

# Accepted Manuscript

Comparative effectiveness of conservative interventions for non-specific chronic spinal pain: Physical, behavioural/psychologically informed or combined? A systematic review and meta-analysis

Mary O’Keeffe, BSc Physio, Helen Purtill, PhD, Norelee Kennedy, PhD, Mairead Conneely, M Sports Physio, John Hurley, BSc Physio, Peter O’Sullivan, PhD, PGDip, Wim Dankaerts, PhD, PGDip, Kieran O’Sullivan, PhD

PII: S1526-5900(16)00504-6

DOI: [10.1016/j.jpain.2016.01.473](https://doi.org/10.1016/j.jpain.2016.01.473)

Reference: YJPAI 3215

To appear in: *Journal of Pain*

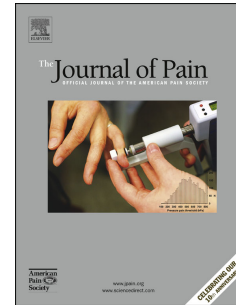
Received Date: 25 February 2015

Revised Date: 5 December 2015

Accepted Date: 14 January 2016

Please cite this article as: O’Keeffe M, Purtill H, Kennedy N, Conneely M, Hurley J, O’Sullivan P, Dankaerts W, O’Sullivan K, Comparative effectiveness of conservative interventions for non-specific chronic spinal pain: Physical, behavioural/psychologically informed or combined? A systematic review and meta-analysis, *Journal of Pain* (2016), doi: 10.1016/j.jpain.2016.01.473.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



**Title:** Comparative effectiveness of conservative interventions for non-specific chronic spinal pain: Physical, behavioural/psychologically informed or combined? A systematic review and meta-analysis.

Mary O’Keeffe, BSc Physio,<sup>1</sup> Helen Purtill, PhD,<sup>2</sup> Norelee Kennedy, PhD,<sup>1</sup> Mairead Conneely, M Sports Physio,<sup>1</sup> John Hurley, BSc Physio,<sup>1</sup> Peter O’Sullivan, PhD, PGDip,<sup>3</sup> Wim Dankaerts, PhD, PGDip,<sup>4</sup> Kieran O’Sullivan, PhD<sup>1</sup>

<sup>1</sup>Department of Clinical Therapies, University of Limerick, Limerick, Ireland

<sup>2</sup>Department of Mathematics and Statistics, University of Limerick, Limerick, Ireland

<sup>3</sup>School of Physiotherapy and Exercise Science, Curtin University, Perth, Australia

<sup>4</sup>Musculoskeletal Unit, Department of Rehabilitation Sciences, University of Leuven, Leuven, Belgium

**Corresponding Author:**

Mary O’Keeffe, BSc Physiotherapy,

Department of Clinical Therapies, University of Limerick, Limerick, Ireland.

Phone: +353876726003

Email: [Mary.OKeeffe@ul.ie](mailto:Mary.OKeeffe@ul.ie)

**Disclosures**

One of the authors (MOK) is supported by the Irish Research Council (IRC). The IRC were not involved in any part of the design, execution, or interpretation of this study. Three of the authors (KOS, WD, POS) receive income from delivering educational courses on the use of specific combined approaches to managing spinal pain. The authors declare that they have no conflicts of interest in the authorship and publication of this review.

**Abstract**

Non-specific chronic spinal pain (NSCSP) is highly disabling. Current conservative rehabilitation commonly includes physical and behavioural interventions, or a combination of these approaches. Physical interventions aim to enhance physical capacity by using methods such as exercise, manual therapy and ergonomics. Behavioural and/or psychologically informed interventions aim to enhance behaviours, cognitions or mood by using methods such as relaxation and cognitive behavioural therapy (CBT). Combined interventions aim to target both physical and behavioural and/or psychological factors contributing to patients' pain by using methods such as multidisciplinary pain management programmes. Since it remains unclear whether any of these approaches are superior, this review aimed to assess the comparative effectiveness of physical, behavioural and/or psychologically informed, and combined interventions on pain and disability in patients with NSCSP. Nine electronic databases were searched for randomised controlled trials (RCTs) including participants reporting NSCSP. Studies were required to have an "active" conservative treatment control group for comparison. Studies were not eligible if the interventions were from the same domain (e.g. if the study compared two physical interventions). Study quality was assessed using the Cochrane Back Review Group risk of bias criteria. The treatment effects of physical, behavioural and/or psychologically informed, and combined interventions were assessed using meta-analyses. 24 studies were included. No clinically significant differences were found for pain and disability between physical, behavioural and/or psychologically informed and combined interventions. The simple categorisation of interventions into physical, behavioural and/or psychologically informed and combined could be considered a limitation of this review, as these interventions may not be easily differentiated to allow accurate comparisons to be made. Further work should consider investigating whether tailoring

rehabilitation to individual patients and their perceived risk of chronicity, as seen in recent RCTs for low back pain (LBP), can enhance outcomes in NSCSP.

