Physiotherapy

Physiotherapy 94 (2008) 179–189

Systematic review

Stabilisation exercises for low back pain: a systematic review

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Abstract

Objectives To examine the literature to determine if stabilisation exercises are effective for the treatment of pain and dysfunction in patients with low back pain.

Data sources PubMed (MEDLINE), CINAHL, AMED, PEDro and the Cochrane Library were searched up to October 2006.

Review methods Inclusion criteria were: randomised clinical trials; in English; full publications; subjects were adults with low back pain; one group received specific stabilisation exercises as the primary intervention; and outcome measures included some measure of pain and/or function. Following a systematic search of major databases, articles were scored according to the PEDro criteria for quality. Due to heterogeneity of specific interventions, control groups, duration of follow-up, outcome measures and study population, a meta-analysis was not conducted. A qualitative review was undertaken that focused on study quality, study population and type of control group.

Results In total, 18 trials were included in the review; a large number of trials were excluded. There was little evidence to support the use of stabilisation exercises for acute low back pain. There was some evidence to support the use of stabilisation exercises in chronic back pain, with the majority of high-quality trials showing a significant difference in favour of stabilisation exercises. Overall, however, the evidence was conflicting, and significant differences favouring stabilisation exercises were less likely when they were compared with active treatment control groups rather than inactive control groups.

Conclusions There may be a role for specific stabilisation exercises in some patients with chronic low back pain, but these are no more effective than other active interventions.

Keywords: Low back pain; Exercise therapy; Review

Introduction

Low back pain is extremely common. Whilst largely benign and self limiting, it is very costly to society as a whole, especially chronic low back pain and disability [1–3]. Most low back pain is treated conservatively by a range of interventions [4]. Exercises are frequently used by physical therapists for the treatment of low back pain. Specific exercises that activate abdominal and/or back extensor muscles are advocated to reduce pain and disability [5–8]. It is claimed that there is a link between local muscle dysfunction and low back pain, with the development of clinical instability in which there is an excessive range of abnormal segmental movement without muscular control [6]. Thus, stabilisation exercises have been designed in order to enhance the neuromuscular control system and correct the dysfunction [6–8]. A number of randomised clinical trials (RCTs) have been performed to evaluate the effectiveness of stabilisation exercises [9–11], and there are some indications of long-term benefit regarding decreased recurrence of low back pain episodes and healthcare usage [12].

A large number of systematic reviews of exercises for low back pain have been conducted [13–20]. The general conclusion is that exercises are ineffective for acute low back pain or as effective as other treatments, but are effective for chronic low back pain or more effective than other treatments. However, there is limited evidence for specific rather than general exercises. Strengthening exercises have been considered in some of these reviews [15,18,20], and along with stretching exercises have demonstrated the largest improvements compared with controls [21]. These classic trunk strengthening exercises involve activation of abdominal and paraspinal musculature at high levels of contraction. Such gross strengthening exercises differ from stabilisation exercises in which there is preferential training of stabil-

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doi:10.1016/j.physio.2007.08.010

ising muscles, initially with low-level isometric activation followed by progressive integration into everyday activities [6,8]. If performed incorrectly, classic trunk strengthening exercises may lead to inappropriate muscle coordination patterns and increased risk of further injury [6,22]. In addition, exercises that are said to preferentially select transversus abdominus and multifidus, as described by Richardson *et al.* [6] and O'Sullivan *et al.* [10], are distinguished [23] from general trunk stabilisation exercises, as described by McGill [7].

Two systematic reviews directly relevant to stabilisation exercises were located [24,25]. One considered 'therapeutic exercise in treating instability-related lumbar spine pain' [24]. This review only included seven articles, and of these, only four were RCTs. No attempt was made to judge the quality of the studies, and the emphasis of the review was on the mechanism by which stabilisation exercises may work. The other systematic review [25] was published whilst the current review was in preparation and contained 13 studies. Of these, three were only available as abstracts at that time, one was published in German and one involved patients with neck pain and headache. Thus, eight of these studies would have met the inclusion criteria for the present review; however, the present authors had already located 16 studies so it seemed worth continuing with this more up-to-date review. The aim of this systematic review was to evaluate the effectiveness of stabilisation exercises in the treatment of pain and dysfunction from low back pain.

