tiab])) OR (("Intervertebral Disc"[Mesh] OR Disc*[tiab] OR DISK*[TIAB] OR vertebra*[TIAB] OR Intervertebr*[TIAB]) AND (hernia*[tiab] OR "Hernia"[Mesh] OR Degenerat*[TIAB] OR Degradation*[TIAB] OR disorder*[tiab] OR Slipped[TIAB] OR Prolapse*[TIAB] OR Displacement[TIAB])) OR Discitis[TIAB] OR Discitides[TIAB] OR Diskitis[TIAB] OR Diskitides[TIAB] OR Spondylodiskitis[TIAB] OR Spondylodiskitides[TIAB] OR Spondylodiscitis[TIAB] OR Spondylodiscitides[tiab] OR OR (nucleus[TIAB] AND pulposus[TIAB] AND hernia [tiab]) OR "Intervertebral Disc Displacement"[Mesh] OR "Intervertebral Disc Degeneration"[Mesh] OR "Intervertebral disc disease"[Supplementary Concept] OR "Diskectomy"[Mesh] OR Diskectomies[tiab] OR Discectomy[tiab] OR Discectomies[tiab] OR Diskectomy[TIAB] OR "Sciatica"[Mesh] OR Sciatic*[tiab] OR ischias[tiab] OR ischiatic[tiab] OR discospondylitis[TIAB] OR diskospondylitis[TIAB] OR discospondylitis[TIAB] OR diskospondylitis[TIAB] OR spondylodiskitis[TIAB]) AND ((motor [tiab] AND control [tiab] AND training[tiab]) OR "Exercise"[Mesh] OR exercise*[tiab] OR stabilization[TIAB] OR stabilisation[TIAB] OR stability [tiab] OR multifidi*[TIAB] OR multifidus[tiab] OR transversus[tiab] OR "Exercise Movement Techniques"[Mesh] OR (Pilate*[tiab] AND (Exercise*[tiab] OR Training[tiab])) OR Rehab*[tiab] OR "Rehabilitation"[Mesh] OR habilitat*[TIAB])AND ("Randomized Controlled Trials as Topic"[Mesh] OR RCT[tiab] OR Trial*[tiab] OR "Clinical Trials as Topic"[Mesh] OR "Clinical Trial" [Publication Type] OR RANDOM*[TIAB])

ARTICLE TYPE: clinical trial, randomized controlled trial

Search strategy for WEB OF SCIENCE (WoS)

Last searched April 30, 2021

Ts=((((("Radiculopathy" OR Radiculopathy OR Radiculitis OR Radiculitides OR nerve OR neutral OR nervi) AND (root OR radix) AND (disorders OR Inflammation)) OR (("Intervertebral Disc" OR Disc* OR DISK* OR vertebra* OR Intervertebr*) AND (hernia* OR "Hernia" OR Degenerat* OR Degradation* OR disorder OR disorders OR Inflammation OR infection* OR Slipped OR Prolapse* OR Displacement)) OR Discitis OR Discitides OR Diskitis OR Diskitides OR Spondylodiskitis OR Spondylodiskitides OR Spondylodiscitis OR Spondylodiscitides OR (nucleus AND pulposus AND hernia) OR "Intervertebral Disc Displacement" OR "Intervertebral Disc Degeneration" OR "Intervertebral disc disease" OR "Diskectomy" OR Diskectomies OR Discectomy OR Discectomies OR Diskectomy OR "Sciatica" OR Sciatic* OR ischias OR ischiatic OR discospondylitis OR diskospondylitis OR discospondylitis OR diskospondylitis OR spondylodiskitis) AND ((motor AND control AND training) OR "Exercise" OR exercise* OR stabilization OR stabilisation OR stability OR multifidi* OR multifidus OR transversus OR "Exercise Movement Techniques" OR (Pilate* AND (Exercise* OR Training)) OR Rehab* OR "Rehabilitation" OR habilitat*) AND ("Randomized Controlled Trials as Topic" OR RCT OR Trial* OR "Clinical Trials as Topic" OR "Clinical Trial" OR RANDOM*))

Document Types: Article

Search strategy for Scopus

Last searched April 30, 2021

TITLE-ABS-KEY (((("Radiculopathy" OR radiculopathy OR radiculitis OR radiculitides OR nerve OR neutral OR nervi) AND (root OR radix) AND (disorders OR inflammation)) OR (("Intervertebral Disc" OR disc* OR disk* OR vertebra* OR intervertebr*) AND (hernia* OR "Hernia" OR degenerat* OR degradation* OR disorder OR disorders OR inflammation OR infection* OR slipped OR prolapse* OR displacement)) OR discitis OR discitides OR diskitis OR diskitides OR spondylodiskitis OR spondylodiskitides OR spondylodiscitis OR spondylodiscitides OR (nucleus AND pulposus AND hernia) OR "Intervertebral Disc Displacement" OR "Intervertebral Disc Degeneration" OR "Intervertebral disc disease" OR "Diskectomy" OR diskectomies OR discectomy OR discectomies OR diskectomy OR "Sciatica" OR sciatic* OR ischias OR ischiatic OR discospondylitis OR diskospondylitis OR discospondylitis OR diskospondylitis OR spondylodiskitis) AND ((motor AND control AND training) OR "Exercise" OR exercise* OR stabilization OR stabilisation OR stability OR multifidi* OR multifidus OR transversus OR "Exercise Movement Techniques" OR (pilate* AND (exercise* OR training)) OR rehab* OR "Rehabilitation" OR habilitat*) AND ("Randomized Controlled Trials as Topic" OR rct OR trial* OR "Clinical Trials as Topic" OR "Clinical Trial" OR random*))

Document Type: Article

Source Type: Journal

Search strategy for Embase®

Last searched April 30, 2021

(('radiculopathy'/exp OR radiculopathy OR 'radiculitis'/exp OR radiculitis OR radiculitides OR 'nerve'/exp OR nerve OR 'neutral'/exp OR neutral OR nervi) AND ('root'/exp OR root OR radix) AND ('disorder'/exp OR disorder* OR 'disorders'/exp OR 'inflammation'/exp OR inflammation OR (intervertebral AND disc) OR discs* OR 'disk'/exp OR disk* OR vertebra* OR intervertebr*) AND (hernia* OR 'hernia'/exp OR hernia OR 'disorder'/exp OR disorder OR 'disorders'/exp OR disorders OR 'inflammation'/exp OR inflammation OR infection* OR slipped OR prolapse* OR 'displacement'/exp OR displacement) OR 'discitis'/exp OR discitis OR discitides OR 'diskitis'/exp OR diskitis OR diskitides OR spondylodiskitis OR spondylodiskitides OR spondylodiscitis OR spondylodiscitides OR (('nucleus'/exp OR nucleus) AND pulposus AND ('hernia'/exp OR hernia)) OR 'intervertebral disc displacement'/exp OR 'intervertebral disc displacement' OR 'intervertebral disc degeneration'/exp OR 'intervertebral disc degeneration' OR 'intervertebral disc disease'/exp OR 'intervertebral disc disease' OR 'diskectomy' OR diskectomies OR 'discectomy'/exp OR discectomy OR discectomies OR 'diskectomy'/exp OR diskectomy OR 'sciatica'/exp OR 'sciatica' OR sciatic* OR 'ischias'/exp OR ischias OR ischiatic OR 'discospondylitis'/exp OR discospondylitis OR 'diskospondylitis'/exp OR diskospondylitis OR 'spondylodiskitis'/exp OR spondylodiskitis) AND (('motor'/exp OR motor) AND ('control'/exp OR control) AND ('training'/exp OR training) OR 'exercise'/exp OR 'exercise' OR exercise* OR 'stabilization'/exp OR stabilization OR 'stability'/exp OR stability OR multifidi* OR multifidus OR transversus OR 'exercise movement techniques'/exp OR 'exercise movement techniques' OR (pilate* AND exercise*or AND ('training'/exp OR training)) OR rehab* OR 'rehabilitation'/exp OR 'rehabilitation' OR habilitat*) AND (randomized:ti,ab,kw AND controlled:ti,ab,kw AND trials:ti,ab,kw AND as:ti,ab,kw AND topic:ti,ab,kw OR rct:ti,ab,kw OR trial*:ti,ab,kw OR 'clinical trials as topic':ti,ab,kw OR 'clinical trial':ti,ab,kw OR random*:ti,ab,kw)

Study type: controlled trial, randomized controlled trial, major clinical trial, clinical trial, randomized controlled trial topic, controlled clinical trial, clinical trial topic

Publication types: Article

Search strategy for EBSCO (SPORTDiscus, CINAHL)

Last searched April 30, 2021

((((Radiculopathy OR Radiculitis OR Radiculitides OR nerve OR neutral OR nervi) AND (root OR radix) AND (disorder* OR Inflammation) OR ((Intervertebral Disc OR Disc* OR DISK* OR vertebra* OR Intervertebr*) AND (hernia* OR Hernia OR Degenerat* OR Degradation* OR disorder OR disorders OR Inflammation OR Slipped OR Prolapse* OR Displacement)) OR Discitis OR Discitides OR Diskitis OR Diskitides OR Spondylodiskitis OR Spondylodiskitides OR Spondylodiscitides OR spondylodiscitis OR (nucleus AND pulposus AND hernia) OR "Diskectomy" OR Diskectomies OR Discectomy OR Discectomies OR Diskectomy OR "Sciatica" OR Sciatic* OR ischias OR ischiatic OR discospondylitis OR diskospondylitis OR discospondylitis OR diskospondylitis OR spondylodiskitis) AND ((motor AND control AND training) OR "Exercise" OR exercise* OR stabilization OR stabilization OR stability OR multifidi* OR multifidus OR transversus OR "Exercise Movement Techniques" OR kinesiotherapy OR (Pilate* AND (Exercise*OR Training)) OR Rehab* OR habilitat*) AND (RCT OR Trial* OR RANDOM*))

Source Types: Academic Journals

Age: adult: 19-44 years

Search strategy for Cochrane

Last searched April 30, 2021

((((Radiculopathy OR Radiculitis OR Radiculitides OR nerve OR neutral OR nervi) AND (root OR radix) AND (disorder OR disorders OR Inflammation)) OR ((Intervertebral Disc OR Disc* OR DISK* OR vertebra* OR Intervertebr*) AND (hernia* OR Hernia OR Degenerat* OR Degradation* OR disorder OR disorders OR Inflammation OR Slipped OR Prolapse* OR Displacement)) OR Discitis OR Discitides OR Diskitis OR Diskitides OR Spondylodiskitis OR Spondylodiskitides OR Spondylodiscitides OR spondylodiscitis OR (nucleus AND pulposus AND hernia) OR "Diskectomy" OR Diskectomies OR Discectomy OR Discectomies OR Diskectomy OR "Sciatica" OR Sciatic* OR ischias OR ischiatic OR (arthritis AND spine) OR (Spine AND Arthritide) OR (vertebra* AND arthritis) OR (vertebra* AND osteo-arthritis) OR (vertebra* AND osteoarthritis) OR (slipped OR vertebra*) OR spondylo-listhesis OR (vertebral* AND sliding) OR discospondylitis OR diskospondylitis OR discospondylitis OR diskospondylitis OR Spondylitis OR spondylodiskitis OR (vertebral AND osteomyelitis) OR (arthrosis AND spine))

AND ((motor AND control AND training) OR "Exercise" OR exercise* OR stabilization OR stabilization OR stability OR multifidi* OR multifidus OR transversus OR "Exercise Movement Techniques" OR kinesiotherapy OR (Pilate* AND (Exercise*OR Training)) OR Rehab* OR habilitat*)

AND (RCT OR Trial* OR RANDOM*))

Search strategy for PEDro

Last searched April 30, 2021. The method section was left blank and the New record since field was used instead of the Published since field

Therapy: strength training

Problem: pain

Body Part: lumbar spine, sacro-iliac joint or pelvis

Method: clinical trial

When Searching: ● Match all search terms (AND)

APPENDIX II: Main data collected from included studies.