**Perspective:** In this systematic review of RCTs in NSCSP, only small differences in pain or disability were observed between physical, behavioural and/or psychologically informed and combined interventions.

**Keywords:** non-specific chronic spinal pain; physical; behavioural/psychological; combined; systematic review

ACCEPTED MANUSCRIPT

## Introduction

Non-specific chronic spinal pain (NSCSP), particularly low back pain (LBP) and neck pain (NP), remains a common musculoskeletal disorder, resulting in a significant personal, social and economic burden.<sup>50, 64, 121</sup> While LBP and NP occupy different body regions, strong evidence exists that both are best considered multidimensional disorders, associated with a complex interaction of contributory factors.<sup>56, 83, 99, 101</sup> While a plethora of interventions for NSCSP have been tested, heralding similar short-term outcomes,<sup>5, 105</sup> positive long-term outcomes are infrequent. One explanation for this relative ineffectiveness is the fact that many interventions used are uni-dimensional, either focusing on physical or behavioural and/or psychological factors, rather than combining these approaches and/or tailoring them to the individual needs of the person with NSCSP.<sup>68, 83</sup> However, research on the tailoring of care to date has mixed results, with some studies showing encouraging findings<sup>33, 47</sup>, and others not showing an effect.<sup>44</sup> Considering the increase in the number of randomised controlled trials (RCTs) conducted on NSCSP there is a need for a systematic review to determine which of these interventions has the greatest level of evidence.

Physical factors which have been described among people with NSCSP include maladaptive postures,<sup>27, 127</sup> movement patterns associated with altered levels of muscle activity<sup>32, 48</sup>, altered body perception,<sup>14, 94</sup> pain behaviours (e.g propping, breath-holding, bracing),<sup>72</sup> and muscular deconditioning.<sup>28, 128</sup> Behavioural and/or psychological factors which have been described among people with NSCSP include fear,<sup>80, 81</sup> maladaptive beliefs,<sup>16, 86</sup> catastrophic thoughts,<sup>13, 123</sup> hypervigilance,<sup>85, 125</sup> anxiety, depression, stress,<sup>17, 116</sup> poor pacing, maladaptive coping strategies,<sup>1, 18</sup> poor self-efficacy,<sup>106, 126</sup> physical inactivity<sup>39</sup> and sleep problems.<sup>58</sup>

Therefore, current rehabilitation for NSCSP comprises a range of interventions, primarily aimed at addressing physical, behavioural and/or psychological or both of these factors.

Physical interventions aim to enhance physical capacity by using methods such as exercise, manual therapy and ergonomics.<sup>112</sup> Despite many treatment options, numerous trials have shown that most physical interventions have similar modest levels of effectiveness in the treatment of NSCSP.<sup>7, 52, 65, 71, 122</sup> Furthermore, positive results for these physical interventions are most evident when compared to minimal interventions, placebo or waiting list control groups.<sup>9, 38, 43, 59, 75</sup>

Behavioural and/or psychologically informed interventions use educational, cognitive or psychological strategies to enhance behaviours, cognitions or moods. These include relaxation, biofeedback, cognitive-behavioural therapy (CBT), mindfulness-based stress reduction (MBSR) as well as acceptance and commitment therapy (ACT).<sup>49</sup> Similar to the evidence for physical interventions, no behavioural and/or psychologically informed intervention has been found to be superior to another.<sup>45, 103, 114, 115</sup> In addition, positive effects are once again most evident when compared to minimal interventions, placebo or waiting list control groups.<sup>22, 31, 45, 84, 102, 124</sup>

Combined interventions aim to target both physical and behavioural and/or psychological factors contributing to a patients' pain. These include multidisciplinary pain management programmes, functional restoration programmes (FRP), yoga, graded activity, graded exposure, behaviourally-informed physiotherapy or exercise combined with behavioural

and/or psychologically informed interventions such as relaxation or CBT.<sup>23, 41, 89, 97, 111</sup>

Combined interventions have been shown to be superior to minimal interventions, placebo or waiting list control groups.<sup>54, 76, 87, 109</sup>. One review<sup>54</sup> conducted in CLBP found that MDT programmes were more effective than physical treatments and concluded that cost and resources should be considered when deciding whether such interventions are worthwhile, considering the small size of the effect. This review<sup>54</sup> also suggests that combined interventions should be reserved for more complex patients.

While it seems clear that physical, behavioural/psychologically informed and combined interventions are superior to minimal or no treatment,<sup>6, 57, 84</sup> it remains unclear whether either is superior to the other. While one systematic review<sup>54</sup> has compared the effectiveness of physical and multidisciplinary programmes in people with CLBP, no systematic review has compared the effectiveness of the current interventions in a NSCSP population. Furthermore, no review has compared the effectiveness of behavioural and combined treatments in this population. Therefore, the primary objective of this systematic review was to assess the comparative effectiveness of physical, behavioural/psychologically informed, and combined interventions on pain and disability in patients with NSCSP.