Methods

Identification and inclusion criteria

A literature search of PubMed (MEDLINE) (January 1966 to October 2006), CINAHL (1982 to October 2006), AMED (1985 to October 2006), PEDro (October 2006) and the Cochrane Library (2006, Issue 1) was conducted. The following search terms were used: lumbar spine; back pain; low back pain; randomized controlled trial; clinical trial; exercises; rehabilitation; (lumbar) stabili*; core stability; transversus abdominus; and multifidus. This was supplemented by hand searching the reference lists of the articles found in the electronic search. Titles and abstracts from electronic searches and reference lists were screened by one reviewer, and full copies of potentially eligible papers were retrieved and screened by two reviewers. Included articles had to meet the following criteria.

- Results must be published as full reports before October 2006 – abstracts were not included.
- The study had to be written in English.
- The study involved adults (>18 years) with low back pain present for any length of time.
- Low back pain was non-specific or specific in nature.
- The study was an RCT.
- One intervention arm primarily used stabilisation exercises as defined by: facilitation of abdominal and/or lumbar extensor muscles initially at low levels of contraction and progressing to integration into everyday activities according to Richardson *et al.* [6], Norris [8] or O'Sullivan *et al.* [10].
- The control group received an alternative intervention.
- Studies included measurement of pain and/or functional disability outcomes.

Study quality

Studies meeting the above inclusion criteria were assessed for methodological quality using the PEDro scale [26]. PEDro scores were extracted from the PEDro database and where an article had not been previously scored, it was reviewed and scored independently by two reviewers. Any disagreements were resolved by consensus. Studies scoring ≥6 out of 10 were considered to be high-quality trials in this review.

Data extraction

Data were extracted independently from each included study by two investigators using a standardised data extraction form. Disagreements were resolved by consensus. Effectiveness was judged for short-term (≤3 months from randomisation), medium-term (>3 and <12 months) and long-term (≥12 months) outcomes according to the Cochrane Collaboration Back Review Group [27].

Data analysis

Pain and disability scores were transformed to a score ranging from 0 to 100. The mean and 95% confidence intervals (CI) were calculated to describe the effect of treatment, and to calculate between group differences at appropriate end points [28]. Where numerical data were not provided, they were interpolated from available graphs. Where available, the mean (standard deviation) and the number of groups were entered into an Excel spreadsheet that allowed calculation of the size of the treatment effect, which was the difference between the group means of the stabilisation exercises and the control group, and the 95% CI [28]. If median data were presented and met the criteria for normal distribution, this was used in place of the mean.

If trials were considered to be sufficiently homogeneous, outcome data were pooled according to back pain type (specific, non-specific), outcomes (pain, disability), symptom duration (acute, chronic), methodological quality (PEDro score <6, ≥6) and treatment comparisons (minimal intervention, active intervention). Pooled estimates were obtained using a random effects model. If the trials were considered to be heterogeneous, the reasons were given and a qualitative data analysis was performed based on levels of evidence. The following levels of evidence were adopted from the Cochrane Collaboration Back Review Group [27].

- Strong – consistent findings amongst multiple (three or more) high-quality RCTs.
- Moderate – consistent findings amongst multiple low-quality RCTs and/or controlled clinical trials (CCTs) and/or one high-quality RCT.
- Limited – one low-quality RCT and/or CCT.
- Conflicting – inconsistent findings amongst multiple trials (RCTs and/or CCTs).
- No evidence – no trials.

Results

Fifty-one publications were retrieved for initial screening, and 21 of these were included in the final review. The list of excluded studies and the reasons for exclusion is available from the authors on request. Of the 21 included publications [9–12,29–45], three reported long-term follow-up on a previous study [12,31,36]. Thus, 18 separate trials were included in the study.

Heterogeneous populations were involved in the different studies regarding duration of low back pain and specific or non-specific low back pain (Table 1). Four trials involved patients with acute and subacute back pain [9,12,34,37,43], and 12 trials involved patients with chronic low back pain [10,11,29–33,35,36,38,39,41,44,45]. The duration of symptoms was unclear in two studies [40,42]. Eight trials involved patients with specific back pain, namely: first-time unilateral low back pain of less than 3 weeks with multifidus asymmetry >11% [9,12]; a radiological diagnosis of spondylolysis or spondylolisthesis [10]; pregnancy-related back pain [35,36,42]; positive to sacro-iliac joint pain provocation tests [37]; women with signs of instability [41]; sciatica [38]; and post-lumbar discectomy [40].