Study ID	Reviewer initials	Author	Year	Journal	Ethnicity	Country	Language of paper
Affiliation	Study period	Setting	Participants (non-surgery, surgery)	Level of disc herniation	Sample size	# of females	Mean age
Age range	Mean weight	Mean BMI	Occupation	Sampling method	# treatment weeks	# of sessions	Frequency
Hours/ week	Supervised vs. unsupervised	Clinician (PT, MD, etc.)	Sample size in intervention group (IG)	Sample size in control group (CG)	Additional treatment(s) in IG	Control intervention	Questionnaire used to assess pain
Questionnaire used to assess functional status	Muscle(s) thickness	Measurement tool	Muscle(s) endurance	Endurance measurement	Quality of life tool	Functional test	Return to work
Funding	Conflicts of interest	Mean pain after intervention in IC	SD pain after intervention in IC	Mean pain after intervention in CG	SD pain after intervention in CG	Mean functional status after intervention in IC	SD functional status after intervention in IC
Mean functional status after intervention in CG	SD functional status after intervention in CG	RoB total	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5
Qualification	Follow up (short, intermediate, long)	Study design	Categorization of control intervention (*i.e.*, surgery; other forms of exercises, minimal intervention, self-management, or no intervention; other methods of physical therapy)			Date of extraction	Other notes

eTable 1: List of excluded articles with reasons.

#	Author(s)	Article title	Reason for exclusion
1	Abbott (2010)	Early rehabilitation targeting cognition, behavior, and motor function after lumbar fusion	Less than 50% of total intervention was MCT
2	Abou-Elroos (2017)	Prolonged physiotherapy versus early surgical intervention in patients with lumbar disk herniation: short-term outcomes of clinical randomized trial	Less than 50% of total intervention was MCT
3	Albert and Manniche (2012)	The efficacy of systematic active conservative treatment for patients with severe sciatica: a single-blind, randomized, clinical, controlled trial	Confirmation of LDH was unknown
4	Babur (2011)	Comparing the effectiveness of lumbar stabilization exercises with general spinal exercises in patients with postero-lateral disc herniation (Rawal Medical Journal)	Duplicate publication
5	Babur (2011)	Comparing the effectiveness of lumbar stabilization exercises with general spinal exercises in patients with postero-lateral disc herniation (Indian Journal of Physiotherapy and Occupational Therapy)	Less than 50% of total intervention was MCT
6	Bak (2006)	Strengthening versus sensory motor training in the rehabilitation of patients after lumbar disc surgery: A randomised, controlled clinical trial	Less than 50% of total intervention was MCT
7	Berglund (2018)	Sagittal lumbopelvic alignment in patients with low back pain and the effects of a high-load lifting exercise and individualized low-load motor control exercises—a randomized controlled trial	No patients with LDH were included
8	Boucher (2016)	The effects of an 8-week stabilization exercise program on lumbar movement sense in patients with low back pain	No patients with LDH were included
9	Brox (2003)	Randomized clinical trial of lumbar instrumented fusion and cognitive intervention and exercises in patients with chronic low back pain and disc degeneration	No patients with LDH were included
10	Brox (2010)	Four-year follow-up of surgical versus non-surgical therapy for chronic low back pain	No patients with LDH were included
11	Canbulat (2011)	A rehabilitation protocol for patients with lumbar degenerative disk disease treated with lumbar total disk replacement	Less than 50% of total intervention was MCT
12	Ceccato (2014)	Evaluation of the lumbar *multifidus* in rowers during spinal stabilization exercise	No patients with LDH were included
13	Chen (2015)	Is rehabilitation intervention during hospitalization enough for functional improvements in patients undergoing lumbar decompression surgery? A prospective randomized controlled study	Less than 50% of total intervention was MCT; no patients with LDH were included
14	Chung (2013)	Effects of stabilization exercise using a ball on mutifidus cross-sectional area in patients with chronic low back pain	No patients with LDH were included
15	Danielsen (2000)	Early aggressive exercise for postoperative rehabilitation after discectomy	No detailed description of main intervention
16	Demir (2013)	Spontaneous regression of lumbar disc herniation: conservative treatment in a case with motor deficit	Ineligible design (case report)
17	Demirel (2017)	Regression of lumbar disc herniation by physiotherapy. Does non-surgical spinal decompression therapy make difference? Double-blind randomized controlled trial	Less than 50% of total intervention was MCT
18	Dincer (2007)	Caudal epidural injection versus non-steroidal anti-inflammatory drugs in the treatment of low back pain accompanied with radicular pain	Less than 50% of total intervention was MCT
19	Donaldson (2006)	Comparison of usual surgical advice versus a nonaggravating six-month gym-based exercise rehabilitation program post–lumbar discectomy: results at one-year follow-up	No MCT intervention
20	Donceel (1999)	Return to work after surgery for lumbar disc herniation. A rehabilitation-oriented approach in insurance medicine	No MCT intervention
21	Ebenbichler (2014)	Twelve-year follow-up of a randomized controlled trial of comprehensive physiotherapy following disc herniation operation	No detailed description of main intervention
22	Ebrahimi (2014)	Effect of 8-week core stabilization exercises on low back pain, abdominal and back muscle endurance in patients with chronic low back pain due to disc herniation	Confirmation of LDH was unknown
23	Erdogmus (2007)	Physiotherapy-based rehabilitation following disc herniation operation	Less than 50% of total intervention was MCT
24	Erginousakis (2011)	Comparative prospective randomized study comparing conservative treatment and percutaneous disk decompression for treatment of intervertebral disk herniation	No MCT intervention

25	França (2012)	Lumbar stabilization and transcutaneous electrical nerve stimulation in lumbar disc herniation: preliminary study	It was a poster. However, the main paper was later published in 2019
26	Furunes (2017)	Total disc replacement versus multidisciplinary rehabilitation in patients with chronic low back pain and degenerative discs: 8-year follow-up of a randomized controlled multicenter trial	Less than 50% of total intervention was MCT
27	Ganiyu (2014)	Effects of acupuncture, core-stability exercises, and treadmill walking exercises in treating a patient with postsurgical lumbar disc herniation: a clinical case report	Ineligible design (case report)
28	Gaowgzeh (2019)	Effect of spinal decompression therapy and core stabilization exercises in management of lumbar disc prolapse: A single blind randomized controlled trial	MCT was not the main intervention; furthermore, less than 50% of total intervention was MCT
29	Gulsen and Koz (2019)	Effect of proprioceptif neuromuscular facilitation and lumbar stabilization exercises on muscle strength and muscle endurance in patients with lumbar disc hernia	Confirmation of LDH was unknown
30	Häkkinen (2005)	Effects of home strength training and stretching versus stretching alone after lumbar disk surgery: a randomized study with a 1-year follow-up	MCT was used as a co-intervention
31	Hashemi Javaheri (2011)	The effect of combined therapeutic protocol (exercise therapy and massage) on quality of life in male patients suffering from chronic low back pain due to lumbar disc herniation	Less than 50% of total intervention was MCT
32	Hebert (2014)	Early multimodal rehabilitation following lumbar disc surgery: a randomised clinical trial comparing the effects of two exercise programmes on clinical outcome and lumbar multifidus muscle function	Less than 50% of total intervention was MCT
33	Hellum (2011)	Surgery with disc prosthesis versus rehabilitation in patients with low back pain and degenerative disc: two year follow-up of randomised study	No patients with LDH were included
34	Hosseinifar (2014)	The effect of stabilization exercises on lumbar lordosis in patients with low back pain	No patients with LDH were included
35	Huber (2011)	The effect of early isometric exercises on clinical and neurophysiological parameters in patients with sciatica: An interventional randomized single-blinded study	Confirmation of LDH was unknown
36	Ibrahim (2018)	Motor control exercise and patient education program for low resource rural community dwelling adults with chronic low back pain: a pilot randomized clinical trial	No patients with LDH were included
37	Janssens (2016)	Proprioceptive use and sit-to-stand-to-sit after lumbar microdiscectomy: The effect of surgical approach and early physiotherapy	Less than 50% of total intervention was MCT
38	Johnsen (2013)	Segmental mobility, disc height and patient reported outcomes after surgery for degenerative disc disease: a prospective randomised trial comparing disc replacement and multidisciplinary rehabilitation	No MCT intervention
39	Ju (2012)	Effects of an exercise treatment program on lumbar extensor muscle strength and pain of rehabilitation patients recovering from lumbar disc herniation surgery	No MCT intervention
40	Kang (2016)	Effect of spinal decompression on the lumbar muscle activity and disk height in patients with herniated intervertebral disk	MCT was used as a co-intervention
41	Keller (2004)	Trunk muscle strength, cross-sectional area, and density in patients with chronic low back pain randomized to lumbar fusion or cognitive intervention and exercises	Confirmation of LDH was unknown
42	Khanzadeh (2012)	The effect of combined therapeutic protocol (therapeutic exercises and massage) on the pain and physical performance in men with chronic low back pain due to lumbar disc herniation	Less than 50% of total intervention was MCT
43	Khanzadeh (2020)	The effect of suspension and conventional core stability exercises on characteristics of intervertebral disc and chronic pain in office staff due to lumbar herniated disc	MCT was not the main intervention
44	Kim (2014)	Effects of spinal stabilization exercise on the cross-sectional areas of the lumbar multifidus and psoas major muscles, pain intensity, and lumbar muscle strength of patients with degenerative disc disease	Ineligible design (pre- and post-trial)
45	Kim (2015)	The effects of the CORE programme on pain at rest, movement-induced and secondary pain, active range of motion, and proprioception in female office workers with chronic low back pain: a randomized controlled trial	No patients with LDH were included
46	Kjellby-Wendt (2002)	Results of Early Active Rehabilitation 5–7 Years After Surgical Treatment for Lumbar Disc Herniation	No MCT intervention