Fifteen trials reported short-term pain and/or function, six reported medium-term pain and/or function, and 13 reported long-term pain and/or function (Table 1). In addition, short- (return to work), medium- (depression) and long-term (back pain episodes, healthcare usage for back pain, absence from work and psychosocial issues) outcomes were reported in seven trials. Most outcomes were reported as means, but four trials only reported medians [32,35–37,42] and one trial did not present standard deviations or sufficient primary data to allow their calculation [9].

In most studies, stabilisation exercises were combined with some other intervention, such as manual therapy with or without advice [29–31,35,36,45], other exercises [11,34,42], orthosis [37,41,42] or back school [40,44]. Stabilisation exercises were the sole intervention in four trials [9,10,12,32,33].

The methodological quality of the 21 publications is reported in Tables 2–4; the PEDro scores were from the PEDro database in all but one study. Scores ranged from 3 to 8, and the most common weaknesses were lack of patient and therapist blinding, intention-to-treat analysis and concealed allocation. Twelve publications scored ≥6 and thus were considered to be of high quality.

Amongst the 18 trials, four had three treatment groups; thus, there were a total of 22 comparisons between the stabilisation group and a control group. Eleven comparisons were against ‘inactive control’ groups, meaning limited or unmonitored patient participation in management or limited therapist input. These comprised: medical management [9,10,12,29–31,33], laser [37], orthosis [41], no treatment control [38,40], education [44] or standard treatment [42]. Eleven ‘active’ comparisons were treatments involving the patient exercising or the therapist performing additional interventions. These comprised: manual therapy [32,43,44], manual therapy and exercises [34–36,45], general strengthening exercises [11], McKenzie method [39], directional preference exercises [43], flexibility exercises [40] and acupuncture [42].

The studies were heterogeneous regarding specific interventions, control groups, duration of follow-up, outcome measures, and study population with a mixture of duration of low back pain and specific and non-specific low back pain. As such, a meta-analysis was not attempted and a qualitative analysis was performed.

Outcomes are reported in Tables 2–4 as mean percentage differences between the groups (95% confidence intervals), with positive values favouring the stabilisation group and negative values favouring the control group. These tables also provide the statistical significance found by the authors of the different trials. Bold *P*-values indicate a significant difference in favour of the stabilisation exercises, and non-bold *P*-values indicate either that there was a significant difference in favour of the control group or that there was no significant difference (NS) between the groups.

Regarding the treatment of acute and subacute back pain with stabilisation exercises, four trials were available [9,12,34,37,43], three of which were of high quality [9,12,34,43]. Short- and medium-term function scores were significantly better in the control group in one high-quality study [34]. In one high quality trial short-term pain score was not significantly different [9]. In one high-quality trial functional disability score short and long-term was not significantly different [43] (Table 2). Short- and long-term pain scores were significantly better in the stabilisation group in one poor-quality study [37]. The mean number of back pain episodes was lower in the stabilisation group in the long term in one study; the relative risk for back pain was 0.36 (95% CI 0.18 to 0.72) in the first year and 0.55 (95% CI 0.28 to 1.1) in the second year [12]. However, this was a very specific subgroup and it is probably unwise to assume generalisability. Overall, it must be concluded that there was conflicting evidence about the effectiveness of stabilisation exercises for acute back pain, but they do not appear to be effective.

Regarding the effectiveness of stabilisation exercises for chronic back pain, 10 trials reported pain and function scores in the short term [10,11,29,32,33,35,38–40,44], of which six were high quality. In the short term, five,

Table 1
Summary of included trials

Trial	Number	Setting	Duration	Subgroup[a]	Intervention	Outcome/follow-up
Hides *et al.* [9]	39	A&E dept	<3 weeks, first episode	Unilateral LBP +/−, multifidus asymmetry >11%	1. Multifidus and abdominal training[b] 2. Medical management muscle	Pain, RMDQ, ROM, activity, muscle CSA at 1, 2, 3 and 4 weeks
O'Sullivan *et al.* [10]	44	?	>3 months	CLBP +/−, spondylolysis or spondylolisthesis	1. Multifidus and abdominal training[b] 2. General exercise	Pain, Oswestry at 3, 6 and 30 months, ROM, ability to contract abdominals before and after
Hides *et al.* [12]	39	a/a	a/a	a/a	a/a	Recurrence of LBP at 1 and 3 years
Moseley [29]	57	Physiotherapy clinic	>2 months	CLBP	1. Trunk muscle training[b], manual therapy, education session 2. Medical management	Pain, RMDQ, health care for LBP at 1 month and 1 year
Niemesto *et al.* [30]	204	Hospital setting	>3 months	CLBP +/−, Oswestry >16%	1. Stabilisation exercises[b], manual therapy 2. Medical management	Pain, Oswestry, sick leave, costs, depression at 5 and 12 months
Rasmussen-Barr *et al.* [32]	47	Physiotherapy clinic	>6 weeks	Subacute and CLBP +/−	1. Stabilisation training[b] 2. Manual therapy	Pain, general health, Oswestry, DRI at 3 and 12 months
Shaughnessey and Culfield [33]	41	Hospital setting	Minimum 12 weeks	CLBP +/−	1. Stabilisation exercises[b] 2. No intervention	Oswestry, RMDQ, SF-36 at end of intervention (10 weeks)
Stuge *et al.* [35]	81	Recruited from health practitioners	Mean 7.6 months	Pregnancy-related LBP	1. Stabilisation exercises[b], manual therapy 2. Manual therapy, stretching and strengthening exercises	Pain, Oswestry, SF-36, at 20 weeks and 1 year
Stuge *et al.* [36]	81	a/a	a/a	a/a	a/a	a/a at 2 years
Childs[c] *et al.* [34]	131	Physical therapy clinics	Median 27 days	Subacute +/−	1. Stabilisation exercises[b] plus ROM and aerobic exercises 2. Two sessions of manipulation, then as group 1	Pain, FABQ, Oswestry at 1 and 4 weeks and 6 months
Monticone *et al.* [37]	22	?	<3 months	Acute and subacute with positive pain SIJ tests	1. Stabilisation exercises, SIJ belt, laser 2. Laser	Pain after 12 months
Bakhtiary *et al.* [38]	60	Physical therapy department	>2 months	CLBP with sciatica and disc herniation	1. Stabilisation exercises 4 weeks, no exercise 2. No exercise 4 weeks, stabilisation exercises	Pain, ROM, SLR, time to complete ADL at 4 and 8 weeks
Koumantakis *et al.* [11]	55	Hospital and primary care	Mean 3 months	Recurrent subacute or CLBP, signs or symptoms of instability excluded[d]	1. Stabilisation exercises[b], general exercises 2. General strengthening exercises	Pain, RMDQ, pain beliefs at 2 and 5 months
Celestini *et al.* [41]	48	?	?	Women with relapsing CLBP with signs of instability	1. Stabilising plus orthosis 2. Orthosis only	Pain 3, 6 and 12 months
Niemisto *et al.* [31]	a/a	a/a	a/a	a/a	a/a	Pain, Oswestry, QoL, satisfaction, costs at 2 years

Filiz *et al.* [40]	60	Hospital clinic	1 month post-surgery	Post-lumbar discectomy	1. Stabilisation exercises plus back school 2. Flexibility exercises plus back school 3. Control	Pain, lifting capacity, Oswestry, depression, ROM, endurance, return to work after treatment (8 weeks)
Miller *et al.* [39]	30	Physical therapy clinic	Minimum 7 weeks	CLBP	1. Stabilisation exercises[b] 2. McKenzie method	FSQ, McGill pain questionnaire, SLR after treatment (6 weeks)
Elden *et al.* [42]	386	Maternity care centre	Not stated	Pregnancy-related pelvic girdle pain	1. Stabilisation exercises[b], stretching, massage, plus as 3 2. As 3 plus acupuncture 3. Standard advice, pelvic belt, and strengthening exercises	Pain, independent examiner 1 week after treatment
Brennan *et al.* [43]	123	Physical therapy clinics	<90 days	Subacute, no nerve root	1. Stabilisation exercises[b] 2. Manipulation 3. Directional preference exercises	Oswestry at 4 weeks and 1 year
Goldby *et al.* [44]	302	Physical therapy departments	≥12 weeks	CLBP	1. Stabilisation exercise[b] class, back school 2. Manual therapy, back school 3. One education session, back school	Pain, Oswestry, NHP at 3, 6, 12 and 24 months
Cairns *et al.* [45]	97	Physical therapy departments	Mean 8.7 months	CLBP	1. Stabilisation exercises[b], manual therapy advice 2. Exercises, manual therapy, advice	RMDQ, pain, Zung, DRAM, SF-36 at 12 months