47	Kjellby-Wendt (2001)	Early active rehabilitation after surgery for lumbar disc herniation: a prospective, randomized study of psychometric assessment in 50 patients	No MCT intervention
48	Kjellby-Wendt & Styf (1998)	Early active training after lumbar discectomy. A prospective, randomized, and controlled study.	No MCT intervention
49	Kladny (2003)	Evaluation of specific stabilizing exercise in the treatment of low back pain and lumbar disk disease in outpatient rehabilitation	Confirmation of LDH was unknown
50	Krekoukias (2017)	Spinal mobilization vs conventional physiotherapy in the management of chronic low back pain due to spinal disk degeneration: a randomized controlled trial	No patients with LDH were included
51	Kurth (1996)	Treatment of lumbar disc herniation in the second decade of life	No MCT intervention
52	Larivière (2017)	The effects of an 8-week stabilization exercise program on lumbar multifidus muscle thickness and activation as measured with ultrasound imaging in patients with low back pain: an exploratory study	No patients with LDH were included
53	Li (2017)	Influence of core muscle training combined with pain nursing intervention on rehabilitation of middle-aged patients with lumbar disc herniation [Chinese - simplified characters]	It was no accessible online and the authors were able to be contacted
54	Lie & Frey (1999)	Mobilizing or stabilizing exercise in degenerative disk disease in the lumbar region?	No patients with LDH were included
55	Lin (2004)	Effects of therapeutic exercise on postoperative recurrent lumbar disc protrusion [Chinese - simplified characters]	It was no accessible online and the authors were able to be contacted
56	Lin (2004)	Application of satisfaction with treatment in the evaluation of exercise therapy improving lumbar pain elderly patients with lumbar disc herniation [Chinese - simplified characters]	It was no accessible online and the authors were able to be contacted
57	Londhe (2020)	To find the effectiveness of conventional exercise and core stabilization exercises in conditions with specific low back pain	Confirmation of LDH was unknown
58	Luijsterburg (2007)	Physical therapy plus general practitioners' care versus general practitioners' care alone for sciatica: a randomised clinical trial with a 12-month follow-up	No detailed description of main intervention
59	Lurie (2014)	Surgical versus non-operative treatment for lumbar disc herniation: eight-year results for the spine patient outcomes research trial (SPORT)	No MCT intervention
60	McGregor (2010)	Function After Spinal Treatment, Exercise and Rehabilitation (FASTER): Improving the Functional Outcome of Spinal Surgery	It was a protocol
61	McGregor (2011)	ISSLS Prize Winner: Function after spinal treatment, exercise, and rehabilitation (FASTER) A factorial randomized trial to determine whether the functional outcome of spinal surgery can be improved	Less than 50% of total intervention was MCT
62	Marques (2014)	Effect of stabilizing exercises versus tens in fatigue of the lumbar multifidus muscle and the ability to activate the transversus abdominis: a preliminary study	It was a poster. However, the main paper was later published in 2019
63	Ogutluler ozkara (2015)	Effectiveness of physical therapy and rehabilitation programs starting immediately after lumbar disc surgery	No MCT intervention
64	Ojoawo (2017)	Comparative effectiveness of two stabilization exercise positions on pain and functional disability of patients with low back pain	No patients with LDH were included
65	Oosterhuis (2017)	Early rehabilitation after lumbar disc surgery is not effective or cost-effective compared to no referral: a randomised trial and economic evaluation	Less than 50% of total intervention was MCT
66	Paulsen (2019)	Return to work after surgery for lumbar disc herniation, secondary analyses from a randomized controlled trial comparing supervised rehabilitation versus home exercises	No MCT intervention
67	Plaza-Manzano (2020)	Effects of adding a neurodynamic mobilization to motor control training in patients with lumbar radiculopathy due to disc herniation: a randomized clinical trial	MCT was not the main intervention
68	Rushton (2015)	Physiotherapy post lumbar discectomy: prospective feasibility and pilot randomised controlled trial	Less than 50% of total intervention was MCT

69	Sadat Mojtabavi (2020)	The effect of a isometric training protocol on some functional disorders of the lower limb in patients with lumbar disc surgery	No MCT intervention
70	Selkowitz (2006)	The immediate and long-term effects of exercise and patient education on physical, functional, and quality-of-life outcome measures after single-level lumbar microdiscectomy: a randomized controlled trial protocol	It was a protocol and no data were available
71	Suh (2019)	The effect of lumbar stabilization and walking exercises on chronic low back pain: A randomized controlled trial	No patients with LDH were included
72	Unsgaard-Tøndel (2010)	Motor control exercises, sling exercises, and general exercises for patients with chronic low back pain: a randomized controlled trial with 1-year follow-up.	No patients with LDH were included
73	Vad (2007)	The role of the *Back Rx* exercise program in diskogenic low back pain: a prospective randomized trial	Less than 50% of total intervention was MCT
74	Weinert & Rizzo (1992)	Nonoperative management of multilevel lumbar disk herniations in an adolescent athlete	Ineligible design (case report)
75	Weinstein (2006)	Surgical vs nonoperative treatment for lumbar disk herniation the spine patient outcomes research trial (SPORT): A randomized trial	Less than 50% of total intervention was MCT
76	Yazdani (2016)	Effects of six-week exercise training protocol on pain relief in patients with lumbar disc herniation	No MCT intervention

eTable 2: Summary of studies' characteristics in the systematic review of MCT for LDH.

Author	Study design	Population	Types of comparison(s)	Additional treatment in intervention group	Maximum number treatments MCT allowed and duration	Postintervention assessment timepoints
Ahmed et al., 2012	Randomized clinical trial	1- Patients with established diagnosis of disc herniation 2- Patients who have undergone surgery due to postero-lateral herniation Number of patients in final analysis= 60 (19 male and 41 female) Mean age 36.81 ± 5.29 years	Grp 1: Conventional physical therapy	–	?	Immediate post intervention
Bakhtiary et al., 2005	Cross-over trial (after 4 weeks, the study parameters were reversed among the groups)	Patients with lumbar disc herniation Number of patients in final analysis= 60 Age range: 18 to 65 years	Grp 1: No exercise	–	4 sessions over 4 weeks	Immediate post intervention
Bayraktar et al., 2016	Randomized clinical trial	Patients with established diagnosis of disc herniation Number of patients in final analysis= 23 Age range: 18 to 65 years	Grp 1: Water-based MCT	10 min warming up (walking, stretching and basic calisthenics) and 5 min cooling down (stretching and relaxing)	24 sessions over 8 weeks	Immediate post intervention
Brox et al., 2006	Randomized clinical trial	Patients with chronic back pain after previous surgery for disc herniation Number of patients in final analysis= 57 Age range: 25 to 60 years	Grp 1: Lumbar instrumented fusion	Cognitive intervention	5 weeks	1 year post intervention

Demir et al., 2014	Add-on trial	Patients with lumbar microdiscectomy Number of patients in final analysis= 44 (24 male and 20 female) Mean age 41.1 ± 2.69 years	Grp 1: Home exercise The home exercise program prescribed to both groups consisted of stretching, pelvic tilt, flexion and extension strengthening of the abdomen and the trunk, to be conducted in sessions of 45 minutes, once every day, with ten repetitions for each exercise.	Home exercise	12 sessions over 4 weeks	1, 2, and 6 months post intervention
Filiz et al., 2005	Randomized clinical trial	Patients with lumbar disc operation (single level discectomy) Number of patients in final analysis= 60 Mean age 39.88 ± 1.55 years	Grp 1: Classic exercise This group received back education involving basic body mechanics and were taught classical exercises. Moreover, this group learned the McKenzie and Williams exercises in the clinic and later did these exercises at home three days a week. The home exercise programme was followed up by telephoning the patients once a week. Grp 2: No exercise This group were advised to be as active as possible with their daily routines.	Back education programme The patients were informed about the appropriate 'use of body mechanics' for the whole body and they were taught back protection methods (the structure and function of the spine, main causes of low back pain, importance of relaxation and exercises, appropriate standing, sitting, lying down and getting up, sleeping, weight lifting and weight carrying, etc.)	24 sessions over 8 weeks	Immediate post intervention
França et al., 2019	Randomized clinical trial	Patients with disc herniation with associated radiculopathy Number of patients in final analysis= 40 (15 male and 25 female) Mean age 44.95 ± 2.62 years	Grp 1: Transcutaneous electrical nerve stimulation (TENS) Participants in this group used a TENS unit with a frequency of 20 Hz.	–	16 sessions over 8 weeks	Immediate post intervention
Janssens et al., 2012	Randomized clinical trial	Patients with lumbar microdiscectomy	Grp 1: Control intervention (?)	Ergonomic advice	?	2 (baseline), 8 and 24 weeks post surgery

		Number of patients in final analysis= 25 Middle aged patients were recruited.				
Jeong et al., 2017	Randomized clinical trial	Patients with lumbar disc herniation Number of patients in final analysis= 30 Mean age 33.75 ± 2.47 years	Grp 1: Balance center stabilization resistance exercise The balance center stabilization resistance exercise was conducted in the patients for about 15–30 minutes using programs consisting of exercise mixed with core and balance. All participants controlled the handle checking out whether the proper force was delivered through the monitor while exercising on the moving platform.	–	12 sessions over 4 weeks	Immediate post intervention
Johansson et al., 2009	Randomized clinical trial	Patients with first-time lumbar disc surgery Number of patients in final analysis= 57 Age range: 18 to 60 years	Grp 1: Home-based training The programme comprised back and hip mobility, trunk stability, strengthening of back, abdominal and leg muscles, and stretching of back, hamstring, quadriceps femoris and calf muscles. The patients were recommended to continue, and gradually extend, their daily walks and return to their normal daily routines and work as soon as possible. They were given no restrictions apart from heavy lifting during the first 3 months after surgery.	Mobility exercise	8 sessions over 8 weeks	3 and 12 months post intervention
Mannion et al., 2007	Randomized clinical trial	Patients after surgical decompression Number of patients in final analysis= 155 Mean age 64.87 ± 0.76 years	Grp 1; Self-management Patients were advised to keep as active as possible by doing the type of exercise/physical activities they enjoyed and documenting these in a daily exercise diary. They were not given any specific exercises to do, but	–	24 sessions over 12 weeks	Immediate post rehabilitation intervention, 12, and 24 months after operation.

			were told that the project manager was happy to discuss with them their individual needs/give advice if they wished. Grp 2: Physiotherapy using mixed techniques This treatment was administered in accordance with the professional judgment and experience of the treating physiotherapist. Patients were invited to locate the practice that was most convenient for them to attend. Each physiotherapist was allowed the freedom to adopt the treatment that they considered to be most appropriate for the given patient. No attempt was made to standardize this, as the treatment was intended to reflect ''daily practice'', in all its (potential) variety.			
Millisdotter and Strömqvist 2007	Randomized clinical trial	Patients with lumbar disc herniation managed surgically by open or microscopic technique during a 3-year period Number of patients in final analysis= 56 (36 male and 20 female) Mean age 38 ± 1 years	Grp 1: Traditional exercise Participants in this group trained on stabilization exercises mainly using different types of stationary gym equipment and also focused on coordination and mobility.	–	22-26 sessions	6 weeks, 4, and 12 months postoperatively
Ramos et al., 2019	Randomized clinical trial	Patients with lumbar disc herniation Number of patients in final analysis= 29 (15 male and 14 female) Mean age 42.1 ± 1.70 years	Grp 1: Transcutaneous electrical nerve stimulation (TENS) Transcutaneous electrical nerve stimulation current was used for 60 minutes, with a frequency of 20 Hz.	–	16 sessions over 8 weeks	Immediate post intervention
Sparkes et al., 2004	Randomized clinical trial	Patients after surgery for prolapsed intervertebral disc	Grp 1: Mobilization	–	?	3 and 12 months post intervention

		Number of patients in final analysis= 60				
Ye et al., 2015	Randomized clinical trial	Male patients with lumbar disc herniation Number of patients in final analysis= 63 (male) Mean age 23.91 ± 0.38 years	Grp 1: General exercise The general exercise program included stretching exercises of the limbs and spine and strengthening of the abdominal flexor muscles and lumbar extensor muscles. These exercises were adapted to individual patient's needs	10-minute jogging as a warm-up exercise	36 sessions over 12 weeks	Immediate post intervention
Yílmaz et al. 2003	Randomized clinical trial	Patients with lumbar disc herniation managed surgically by microdiscectomy Number of patients in final analysis= 42 (22 male and 20 female) Mean age 43.26 ± 2.53 years	Grp1: Home exercise Flexion and extension (Williams-McKenzie), pelvic tilt and exercises for strengthening abdominal and trunk muscles were demonstrated by a physician and patients received a written outline and description of the exercise programme. Grp 2: No treatment	–	8 weeks	Immediate post intervention

eTable 3. LDH definition of each included study.