A&E, accident and emergency; RMDQ, Roland-Morris Disability Questionnaire; ROM, range of movement; CSA, cross-sectional area; DRI, Disability Rating Index; FSQ, Functional Status Questionnaire; NHP, Nottingham Health Profile; SLR, straight leg raise test; QoL, quality of life; DRAM, Distress Risk Assessment Method; LBP, low back pain; CLBP, chronic low back pain; SF-36, Short Form-36; ADL, activities of daily living. a/a, as in initial trial above; SIJ, sacroiliac joint; FABQ, Fear-avoidance belief questionnaire.

[a] Where subgroup has +/−, indicates with and without referred symptoms.

[b] Training in line with work by Richardson *et al.* [6].

[c] Stabilisation intervention described in more detail in related article (Fritz *et al.* [50]).

[d] "Radiological diagnosis of spondylolysis or spondylolisthesis corresponding to a symptomatic level; 'catching', 'locking', 'giving way', or 'a feeling of instability' in one direction or multiple directions of spinal movements" (Koumantakis *et al.* [11]).

Table 2
Outcomes for acute low back pain – mean percentage difference (95% confidence interval) except where indicated

Reference/follow-up/control[a]	PEDro score	Pain[b]	*P*-value[c]	Function[b]	*P*-value[c]
Short-term outcomes (≤3 months from randomisation)					
Childs *et al.* [34]:					
1 week	8			−9.2 (−4.4 to −14.1)	<0.006
4 weeks				−8.3 (−2.4 to −14.2)	
Manipulation + stabilisation exercises					
Hides *et al.* [9][d]	7	4	0.96	−1	NS
Medical management					
Brennan *et al.* [43]: 4 weeks	7				
Manipulation				−4.4 (−12.9 to 4.1)	NS
Directional preference exercises				0.2 (−8 to 8.4)	NS
Monticone *et al.* [37][e]: after	5	50	**<0.05**		
Laser					
Medium-term outcomes (>3 months and <12 months from randomisation)					
Childs *et al.* [34]: 6 months	8			−10.1 (−4.3 to −15.9)	<0.006
Manipulation + stabilisation exercises					
Long-term outcomes (≥12 months from randomisation)					
Brennan *et al.* [43]: 1 year	7				
Manipulation				−4.1 (−14.7 to 6.5)	NS
Directional preference exercises				−4.2 (−13.7 to 5.3)	NS
Monticone *et al.* [37][e]: 12 months	5	50	**<0.05**		
Laser					

[a] Bold text indicates the ‘active’ control group, and non-bold text indicates the ‘inactive’ control group (see text).
[b] Percentage difference between groups with positive scores indicating stabilisation exercises more effective than comparison from baseline (95% confidence interval).
[c] Bold text indicates stabilisation exercises significantly better than control, and non-bold text indicates no significant differences (NS) or control significantly better than stabilisation exercises.
[d] Figures estimated from graph with no standard deviation.
[e] Outcomes presented as medians.

mainly high-quality, trials showed significant differences for pain and function favouring stabilisation exercises, one high-quality trial showed a significant difference for function for the control group, and four, mostly poor-quality, trials showed no significant differences for pain or function between stabilisation exercises and the control group.

In the medium term, there were significant differences in pain and function favouring stabilisation exercises in two high-quality trials, and non-significant differences in three and two trials, respectively, one of which was high quality. In the long term, there were significant differences in pain and function scores in four and five trials, respectively, in favour of stabilisation exercises; most of these were high-quality trials. There were no significant differences in pain and function in four and three trials, respectively; most of these were poor-quality trials. Thus, overall, although the majority of high-quality trials favoured stabilisation exercises, the evidence was contradictory. Furthermore, when compared with ‘inactive’ controls, stabilisation exercises were consistently significantly better than the controls, but when compared with ‘active’ treatments, significant differences were less likely (Tables 2–4).

Discussion

For this systematic review, 18 RCTs were found that compared stabilisation exercises with a control group; three of these had additional long-term follow-up. The overall quality of the trials was moderate, with 13 publications scoring ≥6 on the PEDro scale. A large number of potential studies were excluded, and only studies using clearly defined stabilisation exercises [6,10] as the main treatment were included.

Overall, the exercises were applied to a wide variety of patients, including patients with acute and chronic back pain, and patients with specific and non-specific back pain, including pregnancy-related back pain. Most of the specific back pain groups were only investigated in one trial, so it is impossible to draw any conclusions about the specific groups investigated. Back pain related to pregnancy was investigated in two trials, one of which favoured the stabilisation group [35,36], whereas in the other trial, standard treatment was less effective but acupuncture was more effective than in the stabilisation group [42]. The evidence for the use of stabilisation exercises in patients with acute and subacute back pain is limited. One high-quality [12] and one poor-quality study [37] clearly favoured the stabilisation group, one study

Table 3
Outcomes for chronic low back pain – mean percentage difference (95% confidence interval) except where indicated

Reference/follow-up/control[a]	PEDro score	Pain[b]	P-value[c]	Function[b]	P-value[c]
Short-term outcomes (≤3 months from randomisation)					
O'Sullivan *et al.* [10]:					
after	7	35 (20.9 to 49.1)	**<0.0001**	13 (3 to 23)	**<0.0001**
3 months		32 (15.7 to 48.3)	**<0.0001**	10 (−0.7 to 20.7)	**<0.0001**
Medical management					
Stuge *et al.* [35][d]: after	7	18.2 (10.1 to 26.3)	**<0.005**	18.6 (10.4 to 26.8)	**<0.001**
Manual therapy and exercises					
Bakhtiary *et al.* [38]: 4 weeks	7	27 (19 to 35)	**<0.0001**		
No intervention					
Koumantakis *et al.* [11]: 8 weeks	7	−0.5 (−11.9 to 10.9)	NS	−10.4 (−19.9 to −0.9)	0.027
General strengthening exercises					
Moseley [29]	6	15 (7 to 23)	**<0.01**	21.4 (11 to 31.9)	**<0.01**
Medical management					
Rasmussen-Barr *et al.* [32][d]:					
after	5	5	NS	7	**0.042**
3 months		9	NS	11	NS
Manual therapy					
Shaughnessey and Culfield [33]: after	5				
No intervention control		19 (10.3 to 27.7)	**<0.0001**	14 (5.1 to 22.9)	**<0.0001**
Miller *et al.* [39]: after	5	6 (−8.6 to 20.6)	NS	4.3 (−5.7 to 14.3)	NS
McKenzie					
Goldby *et al.* [44]: 3 months	4		NS		NS
Manual therapy		−3.4 (−12 to 5.2)		1.7 (−3.1 to 6.5)	
Education		13.7 (1.8 to 25.6)		4.1 (−2.1 to 10.3)	
Medium-term outcomes (>3 months and <12 months from randomisation)					
Niemisto *et al.* [30]: 5 months	8	17.1 (10.8 to 23.4)	**<0.001**	4.6 (1.6 to 7.6)	**<0.001**
Medical management					
O'Sullivan *et al.* [10]: 6 months	7	36 (20.7 to 51.3)	**<0.0001**	15 (5.2 to 24.8)	**<0.0001**
Medical management					
Koumantakis *et al.* [11]: 5 months	7	−0.3 (−11.9 to 11.3)	NS	−5.9 (−15.3 to 3.5)	NS
General strengthening exercises					
Goldby *et al.* [44]: 6 months	4		NS		NS
Manual therapy		4.1 (−5 to 13.2)		6 (0.6 to 11.4)	
Education		15.2 (2.1 to 28.3)		5 (−2.4 to 12.4)	
Celestini *et al.* [41]: 6 months[e]	3	42%	NS		
Orthosis					
Long-term outcomes (≥12 months from randomisation)					
Niemisto *et al.* [30]: 12 months	8	12.7 (6.5 to 18.9)	**<0.001**	3.5 (0.5 to 6.5)	**<0.001**
Medical management					
O'Sullivan *et al.* [10]: 30 months	7	35 (18.9 to 51.1)	**<0.0001**	18 (6.9 to 29.1)	**<0.0001**
Medical management					
Stuge *et al.* [35][d]: 1 year	7	21.4 (12.7 to 30.1)	**<0.005**	15.3 (7.2 to 23.4)	**<0.001**
Manual therapy and exercises					
Cairns *et al.* [45]: 12 months	7	−1 (−10.9 to 8.9)	NS	−1.5 (−9.8 to 6.8)	NS
Manual therapy and exercises					
Moseley [29]: 1 year	6	19 (10 to 28)	**<0.025**	21.4 (12.6 to 31.9)	**<0.025**
Medical management					
Niemisto *et al.* [31]: 2 years	5	7.1 (0 to 14.2)	**0.01**	1.8 (−1.4 to 5)	NS
Medical management					
Rasmussen-Barr *et al.* [32][d]: 12 months	5	6	NS	4	NS
Manual therapy					
Stuge *et al.* [36][d]: 2 years	5	19 (10.4 to 27.6)	**<0.005**	5.5 (−3.2 to 14.2)	**<0.001**
Manual therapy and exercises					