#	Author	Inclusion criteria
1	Ahmed et al., 2012	1. Patients with established diagnosis of disc herniation. 2. Patients who have undergone surgery due to postero-lateral herniation are also included in the study.
2	Bakhtiary et al., 2005	Sixty patients with clinically diagnosed herniated lumbar disc at L4-L5 or L5- S1 level, confirmed by MRI or CT scan, participated in this randomized clinical trial study.
3	Bayraktar et al., 2016	The inclusion criteria were as follows: being 18–65 years old, having a diagnosis of protruded disc according to magnetic resonance imaging, getting a referral to physiotherapy by the neurosurgeon and having symptoms such as pain in low back area or radiating to the leg or loss of functional status for at least 3 months.
4	Brox et al., 2006	Patients with chronic low back pain and previous surgery for disc herniation, referred from departments of orthopedic surgery, neurosurgery, and physical medicine and rehabilitation from all regions in Norway during the period 1997–2000, were eligible to participate in the study.
5	Demir et al., 2014	Patients aged between 20-65 years, who received their first ever lumbar disk hernia surgery, and who had sufficient mental functions and language abilities to understand the physiatrist, were included in the study. As a surgical method, microdiscectomy was also among the inclusion criteria. The level of lesion in lumbar microdiscectomy was confirmed radiologically.
6	Filiz et al., 2005	Sixty patients attending the outpatient clinic of the Istanbul Faculty of Medicine, Department of Physical Medicine and Rehabilitation after lumbar disc surgery were included in this study.
7	França et al., 2019	Participants aged 18–60 yrs with LDH diagnosis, associated with both low back and leg pain and diagnosed through MRI or computed tomography (performed by an experienced doctor) were included
8	Janssens et al., 2012	Twenty-five middle-aged subjects after lumbar microdiscectomy were randomly divided into an intervention (PT) (n=12) and control group (n=13).
9	Jeong et al., 2017	A total of 30 patients aged 25–50 years who were diagnosed with lumbar disc herniation (below the protrusion) and visited the medical institutions in Seoul were included. The diagnoses of the 30 patients were verified using magnetic resonance imaging (MRI).
10	Johansson et al., 2009	Patients were eligible for inclusion if they were scheduled for planned (not acute) first-time lumbar disc surgery, were between 18 and 60 years old, and had a lumbar disc herniation confirmed by MRI.
11	Mannion et al., 2007	The inclusion criteria for the study were: diagnosis of degenerative spinal disease (spinal stenosis or lumbar herniated disc) as ascertained from the medical history, clinical examination, conventional radiography and MRI/ CT of the lumbar spine, with an indication for decompression surgery without fusion (if fusion was subsequently deemed necessary, intraoperatively, the patient was excluded from further analysis); failed conservative therapy; willingness to comply with any programme to which randomly assigned, attend for all necessary follow-ups, and complete postal questionnaires; a good understanding of written and spoken German; and aged over 45 years.
12	Millisdotter and Strömqvist 2007	The inclusion criteria for this study specified patients aged 15–50 years, scheduled to undergo surgery for a symptomatic, MRI-verified disc prolapse at L4–L5 or L5–S1.
13	Ramos et al., 2019	Patients with LDH associated with low back pain and diagnosed by magnetic resonance imaging or computed tomography were included. Participants diagnosed only radiologically or with myelography were not eligible to participate in the study because these techniques do not directly visualize disk herniation.
14	Sparkes et al., 2004	60 subjects with single level lumbar disc surgery.
15	Ye et al., 2015	The diagnosis of LDH was confirmed by predominant symptoms in the lower back and leg radicular pain, which are positive signs of straight leg raise testing and nerve root tension, and by magnetic resonance imaging (MRI).
16	Yİlmaz et al. 2003	In this open, prospective and controlled study we examined 42 patients who had undergone microdiscectomy between January and September 1998 in the Neurosurgery Clinics of Sisli Etfal and Taksim Education and Research Hospitals. Lumbar disc herniation was diagnosed using a clinical radiological (MRI) examination in the neurosurgery clinics. Patients were selected and categorized according to our inclusion criteria, as follows: • age between 20 and 60 years

		• undergoing the lumbar disc herniation operation for the first time • being operated on at a single level • being in the first post-operative month • absence of a systemic disease (cardiovascular, infectious and/or metabolic disease that could interrupt exercises) • absence of spinal stability problems (*e.g.*, spondilolysis, spondilolisthesis)

APPENDIX III: Version 2 of the Cochrane risk-of-bias assessment tool for randomized trials

eTable 4. Version 2 of the Cochrane risk-of-bias assessment tool for randomized trials: bias domains, signalling questions, response options, and risk-of-bias judgments [1].

Bias domain and signalling question*	Response options		
	Lower risk of bias	Higher risk of bias	Other
Bias arising from the randomisation process			
1.1 Was the allocation sequence random?	Y/PY	N/PN	NI
1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions?	Y/PY	N/PN	NI
1.3 Did baseline differences between intervention groups suggest a problem with the randomisation process?	N/PN	Y/PY	NI
Risk-of-bias judgment (low/high/some concerns)			
Bias due to deviations from intended interventions			
2.1 Were participants aware of their assigned intervention during the trial?	N/PN	Y/PY	NI
2.2 Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?	N/PN	Y/PY	NI
2.3 If Y/PY/NI to 2.1 or 2.2: Were there deviations from the intended intervention that arose because of the trial context?	N/PN	Y/PY	NA/NI
2.4 If Y/PY/NI to 2.3: Were these deviations likely to have affected the outcome?	N/PN	Y/PY	NA/NI
2.5 If Y/PY to 2.4: Were these deviations from intended intervention balanced between groups?	Y/PY	N/PN	NA/NI
2.6 Was an appropriate analysis used to estimate the effect of assignment to intervention?	Y/PY	N/PN	NI
2.7 If N/PN/NI to 2.6: Was there potential for a substantial impact (on the result) of the failure to analyse participants in the group to which they were randomised?	N/PN	Y/PY	NA/NI
Risk-of-bias judgment (low/high/some concerns)			
Bias due to missing outcome data			
3.1 Were data for this outcome available for all, or nearly all, participants randomised?	Y/PY	N/PN	NI
3.2 If N/PN/NI to 3.1: Is there evidence that the result was not biased by missing outcome data?	Y/PY	N/PN	NA
3.3 If N/PN to 3.2: Could missingness in the outcome depend on its true value?	N/PN	Y/PY	NA/NI
3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value?	N/PN	Y/PY	NA/NI
Risk-of-bias judgment (low/high/some concerns)			
Bias in measurement of the outcome			

4.1 Was the method of measuring the outcome inappropriate?	N/PN	Y/PY	NI
4.2 Could measurement or ascertainment of the outcome have differed between intervention groups?	N/PN	Y/PY	NI
4.3 If N/PN/NI to 4.1 and 4.2: Were outcome assessors aware of the intervention received by study participants?	N/PN	Y/PY	NI
4.4 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by knowledge of intervention received?	N/PN	Y/PY	NA/NI
4.5 If Y/PY/NI to 4.4: Is it likely that assessment of the outcome was influenced by knowledge of intervention received?	N/PN	Y/PY	NA/NI
Risk-of-bias judgment (low/high/some concerns)			
Bias in selection of the reported result			
5.1 Were the data that produced this result analysed in accordance with a prespecified analysis plan that was finalised before unblinded outcome data were available for analysis?	Y/PY	N/PN	NI
Is the numerical result being assessed likely to have been selected, on the basis of the results, from:			
5.2 ... multiple eligible outcome measurements (eg, scales, definitions, time points) within the outcome domain?	N/PN	Y/PY	NI
5.3 ... multiple eligible analyses of the data?	N/PN	Y/PY	NI
Risk-of-bias judgment (low/high/some concerns)			
Overall bias			
Risk-of-bias judgment (low/high/some concerns)			

Abbreviation: Y=yes; PY=probably yes; PN=probably no; N=no; NA=not applicable; NI=no information.
* Signalling questions for bias due to deviations from intended interventions relate to the effect of assignment to intervention.

Reference:

1. Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ*. 2019;366:l4898.

Risk of bias assessment of each included study.

Title: Efficacy of Dynamic Lumbar Stabilization Exercise in Lumbar Microdiscectomy

Authors: Yílmaz *et al.* **Year:** 2003

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	NI	A prospective, randomized, controlled study. Patients were divided randomly into three treatment groups.
	1.2	NI	
	1.3	Y	More than one characteristic variable was not balanced between the two groups (*e.g.,* AGE: G1&G2, G1&G3, WEIGHT G1&G3).
	Total	**High Risk**	
Effect of assignment to intervention	2.1	NI	
	2.2	Y	Exercises were conducted under the supervision of a physiotherapist who instructed the patients initially on an individual basis.
	2.3	NI	
	2.4	NI	
	2.5	NA	
	2.6	Y	All patients were examined twice, once before the exercise program and once 8 weeks later.
	2.7	NA	
	Total	**Some Concern**	
Missing outcome data	3.1	Y	All patients were examined twice, once before the exercise program and once 8 weeks later.
	3.2	NA	
	3.3	NA	
	3.4	NA	
	Total	**Low Risk**	
Measurement of the outcome	4.1	N	VAS, modified Oswestry index (MOI), Beck Depression Scale (BDS), spinal mobility (fingertip–floor distance (FFD), lumbar Schober (LS), modified lumbar Schober (MLS), lumbar extension (LE), lateral flexion (LF) and rotation, weight lifting capacity (by progressive isoinertial lifting evaluation (PILE) test
	4.2	N	
	4.3	NI	
	4.4	NI	
	4.5	NI	
	Total	**High Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	N	See item 4.1, and Tables 2-5.
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

Title: The effect of a muscle stabilisation programme on function and the cross-sectional area of the lumbar multifidus after surgery for prolapsed intervertebral disc

Authors: Sparkes *et al.* **Year:** 2004

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	NI	Randomised, comparative, single blind trial.
	1.2	NI	
	1.3	NI	
	Total	**Some Concern**	
Effect of assignment to intervention	2.1	NI	single blind trial
	2.2	NI	single blind trial
	2.3	NI	
	2.4	NI	
	2.5	NA	
	2.6	NI	
	2.7	NI	
	Total	**High Risk**	
Missing outcome data	3.1	NI	
	3.2	NI	
	3.3	NA	
	3.4	NA	
	Total	**High Risk**	
Measurement of the outcome	4.1	N	The Roland-Morris disability questionnaire, SF36 health questionnaire, visual analogue scale, shuttle walking test, and employment status were recorded.
	4.2	N	Participants were randomised into one of two groups, a muscle stabilisation or a mobilisation programme. Measurements were taken at baseline, 3 and 12 months.
	4.3	NI	
	4.4	NI	
	4.5	NI	
	Total	**High Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	NI	Analysis intentions were not available, or the analysis intentions are not reported in sufficient detail to enable an assessment.
	5.3	PY	Following adjustment for baseline deficit, the difference was 5.9% (confidence interval: 1.5% to 13.4%), which was not statistically significant.
	Total	**High Risk**	
Total	**High Risk**		

Title: The effectiveness of exercise programmes after lumbar disc surgery: a randomized controlled study