Table 3 (*Continued*)

Reference/follow-up/control[a]	PEDro score	Pain[b]	*P*-value[c]	Function[b]	*P*-value[c]
Goldby *et al.* [44]: 1 year	4		NS		**<0.001**
Manual therapy		−4 (−13.4 to 5.4)		6.1 (0.6 to 11.6)	
Education		8.9 (−4.1 to 21.9)		9.1 (2 to 16.2)	
Celestini *et al.* [41]: 6 months[e]	3	0%	NS		
Orthosis					

[a] Bold text indicates 'active' control group, and non-bold text indicates 'inactive' control group (see text).
[b] Percentage difference between groups with positive scores indicating stabilisation exercises more effective than comparison from baseline (95% confidence interval) unless stated.
[c] Bold text indicates stabilisation exercises significantly better than control, and non-bold text indicates no significant differences (NS) or control significantly better than stabilisation exercises.
[d] Outcomes presented as medians.
[e] Difference between groups in 'no pain'.

favoured the control group [34], and two studies reported non-significant differences in pain and function [9,43]. The evidence for the use of stabilisation exercises in patients with chronic back pain is stronger but conflicting. Of 12 trials, five favoured the stabilisation group for short-term outcomes, two for medium-term outcomes, and four for long-term outcomes.

However, although both the high-quality studies and the majority of studies favoured stabilisation treatment, its effectiveness was less clear when the type of control group was considered. Against 'inactive' treatments, meaning limited or unmonitored patient participation in management or limited therapist input, stabilisation exercises were consistently significantly better. However, compared with 'active' treatments, involving the patient exercising or the therapist performing additional interventions, stabilisation exercises were less likely to be significantly better. It should also be noted that only four trials used stabilisation exercises as the sole treatment; in the majority of studies with a positive outcome, stabilisation exercises were combined with some other intervention, most commonly manual therapy. This suggests that it was the whole package of interventions that was effective rather than the stabilisation exercises alone; this inference cannot be denied when multiple interventions are investigated in this way.

It has been suggested that changes greater than 2 points on a 10-point scale represent a minimal clinically meaningful change in pain [46], whilst the minimal level of detectable change is between 4 and 5 points for moderate disability on the Roland Morris Disability Questionnaire [47]. These convert to differences in pain of 20% and differences in function of between 17% and 21%. These types of difference were only obtained in a minority of trials, so the clinical significance of any statistical differences between the groups was not distinctive.

All studies included measures of pain and/or disability caused by back pain, which was the focus of this review. These were standardised tools, such as the Numeric Pain Rating Scale, Oswestry or Roland-Morris Disability Questionnaires, which were commonly used. Only three studies made no attempt to explore function with a standardised questionnaire. In addition to pain and function, some trials considered other relevant outcomes, such as recurrences, healthcare usage, costs, general health or psychosocial outcomes, but these were only included in one trial so conclusions cannot be drawn.

These findings are similar to those of a previous systematic review [25], which reported that stabilisation exercises were effective for pelvic pain and prevention of recurrence,

Table 4
Outcomes for low back pain of unclear duration – mean percentage difference (95% confidence interval) except where indicated

Reference/follow-up/control[a]	PEDro score	Pain[b]	*P*-value[c]	Function[b]	*P*-value[c]
Short-term outcomes (≤3 months from randomisation)					
Elden *et al.* [42][d]: 1 week	8				
Acupuncture		−19	0.013		
Standard		10	**<0.031**		
Filiz *et al.* [40]: after	6				
Flexibility exercises		6 (4.3, 7.7)	**<0.001**	5.4 (1.4, 9.4)	NS
Control		4.5 (−0.9, 9.9)	**<0.001**	7.6 (3.4, 11.8)	**<0.001**