Authors: Filiz *et al.* **Year:** 2005

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	NI	The study was planned as a prospective, single- blind, randomized controlled study. The patients were randomly split into three groups.
	1.2	Y	At the beginning of the programme a nurse prepared 60 sheets of opaque paper, which were folded with the treatment being inside and taped from the corners (in order to prevent the drawer being able to see the method) and put in a box. When the patients were admitted into the programme the second physician who would show and apply the exercises drew a sheet, and thus the patients were divided into groups.
	1.3	Y	More than one characteristic variable was not balanced between the two groups (*e.g.,* age Group 1& Group 2, weight Group 1 & Group 2, height Group 1 & Group 2, visual analogue scale).
	Total	**Some Concern**	
Effect of assignment to intervention	2.1	N	See item 1.2.
	2.2	Y	Two different physicians carried out the treatment and evaluation. The physician who did the evaluation (before and after treatment) was blinded to the treatment. When the patients were admitted into the programme the second physician who would show and apply the exercises drew a sheet, and thus the patients were divided into groups.
	2.3	NI	
	2.4	NA	
	2.5	NA	
	2.6	Y	Figure 1. No attrition was occurred.
	2.7	NA	
	Total	**Some Concern**	
Missing outcome data	3.1	Y	Figure 1
	3.2	NA	
	3.3	NA	
	3.4	NA	
	Total	**Low Risk**	
Measurement of the outcome	4.1	N	PILE test, Body (abdominal and back) endurance test, Lumbar Schober, Visual analogue scale (VAS), Modified Oswestry Disability Index (ODI), Low Back Pain Rating Scale, Beck Depression Inventory, return to work
	4.2	N	Patients were evaluated with the following criteria at the beginning and at the end of treatment (treatment lasted eight weeks)
	4.3	N	The physician who did the evaluation (before and after treatment) was blinded to the treatment.
	4.4	NA	
	4.5	NA	
	Total	**Low Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	N	All outcomes were reported in Table 2.
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

Title: Lumbar stabilizing exercises improve activities of daily living in patients with lumbar disc herniation

Authors: Bakhtiary *et al.* **Year:** 2005

Domain	*Signaling questions*	*RoB*	*Evidence*
Randomization process	1.1	Y	A computer-generated randomization list, drawn up by the statistician, was used to randomly assign patients into one of the two exercise groups, thirty patients in each group.
	1.2	Y	The list was given to the physiotherapy department of the Semnan University of Medical Sciences, in a set of sealed numbered envelopes. These were then opened at the reception, when the qualifying patients had signed informed consent and entered the study. The card inside (A or B) indicated the patient's allocation to one of the two exercise groups. This information was then given to the physiotherapist to administer the appropriate intervention.
	1.3	Y	More than one characteristic variable was not balanced between the two groups (*e.g.,* duration of current main complaints (month), pain, track Trunk flexion).
	Total	**Some Concern**	
Effect of assignment to intervention	2.1	NI	
	2.2	Y	The card inside (A or B) indicated the patient's allocation to one of the two exercise groups. This information was then given to the physiotherapist to administer the appropriate intervention. The accuracy of exercise performance at home was regularly controlled by a physiotherapist during each week.
	2.3	NI	
	2.4	NI	
	2.5	NA	
	2.6	Y	An intention to treat analysis was used which involved all patients randomly assigned to their groups.
	2.7	NA	
	Total	**Some Concern**	
Missing outcome data	3.1	N	Three patients from group A and five patients from group B failed to complete the full term of the study but their data has still been included in the analysis. Availability of data < 87%
	3.2	PN	The methods for the correction of bias (intention-to-treat) were not clearly described.
	3.3	NI	
	3.4	NI	
	Total	**High Risk**	
Measurement of the outcome	4.1	N	Visual analogue scale (VAS), the range of trunk flexion (without pain), the range of left and right straight leg raising (SLR) without pain, the time required to complete several daily tasks.
	4.2	N	Table 2.
	4.3	N	The staff who assessed the outcomes were different from the staff administering the LSE protocols, and they were blinded to the exercise groups (A or B).
	4.4	NA	
	4.5	NA	
	Total	**Low Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	N	Table 2.
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

Title: Lumbar instrumented fusion compared with cognitive intervention and exercises in patients with chronic back pain after previous surgery for disc herniation: A prospective randomized controlled study

Authors: Brox *et al.,* **Year:** 2006

Domain	*Signaling questions*	*RoB*	*Evidence*
Randomization process	1.1	Y	Participants were randomly allocated to one of two treatment groups: posterolateral fusion with pedicle fixation or cognitive intervention and exercises. Each eligible patient was assigned an identification number by the randomization central at the University of Bergen.
	1.2	Y	Concealed random allocation was conducted by a computer generated random list.
	1.3	Y	Pre-randomization beliefs/expectancies in non-surgical treatment variable was not balanced between the groups.
	Total	**Some Concern**	
Effect of assignment to intervention	2.1	Y	Because the patients were recruited from all over Norway, most patients stayed at a patient hotel. Three daily workouts were performed: aerobics or outdoor activities, water gymnastics, and individual exercises. Additionally, individual consultations, group lessons, and discussions were given. Groups of patients met with a former participant in the program in order to exchange experiences. This study was a randomized, single blind, clinical trial with prospective assessment before randomization and blinded assessment of the two parallel treatment groups by two independent observers at 1-year follow-up.
	2.2	Y	This study was a randomized, single blind, clinical trial with prospective assessment before randomization and blinded assessment of the two parallel treatment groups by two independent observers at 1-year follow-up.
	2.3	PN	Six patients in the surgery group did not receive the assigned treatment because they changed their mind after having been randomized to lumbar fusion. In addition, one patient died during the follow-up period. Two patients did not receive the assigned treatment because they changed their mind after having been randomized to the cognitive/exercises group. Additionally, two patients from the cognitive/exercises group had lumbar fusion during the follow-up period.
	2.4	NA	
	2.5	NA	
	2.6	Y	A second analysis, which included only the patients who completed the study, paralleled the intention-to-treat analysis.
	2.7	NA	
	Total	**Low Risk**	
Missing outcome data	3.1	Y	Consort diagram & tables 2 & 3.
	3.2	NA	
	3.3	NA	
	3.4	NA	
	Total	**Low Risk**	
Measurement of the outcome	4.1	N	Primary outcome measure was the difference between groups in change in Oswestry Disability Index (ODI) between baseline and 1-year follow-up. Global Back Disability Question and the Prolo Scale, General Function Score (GFS), Hopkins Symptom Check List-25, Waddell's Fear-Avoidance Belief Questionnaire (FABQ), Global Back Disability Question
	4.2	N	Tables 2 & 3.
	4.3	Y	For patient reported outcomes (*e.g.,* back pain, functional status, General Function Score, etc.) the outcome assessor was the study participants which were not blinded. However, fingertip-floor distance was measured by blinded physiotherapists.
	4.4	PY	Individual consultations, group lessons, and discussions were given. Groups of patients met with a former participant in the program in order to exchange experiences. Additionally, for patient reported outcomes (e.g., back pain, functional status, General Function Score, etc.) the outcome assessor was the study participants which were not blinded to the assigned intervention.
	4.5	PN	There was no strong evidence that the study outcomes were influenced by knowledge of intervention received.
	Total	**Some Concern**	
Selection of the reported result	5.1	Y	The primary outcome measure was predefined in the study protocol.
	5.2	N	Tables 2 & 3.
	5.3	N	Multiple regression analysis predicting 1-year follow-up scores on the outcome measure adjusted for baseline scores and gender was used to measure point estimates and confidence intervals for group differences (Tables 2 and 3).
	Total	**Low Risk**	
Total	**Some Concern**		

Title: Early neuromuscular customized training after surgery for lumbar disc herniation: a prospective controlled study

Authors: Millisdotter *et al.* **Year:** 2007

Domain	*Signaling questions*	*RoB*	*Evidence*
Randomization process	1.1	N	The patients were allocated to an early training group (ETG) and a control group (CG), based on geographic habitat
	1.2	NI	
	1.3	Y	Table 1
	Total	**High Risk**	
Effect of assignment to intervention	2.1	NI	
	2.2	Y	The early training program was supervised by one of two previously instructed physiotherapists and focused on feed-forward co-activation of the deep core muscles.
	2.3	N	No group changes occurred.
	2.4	NA	
	2.5	NA	
	2.6	N	Of the 69 patients, 13 did not complete the study…. Thus, 56 patients (20 women and 36 men) participated in the investigation.
	2.7	Y	Missing >5% (~ 18%)
	Total	**High Risk**	
Missing outcome data	3.1	N	Missing >5% (~ 18%)
	3.2	N	No sensitivity analyses or bias correction methods were performed.
	3.3	N	Of the 69 patients, 13 did not complete the study. Six of these patients belonged to the early training group (ETG; two men and four women) and 7 patients to the control group (CG; two men and five women). Two patients in the ETG had repeat surgery, two patients moved to another part of the country after the second control, and two patients refused participation before starting the training. In the CG, one patient had repeat surgery, one patient moved to another part of the country after the second check-up, and five patients could not be motivated for longer-term follow-up evaluation and only attended the first and second check-ups.
	3.4	NA	
	Total	**Low Risk**	
Measurement of the outcome	4.1	N	The visual analog scale (VAS), Roland–Morris disability questionnaire (RMQ), and disability rating index (DRI) were administered by a secretary. The questionnaires were completed by the patients (after verbal instructions) and returned in sealed envelopes. The envelopes were not opened until after completion of the study.
	4.2	N	Tables 1 & 2.
	4.3	NI	
	4.4	NI	
	4.5	NI	
	Total	**High Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	Y	The VAS, RMQ, and DRI
	5.3	Y	The outcome measurements were not analyzed in multiple eligible ways.
	Total	**High Risk**	
Total	**High Risk**		

Title: A randomised controlled trial of post-operative rehabilitation after surgical decompression of the lumbar spine

Authors: Mannion *et al.* **Year:** 2007

Domain	*Signaling questions*	*RoB*	*Evidence*
Randomization process	1.1	Y	Before randomization, patients were pre-stratified by age (<60 years and ‡60 years) and by gender to prevent unequal distributions of these variables among the treatment groups. Using a restricted randomisation procedure (blocks of 12) and a random numbers table prepared in advance by the lead author, patients were assigned to one of three treatment groups.
	1.2	PY	Group assignment took place immediately after inclusion into the study (*i.e.* after informed consent was signed) but was not revealed until after the patient had completed the first post-operative check-up/assessments.
	1.3	Y	More than one characteristic variable was not balanced between the two groups (*e.g.,* previous spine surgery, no. levels operated, no. other musculoskeletal problems, sleep disturbance, general health, and fear avoidance beliefs about physical activity.
	Total	**High Risk**	
Effect of assignment to intervention	2.1	PY	Patients were partly 'blinded', to control for expectation bias, by being informed that the study sought to compare three popular approaches to post-operative rehabilitation, the relative efficacy of which had not yet been established. However, it seems that two other groups were not blinded to the assigned intervention.
	2.2	Y	Physiotherapy with spine stabilisation exercises (PTStabEx): The treatment was administered by physiotherapists specially trained in the concept of spine stabilisation exercises/"muscle balance". Physiotherapy using mixed techniques (PT-Mixed): This treatment was administered in accordance with the professional judgment and experience of the treating physiotherapist. The physiotherapists in both groups completed an ongoing treatment diary for each session and a post-treatment questionnaire enquiring about the main physiotherapeutic concepts and the specific techniques/methods they had used with the given patient. Supervised physiotherapy programme using mixed physiotherapeutic techniques.
	2.3	Y	Figure 1, flowchart
	2.4	Y	
	2.5	N	Figure 1, flowchart
	2.6	Y	Hundred and fifty-nine patients went on to enter the trial and to be included in the intention-to-treat analysis: N = 54 in CONT group; N = 56 in PT-StabEx; N = 49 in PT Mixed.
	2.7	NA	
	Total	**High Risk**	
Missing outcome data	3.1	N	Figure 1, flowchart.
	3.2	NA	
	3.3	NA	
	3.4	NA	
	Total	**Low Risk**	
Measurement of the outcome	4.1	N	Roland–Morris disability questionnaire (RMQ), leg pain, low back pain, all pain scale, pain frequency, psychological distress (ZUNG and MSPQ), fear avoidance beliefs about physical activity, fear avoidance beliefs about work, and pain medication intake.
	4.2	N	
	4.3	NI	Each stage of the study assessment of eligibility, assignment to the treatments, provision of treatment, and functional assessments/administration of questionnaires) was carried out by different groups of professionals.
	4.4	PY	
	4.5	NI	
	Total	High Risk	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	N	Figure 3
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

Title: Clinic-based training in comparison to home-based training after first-time lumbar disc surgery: a randomised controlled trial

Authors: Johansson *et al.* **Year:** 2009

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	Y	The patients were consecutively randomised to clinic- based training or home-based training during their postoperative stay in hospital. Randomisation was done from a computer-generated random list in blocks of four, stratified by hospital, and distributed in numbered,
	1.2	Y	Concealed envelopes by the physiotherapists at the respective orthopedic departments. These physiotherapists neither took part in the later follow-up (3 weeks after surgery) nor the later treatment of the patients.
	1.3	Y	Following variable was not balanced between the groups: Age in years
	Total	**Some Concern**	
Effect of assignment to intervention	2.1	NI	
	2.2	Y	Patients in both groups were followed up by the same physiotherapist 3 weeks after surgery. For the home-based training group this was the only physiotherapy visit. At this follow-up visit all patients were clinically examined and given a new training programme which they were recommended to do daily.
	2.3	NI	
	2.4	NA	
	2.5	NA	
	2.6	Y	According to the intention-to-treat principle, the two patients who underwent repeated surgery (1 from each treatment group) during the first postoperative period were included in the data analysis. We performed a separate analysis without these two patients and found only minor differences concerning group median values. Moreover, these differences did not influence any of the outcome variables.
	2.7	NA	
	Total	**Some Concern**	
Missing outcome data	3.1	Y	Figure 1
	3.2	NA	
	3.3	NA	
	3.4	NA	
	Total	**Low Risk**	
Measurement of the outcome	4.1	N	Back pain-related disability, assessed with the Oswestry disability questionnaire, Kinesiophobia, evaluated by a modification of the Tampa Scale of Kinesiophobia (TSK), Coping strategies, assessed by the subscales of self-statement and catastrophising from the Coping Strategies Questionnaire (CSQ), visual analogue scales (VAS), Generic health-related quality of life, measured by EuroQol and SF-36
	4.2	N	
	4.3	NI	Before 1–2 weeks of admission to the orthopaedic clinic for surgery, all patients were sent a questionnaire (described below) to be completed and returned on arrival at the hospital. It was not obvious that whether the patient were blinded to the assigned intervention.
	4.4	N	
	4.5	NA	
	Total	**Low Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	N	Tables 2 & 3, figure 2.
	5.3	N	Since the average age of the clinic-based group was 5 years higher than that of the home training group, we ran a linear multiple regression analysis to adjust for age. As adjustments for age had little effect on the results for outcome variables, we present only the crude differences between the groups.
	Total	**Some Concern**	
Total	**Some Concern**		

Title: Early Individualized Physical Therapy After First-Time Lumbar Microdiscectomy and the Effect on Proprioceptive Postural Control, Disability and Pain: A Pilot RCT

Authors: Janssens *et al.* **Year:** 2012

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	NI	Twenty-five middle-aged subjects after LMDT were randomly divided into an intervention (PT) (*n* = 12) and control group (*n* = 13).
	1.2	NI	
	1.3	NI	
	Total	**Some Concern**	
Effect of assignment to intervention	2.1	NI	
	2.2	NI	
	2.3	NI	
	2.4	NI	
	2.5	NA	
	2.6	NI	
	2.7	NI	
	Total	**High Risk**	
Missing outcome data	3.1	NI	
	3.2	NI	
	3.3	NA	
	3.4	NA	
	Total	**High Risk**	
Measurement of the outcome	4.1	N	Disability and back/leg pain were assessed using respectively Oswestry Disability Index (ODI-2) and Numeric Rating Scale (NRS).
	4.2	N	
	4.3	NI	
	4.4	NI	
	4.5	NI	
	Total	**High Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	N	All outcome measures were reported in the result section.
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

Title: Effects of Lumbar Stabilization Exercise in Management of Pain and Restoration of Function in Patients with Postero Lateral Disc Herniation

Authors: Ahmed *et al.* **Year:** 2012

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	Y	It was a randomized controlled trial. Participants were randomly divided into two groups (50 cases in each group) by using lottery method.
	1.2	NI	
	1.3	NI	
	Total	**High Risk**	
Effect of assignment to intervention	2.1	NI	
	2.2	NI	
	2.3	NI	
	2.4	NI	
	2.5	NA	
	2.6	NI	
	2.7	NI	
	Total	**High Risk**	
Missing outcome data	3.1	N	In the result section. The total number of patients after treatment was 60.
	3.2	NA	
	3.3	NA	
	3.4	NA	
	Total	**Low Risk**	
Measurement of the outcome	4.1	N	Modified Oswestry scale. The progress of all the patients was measured on a unified scale describing 5 disability variables, pain intensity, walking, standing, sleeping and social activity according to modified Oswestry Scale.
	4.2	N	
	4.3	NI	
	4.4	NI	
	4.5	NI	
	Total	**High Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	Y	Only Oswestry scale
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

Title: Effects of dynamic lumbar stabilization exercises following lumbar microdiscectomy on pain, mobility and return to work. Randomized controlled trial

Authors: Demir *et al.* **Year:** 2014

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	NI	This study was planned as a prospective randomized controlled study.
	1.2	NI	
	1.3	Y	More than one characteristic variable was not balanced between the two groups (*e.g.,* age, profession [housewife], education [high school], and university).
	Total	**High Risk**	
Effect of assignment to intervention	2.1	NI	
	2.2	Y	Dynamic lumbar stabilization (DLS) exercises were performed under the supervision of a physiatrist.
	2.3	NI	
	2.4	NI	
	2.5	NA	
	2.6	NI	
	2.7	NI	
	Total	**High Risk**	
Missing outcome data	3.1	NI	
	3.2	PN	
	3.3	NI	
	3.4	NI	
	Total	**High Risk**	
Measurement of the outcome	4.1	N	Neurologic examinations were performed according to the classification standards set by the American Spinal Injury Association (ASIA). Magnetic resonance imaging (MRI) findings of patients and their Visual Analog Scale (VAS) scores for low back and leg pain were recorded at the postoperative first, second, and sixth months. A revised Oswestry Disability Index (ODI) was used to measure functional disability. Mobility was evaluated using a modified lumbar Schober (MLS) score, lumbar Schober (LS) score, finger-floor distance (FFD) measurement, and right and left side lateral flexion (LF) measurements. The six-minute walk test was used to measure functional capacity. Quality of life was assessed using Nottingham Health Profile (NHP) scores. The Fear Avoidance Beliefs Questionnaire (FABQ) was used to assess pain fears and patients' avoidance of their daily physical and professional activities.
	4.2	N	
	4.3	NI	
	4.4	NI	
	4.5	NI	
	Total	**High Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	N	Tables 3-8.
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

Title: Comparison of lumbar spine stabilization exercise versus general exercise in young male patients with lumbar disc herniation after 1 year of follow-up

Authors: Ye *et al.* **Year:** 2015

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	NI	The patients were randomly assigned to receive GE (GE group) or LSSE (LSSE group).
	1.2	NI	
	1.3	Y	One characteristic variable was not balanced between the two groups (Oswestry disability index (ODI)).
	Total	**High Risk**	
Effect of assignment to intervention	2.1	NI	
	2.2	Y	Two sessions per week at the outpatient department and were supervised by physiotherapists. After this time, at least one session per week was supervised.
	2.3	NI	
	2.4	NI	
	2.5	NA	
	2.6	Y	Tables 2 & 3.
	2.7	NA	
	Total	**Some Concern**	
Missing outcome data	3.1	Y	Tables 2 & 3.
	3.2	NA	
	3.3	NA	
	3.4	NA	
	Total	**Low Risk**	
Measurement of the outcome	4.1	N	Pain intensity of the lower back and legs was evaluated with the visual analogue scale (VAS), and functional capacity was evaluated with the Oswestry Disability Index (ODI).
	4.2	N	
	4.3	NI	
	4.4	PY	Before intervention (baseline evaluations) and 3 months post-exercise, pain intensity in the lower back and leg and functional capacity were evaluated at the outpatient department by the same investigator who had orthopaedic and/or physiotherapy knowledge.
	4.5	PY	
	Total	**High Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	N	Tables 2 & 3.
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

Title: A comparison of water-based and land-based core stability exercises in patients with lumbar disc herniation: a pilot study

Authors: Bayraktar *et al.* **Year:** 2015

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	Y	Randomization was made with matched pairs design. This method matches patients, according to age and sex. For example, if a patient was assigned in land-based exercise (LBE) group with tossing-up the coin, the age–sex-matched pair was assigned to the water specific therapy (WST) group.
	1.2	NI	
	1.3	Y	More than one characteristic variable was not balanced between the two groups (*e.g.,* pain level [visual analog scale in rest], disability index [ODI]).
	Total	**High Risk**	
Effect of assignment to intervention	2.1	NI	
	2.2	Y	All exercises were supervised by a physiotherapist.
	2.3	NI	
	2.4	NI	
	2.5	NA	
	2.6	N	Figure 3.
	2.7	NI	
	Total	**High Risk**	
Missing outcome data	3.1	N	Figure 3.
	3.2	N	
	3.3	NI	
	3.4	PY	Figure 3.
	Total	**High Risk**	
Measurement of the outcome	4.1	N	Visual Analog Scale (VAS), trunk extensors endurance test, trunk flexors endurance test and lateral bridge test, Oswestry Disability Index (ODI) and Roland– Morris Disability Questionnaire (RMDQ), The Nottingham Health Profile (NHP).
	4.2	N	Tables 1-4.
	4.3	NI	
	4.4	NI	
	4.5	NI	
	Total	**High Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	N	Tables 1-4.
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

Title: Effect of lumbar stabilization exercise on disc herniation index, sacral angle, and functional improvement in patients with lumbar disc herniation

Authors: Jeong *et al.* **year:** 2017

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	NI	They were randomly assigned to the perform the balance center stabilization resistance exercise (experimental group I; *n*=15) or the 3D back stabilization exercise group (experimental group II; *n*=15).
	1.2	NI	
	1.3	Y	More than one characteristic variable was not balanced between the two groups (*e.g.,* age, height, weight).
	Total	**High Risk**	
Effect of assignment to intervention	2.1	NI	
	2.2	NI	
	2.3	NI	
	2.4	NI	
	2.5	NA	
	2.6	NI	
	2.7	NI	
	Total	**High Risk**	
Missing outcome data	3.1	NI	
	3.2	PN	
	3.3	NI	
	3.4	NI	
	Total	**High Risk**	
Measurement of the outcome	4.1	N	Herniation index, sacral angle, and Korean Oswestry Disability Index (KODI).
	4.2	N	Table 2.
	4.3	NI	
	4.4	NI	
	4.5	NI	
	Total	**High Risk**	
Selection of the reported result	5.1	NI	No protocol was available.
	5.2	N	Table 2.
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