[a] Bold text indicates 'active' control group, and non-bold text indicates 'inactive' control group (see text).
[b] Percentage difference between groups with positive scores indicating stabilisation exercises more effective than comparison from baseline (95% confidence interval) unless stated.
[c] Bold text indicates stabilisation exercises significantly better than control, and non-bold text indicates no significant differences (NS) or control significantly better than stabilisation exercises.
[d] Outcomes presented as medians.

but not for pain and disability in acute low back pain. Efficacy in pelvic pain is less clear from the present review. The previous review [25] also reported effectiveness for chronic low back pain against inactive treatments, but not against active treatments as was found in the present review. It remains unclear if stabilisation exercises are superior to other forms of exercise or manual therapy. There were no clinically significant differences between stabilisation exercises and general strengthening [11], McKenzie [39] or directional preference [43] exercises. In comparison with manual therapy, some studies supported the effectiveness of stabilisation exercises [32,35,36], but others only found minor differences [43–45] or found that manual therapy was superior [34].

There may be a subgroup of back pain patients who respond best to stabilisation exercises, as suggested by a clinical prediction rule [48]. In support of this notion, one trial found no significant difference between randomly assigned treatment groups, but did find a significant difference between patients matched to their clinical prediction rule and unmatched patients [43]. However, no distinction was made between those matched to stabilisation, manipulation or directional preference prediction rules. Furthermore, the rule has not been tested prospectively in another population, and the number of potential factors tested in the rule was high given the moderate number of patients ($n = 54$) [49]. Alternatively, there may be physical examination procedures to detect 'instability' that might then be treated with stabilisation exercises. However, only the prone instability test has demonstrated reasonable intertester reliability, with kappa values of 0.69 [50] and 0.87 [51] in two studies. At this stage, there are no completely valid and reliable methods for detecting at baseline those who might respond to stabilisation exercises.

Clinically, the implication of this review is that stabilisation exercises should not be recommended for patients with acute low back pain. For patients with chronic low back pain, stabilisation exercises are likely to produce outcomes little different from other active exercise or manual-therapy-based interventions. There may be a subgroup of the back pain population who respond best to stabilisation exercises; however, recognition of this group, if it exists, requires further study.

There are several implications for research from this review. As interventions appear to do better against inactive than active control groups, any interpretation of efficacy studies must consider the type of control group, and additional economic outcomes would be useful to evaluate interventions. Many of the trials used mixed interventions, and whilst such a strategy may be considered pragmatic in that it mimics everyday clinical practice, it is not as useful from a research perspective as it is unclear which element of the combined treatment was the effective ingredient. In terms of trial quality, two common limitations were lack of blinding of therapists and patients. Whilst these items are routinely included in quality criteria for RCTs, their relevance to physical therapy interventions in which both patients and therapists are actively engaged in the intervention is questionable. Trial quality could be improved by performing sample size calculations prior to recruitment, using standardised outcome measures and ensuring full reporting of results. None of the included studies attempted to measure 'instability' prior to the stabilisation exercises, and whether the exercises had been sufficiently specific to improve this 'abnormality'. Thus, it is not known if a necessary condition for a better outcome is an improvement in this parameter. This would be an important area for future research. One study [9] did show percentage improvement in cross-sectional area of multifidus in stabilisation and control groups, with a marked improvement in the former and slower improvement in the latter. However, there were no significant differences in pain and function outcomes.

There may be limitations to this review. The authors endeavoured to be as systematic and comprehensive in the search strategy as possible, and certainly retrieved more studies than previous reviews [24,25]. However, only studies written in English that were published as full articles (rather than abstracts) were included. Risks of language and publication bias affect all reviews, as studies with negative results may be less likely to be published. These restrictions may mean that some studies were missed, but as the evidence overall was contradictory, this would be unlikely to change the conclusions categorically.

In summary, based on the available evidence, it appears that specific stabilisation exercises may reduce pain and disability in chronic but not acute low back pain. Stabilisation exercises appear to be more effective in specific back pain groups than non-specific back pain groups. However, most subgroups were only evaluated in a single trial. Stabilisation exercises appeared to affect pain more than function. Specific stabilisation exercises were, in general, superior to no treatment, usual care or other minimal interventions, but the effects of stabilisation exercises were little different from other active interventions. As most studies involved a combination of interventions, it cannot be stated conclusively that stabilisation exercises were the effective element.

Conflict of interest: None.

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