Title: Comparison between Transcutaneous Electrical Nerve Stimulation and Stabilization Exercises in Fatigue and Transversus Abdominis Activation in Patients with Lumbar Disk Herniation: A Randomized Study

Authors: Ramos *et al.* **year:** 2018

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	Y	The study was a randomized, controlled, assessment-blind study comparing 2 parallel groups. Using balanced randomization (1:1) with Microsoft Excel for Windows 10 edition (Windows, Redmond, Washington).
	1.2	Y	Participants were allocated in 1 of the 2 groups secretly by a random number sequence, using sealed, opaque envelopes, containing a letter stating to which group the patient belonged.
	1.3	Y	One characteristic variable was not balanced between the two groups (Age).
	Total	**Some Concern**	
Effect of assignment to intervention	2.1	Y	In the present study, the outcome assessor was blinded only.
	2.2	Y	The sessions were supervised by the investigator, and the participants were instructed to report any adverse event, whether or not it was related to exercises or electrotherapy.
	2.3	N	Assigned intervention was consistent with the trial protocol.
	2.4	NA	
	2.5	NA	
	2.6	Y	Figure 2.
	2.7	NA	
	Total	**Low Risk**	
Missing outcome data	3.1	Y	Figure 2.
	3.2	NA	
	3.3	NA	
	3.4	NA	
	Total	**Low Risk**	
Measurement of the outcome	4.1	N	The Sørensen test of efforts, Fatigue (Multifidus muscle), contraction of transversus abdominis pressure biofeedback unit, visual analog scale, Oswestry Disability Index, and multifidus slope angle.
	4.2	N	Tables 2 & 3, figure 3.
	4.3	N	At baseline and at the end of treatment by an investigator (physical therapist) blinded to the randomization.
	4.4	NA	
	4.5	NA	
	Total	**Low Risk**	
Selection of the reported result	5.1	N	In the protocol, the authors mentioned that the pain level would be measured using the visual analogical scale and McGill pain questionnaire. However, no McGill pain questionnaire data were available in the published paper. Protocol was available at www.clinicaltrials.gov NCT01640431.
	5.2	Y	In the protocol, the authors mentioned that the pain level would be measured using the visual analogical scale and McGill pain questionnaire. However, no McGill pain questionnaire data were available in the published paper.
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

Title: Motor Control Training Compared with Transcutaneous Electrical Nerve Stimulation in Patients with Disc Herniation with Associated Radiculopathy

Authors: França *et al.* **year:** 2019

Domain	***Signaling questions***	***RoB***	***Evidence***
Randomization process	1.1	Y	The study was a parallel-group randomized controlled trial with blinded assessment performed during the months of April–December 2016. Balanced randomization (1:1) was performed using Microsoft Excel for Windows 10 by a researcher who was not involved in the recruitment of the participants.
	1.2	Y	Participants were secretly allocated through a random number sequence using sealed opaque envelopes containing a letter that indicated to which group the patient belonged.
	1.3	Y	More than one characteristic variable was not balanced between the two groups (*e.g.,* age, weight).
	Total	**Some Concern**	
Effect of assignment to intervention	2.1	Y	Given the nature of the interventions, it was not possible for the physical therapist or patients to be blinded.
	2.2	Y	Given the nature of the interventions, it was not possible for the physical therapist or patients to be blinded
	2.3	N	Assigned intervention was consistent with the trial protocol.
	2.4	NA	
	2.5	NA	
	2.6	Y	Intention to treat analysis was carried out, and there was no dropout during the study.
	2.7	NA	
	Total	**Low Risk**	
Missing outcome data	3.1	Y	Figure 1.
	3.2	NA	
	3.3	NA	
	3.4	NA	
	Total	**Low Risk**	
Measurement of the outcome	4.1	N	Pain was assessed using a visual analog scale (VAS) and the McGill Pain Questionnaire, Oswestry Disability Index
	4.2	N	Table 3.
	4.3	N	The assessor was blinded to the treatment allocation.
	4.4	NA	
	4.5	NA	
	Total	**Low Risk**	
Selection of the reported result	5.1	Y	Protocol was available at www.clinicaltrials.gov NCT01640431.
	5.2	Y	Table 3.
	5.3	Y	No multiple analyses were performed.
	Total	**High Risk**	
Total	**High Risk**		

APPENDIX IV: Sensitivity analysis

In comparisons with more than one study, we performed exploratory sensitivity analyses for the primary outcomes using the Hartung-Knapp-Sidik-Jonkman (HKSJ) random-effects model to test the robustness of our findings. Previous studies have shown that the HKSJ random-effects model is a suitable method when there is substantial heterogeneity and the number of trials in the meta-analysis is small (Hartung 1999; Sidik and Jonkman 2005). However, extra caution was applied when interpreting the results, since the number of studies in all subgroups was less than the recommended six studies threshold (InHout et al., 2014).

REFERENCES:

1. Hartung J. An alternative method for meta-analysis. *Biometrical Journal: Journal of Mathematical Methods in Biosciences* 1999;41(8):901-16.
2. Sidik K, Jonkman JN. Simple heterogeneity variance estimation for meta-analysis. *Journal of the Royal Statistical Society: Series C (Applied Statistics)* 2005;54(2):367-84.
3. IntHout J, Ioannidis JPA, Borm GF. The Hartung-Knapp-Sidik-Jonkman method for random effects meta-analysis is straightforward and considerably outperforms the standard DerSimonian-Laird method. *BMC Medical Research Methodology* 2014;14(1):25. doi: 10.1186/1471-2288-14-25

APPENDIX V: The GRADE approach to evidence synthesis and explanation of items

GRADE was used to evaluate the quality of the evidence for each *primary outcome*.

The quality of evidence is classified as follows:

- **High** (⨁⨁⨁⨁): further research is very unlikely to change the confidence in the estimate of effect.
- **Moderate** (⨁⨁⨁◯): further research is likely to have an important impact in the confidence in the estimate of effect.
- **Low** (⨁⨁◯◯): further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
- **Very Low** (⨁◯◯◯): any estimate of effect is very uncertain.

The overall quality of evidence took into consideration the following five domains: limitations/risk of bias, inconsistency, indirectness, imprecision, publication bias

1- Limitations/Risk of bias

Limitations in the study design refers to the way in which the various forms of bias may influence the estimates of the treatment effect. We examined all studies for the following forms of bias:

- Selection bias (random sequence generation, allocation concealment, group similarities at baseline).
- Performance bias (blinding of participants and/or healthcare providers).
- Attrition bias (dropouts and intention-to-treat [ITT] analysis).
- Detection bias (blinding of the outcome assessors and timing of outcome assessment).
- Reporting bias (selective reporting).

We considered downgrading the quality of the evidence as follows:

- By one level when the majority of participants (>50%) came from studies with selection bias (specifically, the allocation concealment was not conducted properly) and performance bias was present.
- By two levels when the majority of participants (>50%) came from studies with selection bias (specifically, the allocation concealment was not conducted properly) and performance bias and other bias were present in one or more other categories.

2- Inconsistency

Inconsistency refers to an unexplained heterogeneity of results. Widely differing estimates of the treatment effect (*i.e.,* heterogeneity or variability in results) among studies suggest true differences in the underlying treatment effect. Inconsistency may arise from differences in the parameters of MCT (*e.g.,* larger effects with more treatment sessions), or differences in the timing of the outcome measurements. We considered downgrading the quality of the evidence as follows:

- By one level: when the heterogeneity or variability in results was large (*e.g., I^2* statistic value >50%, representing potentially substantial heterogeneity).
- By two levels: when the heterogeneity or variability in results was large AND there was inconsistency arising from differences in the interventions or outcomes.

3- Indirectness

Indirectness refers to the generalizability of the findings. Indirectness may be a problem and diminish our confidence if the population, type of intervention, comparator, or outcome in the included randomized trials differs broadly from the research question being addressed in this review. We considered downgrading the quality of the evidence as follows:

- By one level: when there is indirectness in only one area. For example, when >50% of the participants were outside the target group.
- By two levels: when there is indirectness in two or more areas (*e.g.,* including other patient populations or use of surrogate outcomes).

4- Imprecision

Imprecision refers to limitations in the interpretation of the results when studies include relatively few participants and few events, leading to wide confidence intervals (CIs) surrounding the estimate of the effect, and thus resulting in uncertainty about the treatment effect. We considered imprecision for either of the following two reasons.

I. There is only one study; when there is more than one study, the total population size is less than 400 (a threshold rule-of-thumb value) (Mueller *et al.* 2007).
II. The 95% CIs includes no effect and the upper or lower confidence limit crosses an effect size of 0.5 or mean difference of 20mm in either direction.

We considered downgrading the quality of the evidence as follows:

- By one level: when there is imprecision due to (I) OR (II) for a continuous or dichotomous outcome.
- By two levels: when there is imprecision due to (I) AND (II) for a continuous or dichotomous outcome.

5- Publication bias

Publication bias refers to bias introduced as a result of the selective publication of studies, typically leading to an underestimation of the effect from studies demonstrating a 'negative' effect which are under-reported. We considered downgrading the quality of evidence as follows:

- By one level: when Egger's linear regression test suggests publication bias.

REFERENCE:

Mueller PS, Montori VM, Bassler D, Koenig BA, Guyatt GH. Ethical issues in stopping randomized trials early because of apparent benefit. *Annals of Internal Medicine*. 2007;146(12):878-881.

APPENDIX VI: Secondary outcomes

Muscle endurance [N=2]—At short-term, one study[44] assessed the effectiveness of MCT versus other forms of exercises and no intervention for improving back extensor muscles using the Biering-Sorensen test in patients who had LDH surgery. The results suggest there is a statistically and clinically significant difference between the comparisons (other forms of exercises, MD 106 seconds, 95% CI 54.82 to 157.18 seconds, participants=40; no intervention, MD 198 seconds, 95% CI 154.49 to 241.51 seconds, participants=40). In addition, one study[42] indicated that there is no clinically meaningful difference between land-based MCT and water-based MCT at short-term (MD -10.70 seconds, 95% CI -36.52 to 15.12 seconds, participants=23).

At short-term, the results showed that there is statistically significant difference between MCT and other forms of exercises and no intervention for improving abdominal muscles endurance[44] (other forms of exercises, MD 74.25 seconds, 95% CI 24.96 to 123.54 seconds, participants=40; no intervention, MD 170.75 seconds, 95% CI 128.56 to 212.94 seconds, participants=40). One study[42] also demonstrated no clinically meaningful difference between land-based MCT and water-based MCT at short-term in patients who did not have surgery (MD -2.10 seconds, 95% CI -24.38 to 20.18 seconds, participants=23).

Quality of life [N=3]—At intermediate-term, one study[43] reported that MCT plus home exercises compared to home exercises alone improved physical mobility based upon the Nottingham Health Profile in patients following lumbar microdiscectomy (median change difference -25).[43] Another study[42] revealed that land-based MCT had similar effects to water-based MCT for short-term improvement in health-related quality of life (MD -18.69, 95% CI -143.47 to 106.1, participants=23). Furthermore, one study[46] indicated that in patients after first-time lumbar disc surgery, there was no clinically meaningful difference between clinic-based training in comparison to home-based training regarding quality of life as measured by the EuroQol and Short Form-36 questionnaires.

Functional tests [N=3]—In a cross-over trial, Bakhtiary et al[48] reported that compared to no intervention, MCT resulted in significant changes in time for 10-meter walking (MD −3.9 seconds, 95% CI −5.4 to −2.4 seconds, participants=60), climbing five steps (MD −1.7 seconds, 95% CI −2.8 to −0.6 seconds, participants=60), laying prone (MD −2.4 seconds, 95% CI −3.5 to −1.5 seconds, participants=60), and standing from lying prone (MD −1.8 seconds, 95% CI −2.6 to −0.8 seconds, participants=60) at the end of the first four weeks in patients with LDH. However, when the condition was reversed, no significant changes were found between the groups at the end of eight weeks.[48] Moreover, Brox et al[49] reported that MCT plus cognitive exercises produced statistically significant long-term improvement in finger-floor distance test compared to lumbar fusion surgery (MD 13.2 cm, 95% CI 3.4 to 23 cm, participants=57). At long-term, one study[46] demonstrated that the number of participants with LDH who walked more than one kilometer was not statistically significant between clinic-based MCT and home-based MCT (p = 0.412).

Return to work [N=3]—At long-term, one study[49] concluded that both MCT plus cognitive exercises and lumbar fusion surgery did not meaningfully result in participants being able to work full-time. Demir et al[43] found no difference in return to work in patients with lumbar microdiscectomy who received MCT as opposed to home exercises (35 days vs. 40 days on average, respectively).[43] At short-term, one study[44] reported that the time for housewives to return to daily activities after single lumbar discectomy was significantly shorter in the MCT group compared to other groups (*i.e.*, classical exercises [McKenzie exercise and Williams exercise] and no exercise; MD −24.56 days, 95% CI −37.64 to −11.47 days).

Adverse event [N=2]—At short-term, three studies,[34 35 47] and at intermediate- and long-term one study[47] reported that no adverse events related to MCT were observed within the period studied. Other studies did not report MCT-related (or other treatment-related) adverse events. For comparison interventions, only one study reported two wound infections among 23 patients who had undergone surgery.[49]

APPENDIX VII: Sensitivity analysis results

The sensitivity analyses showed that the robustness of the results for the primary outcomes in several comparisons was poor, since unlike the DL random-effects model, the 95% CI of the MD or SMD included zero in the HKSJ random-effects model (**eTable 5**). However, it should be noted that the number of selected studies was less than the minimum number of studies recommended for meta-analysis using the HKSJ random-effects model.

eTable 5. Sensitivity analysis using the HKSJ random-effects model.

Analyses	Weighted Mean Difference (95% CI)	Standardized Mean Difference (95% CI)	I^2 (%)	*P*-value of Q Test	*H* Statistic*
PATIENTS WHO DID NOT UNDERGO SURGERY					
MCT versus other physical-therapist-led interventions					
Pain					
Short-term (< 3 months)	-28.85 (-101.38, 43.69)	-1.43 (-7.76, 4.89)	28.6	0.237	1.18
Functional status					
Short-term (< 3 months)	-21.79 (-54.07, 10.46)	-1.98 (-2.94, -1.03)	0.0	0.800	0.25
PATIENTS WHO HAD UNDERGONE SURGERY					
MCT versus other forms of exercises					
Pain					
Short-term (< 3 months)	-8.40 (-17.29, 0.49)	-1.15 (-2.82, 0.53)	52.1	0.099	1.45
Intermediate-term (3 to < 12 months)	-9.92 (-69.34, 49.50)	-0.56 (-4.68, 3.56)	59	0.118	1.32
Functional status					
Short-term (< 3 months)	-4.95 (-6.35, -3.54)	-0.95 (-1.42, -0.49)	0.0	0.726	0.57
MCT versus other physical-therapist-led interventions					
Pain					
Intermediate-term (3 to < 12 months)	-5.88 (-101.51, 89.74)	-0.26 (-4.70, 4.19)	60.8	0.110	1.60
Functional status					
Intermediate-term (3 to < 12 months)	-2.22 (-56.00, 51.55)	-0.14 (-4.13, 3.86)	52.7	0.146	1.45
MCT versus minimal intervention, self-management, or no intervention					
Pain					
Short-term (< 3 months)	-19.50 (-163.82, 124.81)	-1.83 (-4.83, 1.17)	93.5	0.00	3.91
Functional status					
Short-term (< 3 months)	-8.66 (-16.02, -1.29)	-1.34 (-4.39, 1.71)	0.0	0.376	0.89

* *H* statistic is defined as the relative excess in Q over its degree of freedom.
† Colored cells show that the robustness of the results was not confirmed, since the significant comparisons became non-significant.

APPENDIX VIII: Publication bias assessment using Egger's graphs

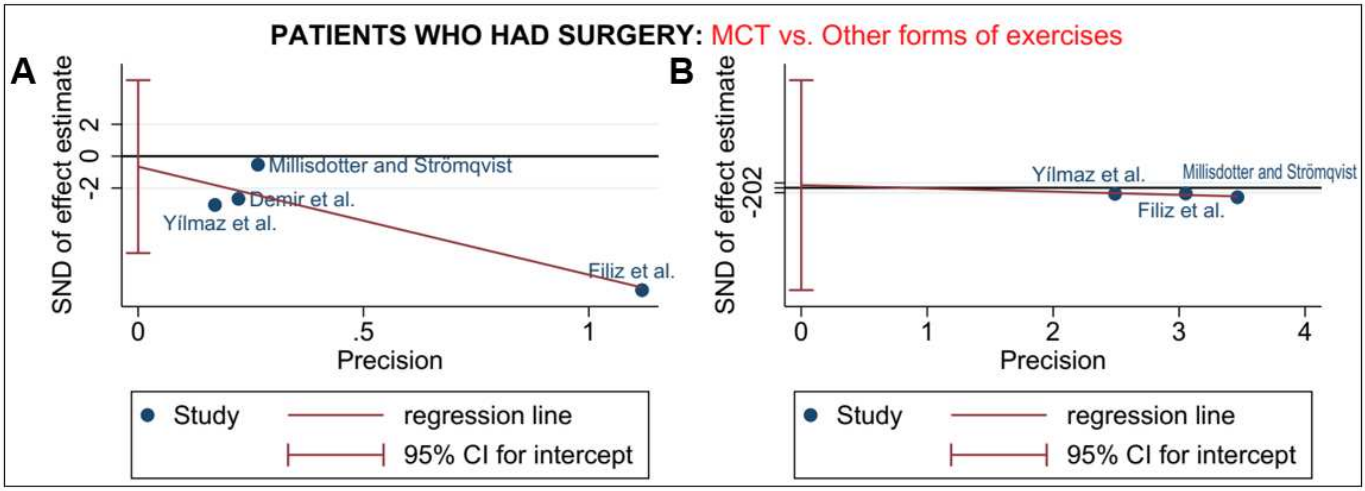

Figure 1: Egger's graphs for the selected comparisons. **A:** Pain at short-term, **B:** functional status at short-term.

APPENDIX IX: More details of comparison with other reviews

A systematic review published in 2010[1] which investigated the effectiveness of conservative management of LDH found that "*[MCT] is more effective than no treatment for reducing pain intensity at short-term follow-up*". However, this conclusion was based on the results of a clinical trial[2] that did not have sufficient data to be included in our meta-analysis, while our results suggest that MCT did not produce greater pain relief in patients who had undergone surgery than minimal intervention, self-management, or no intervention.

Jacobs et al[3] in a systematic review indicated that early surgery in patients with LDH resulted in better short-term pain relief than prolonged non-surgical treatment, but no significant differences were found between surgery and usual non-surgical treatment in any of the clinical outcomes after 1- and 2-years' follow-up. Jacobs et al[3] considered all non-surgical interventions as conservative treatment. Moreover, Rickers et al,[4] in a recent systematic review and network-meta-analysis, also revealed that "*conservative treatment performed significantly worse than the surgical treatments in terms of relieving pain after 1 year*". Another study by Arts et al[5] also reported that lumbar discectomy with bone-anchored annular closure may improve patient symptoms more than non-surgical care. In this regard, our results suggest that MCT did not provide better results in decreasing pain and improving function compared to surgery at long-term in patients who had a previous surgery for disc herniation. However, we should bear in mind that our study focused on MCT only to provide a thorough understanding of the effectiveness of this exercise and the small number of homogeneous studies did not permit us to collate conclusive evidence about MCT for patients with symptomatic LDH.

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APPENDIX X: Implications for clinicians

MCT is an active intervention program that targets the neuromuscular control of the lumbopelvic region by focusing on the recruitment and control of key muscles involved in protection of the spine and pelvis.[1] Although many clinicians use exercise as a standalone therapy, it is expected that supervised MCT needs to be embedded within the constructs of a broader treatment package, together with patient education and manual therapy, as is recommended in the Denmark National Clinical Guidelines for non-surgical treatment of patients with low back pain or lumbar radiculopathy.[2] A recent systematic review of clinical practice guidelines on treatment of lumbosacral radicular pain also reported that exercise as a standalone treatment is consistently recommended as '*could do*', which may have useful practical implications.[3] Likewise, our findings suggest that MCT as a standalone treatment may not produce satisfactorily meaningful pain relief and improved function, which is consistent with previous clinical guidelines.[4] The results of our study suggest that MCT may be better than other forms of exercises in the long-term to improve function in patients with LDH and surgery. Although compliance/adherence was not directly measured in this study, it seems that patients must be motivated and persistent during the treatment period. In a study conducted by Palazzo et al,[5] barriers associated with home-based exercise program adherence in patients with chronic low back pain were identified and categorized as the number of exercises, the complexity and effectiveness of the program, and the burden of exercising. The authors concluded that for patients with chronic low back pain, adherence to exercise programs could be facilitated by increasing the attractiveness of the programs (*e.g.,* using new technologies), favoring a feeling of being supported, and improving patient performance.[5]

It is difficult to evaluate adverse events based on the studies included in this systematic review, because only 2 trials reported no adverse effects with unclear methodology. Hayden et al[6] in a Cochrane review reported mild reactions with increased back pain and muscle soreness as possible adverse events of exercise therapy in patients with low back pain. Nevertheless, due to the nature of MCT, it seems that no serious adverse events will occur in patients receiving this intervention. Notwithstanding, it would be beneficial that future studies clearly document potential adverse events related to MCT.

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APPENDIX XI: Multiple choice questions (MCQs)

1. **Which statement is NOT correct about the effectiveness of MCT in LDH:**

   A. no serious MCT-related adverse events have been reported in the included studies.
   B. in patients who have LDH and no surgery, MCT is better than other forms of exercises to improve function in the short-term follow-up.
   C. land-based MCT has similar effects to water-based MCT for short-term improvement in health-related quality of life in patients who have LDH and no surgery.
   D. MCT results in a large statistically and clinically better effect than transcutaneous electrical nerve stimulation in patients who have LDH and no surgery at short-term follow-up.

2. **Which bias domain has been properly addressed in the included studies?**

   A. missing outcome data
   B. measurement of the outcome
   C. randomization process
   D. selection of the reported result

3. **At which level was disc herniation most commonly seen across the included studies?**

   A. L1-L2
   B. L2-L3
   C. L4-L5
   D. L5-S1

4. **Which approach was not used as a treatment protocol for patients with LDH?**

   A. Saal approach
   B. Akuthota approach
   C. Kwon approach
   D. Diane Lee approach

5. **How was the overall certainty of the evidence for pain and functional status outcomes in management of LDH using MCT?**

   A. the range of overall certainty of the evidence was moderate.
   B. the range of overall certainty of the evidence was high.
   C. the range of overall certainty of the evidence was very low to low.
   D. the overall certainty of the evidence was not assessed.