## Methods

### Literature Search Strategy

The review was registered on the PROSPERO database (Registration number CRD42013005757) and has been reported in accordance with the PRISMA statement.<sup>77</sup> All relevant RCTs and cluster randomised trials meeting the inclusion criteria (see below) were identified by;

- A computer aided search of the Medline, Cinahl, SPORTDiscus, Biomedical Reference Collection, AMED, PsycINFO, PsycARTICLES, Embase and Web of Science databases from the period of inception to January 2013 using the search strategy recommended by the Cochrane Back Review Group (Figure 1). The search was restricted to include trials that involved humans and which were published in English.
- Scanning the reference lists of previous systematic reviews and included studies for further references.

Two independent reviewers conducted the electronic searches. The strategy had four components which were combined: (1) physical/behavioural/psychological/combined intervention, (2) spinal pain, (3) chronic and (4) RCT (see Supplementary appendix A for details).



**Inclusion and exclusion criteria****Study design**

Only published reports of completed RCTs published in peer-reviewed journals were included. Studies were required to have a minimum follow-up period of 12 weeks after completion of treatment.

**Population**

Studies including participants with NSCSP (neck, thoracic, low back, or pelvic) greater than 12 weeks duration and between 18 and 65 years of age, were eligible. Participants with previous spinal surgery (>6 months previously) were eligible. Studies that involved participants with specific pathologies/conditions (e.g. pregnancy, fibromyalgia, rheumatoid arthritis, ankylosing spondylitis, stenosis, psoriatic arthritis, lupus erythematosus, scheurmann's disease, spondylolisthesis or "red flag" disorders (e.g. spinal cord compression/cauda equina, spinal cord injury, neoplasm, fracture) were excluded.

**Interventions**

Studies were required to involve a head-to-head comparison between two of our three chosen categories of interest (i.e. active physical or behavioural/psychologically informed or combined interventions). Therefore, studies that had "no treatment", "waiting list" "treatment as usual" or usual medications as a control group were excluded. If however, "usual treatment" involved some form of therapy other than GP/medications (e.g. usual outpatient physiotherapy/pain clinic rehabilitation), a study was eligible for inclusion. Comparisons to

surgery, percutaneous procedures or pharmacology were excluded, as these were not deemed to be active physical or behavioural and/or psychologically informed interventions. Studies deemed to have a minimalist control group only (e.g. short duration education sessions/seminars or merely provision of education or advice booklets) were excluded, based on data highlighting that physical, behavioural and/or psychologically informed and combined interventions have established superiority over minimalist intervention efforts.<sup>84, 112</sup> Studies were not eligible if the interventions were from the same domain (e.g. if the study compared physical to physical). Education was defined as physical if it was pertaining to physical aspects such as posture, anatomy, exercise or biomechanics. Education was defined as behavioural and or psychologically informed if it was pertaining to cognitive and psychological aspects such as beliefs, fear, stress, relaxation. An intervention was only deemed to have an education component if it was a major aspect of the intervention provided. For example, if an intervention had a large physical component and had an educational leaflet that was behaviour focussed, such an educational leaflet was not adequate to be defined as behavioural. Therefore this intervention would still be defined as physical, not combined.

### **Clinical Outcomes**

Studies had to report results from one or more outcome measures in the domains of pain intensity and/or level of functional disability. Since research highlights that interventions for NSCSP have similar outcomes immediately after treatment,<sup>6</sup> eligible studies were required to have data at least 12 weeks after the completion of treatment. Outcome data were then only abstracted for three time periods: short-term follow-up (12 weeks to <6 months), medium-term follow-up (6 months to <12 months) and long-term follow-up (12 months or more).

### **Selection of studies**

A standard protocol was followed for study selection and data abstraction.<sup>113</sup> After the removal of duplicates, two reviewers independently screened the titles and abstracts from the articles found and discarded the irrelevant citations according to the selection criteria. If no abstract was available, or when it was not clear if the study should be included, full-text articles were retrieved in order to determine inclusion or exclusion. Both reviewers kept a record of their reasons for the inclusion or the exclusion of articles. The screened lists were compared between the two reviewers. To minimize the risk of discarding studies incorrectly, articles that were initially chosen by only one reviewer were included for the next stage of the review. The full-text version of an article was obtained if the title and abstract seemed to fulfil the inclusion criteria or if the eligibility of the study was unclear. Any disagreements on study eligibility were resolved by discussion and a consensus meeting. Original study authors were emailed if clarification was needed on interventions provided.

### **Quality assessment**

Two reviewers conducted the quality assessment independently, using the risk of bias criteria advised by the Cochrane Back Review Group (CBRG)<sup>37</sup> (see Supplementary appendix B for details) which consists of 12 items: random sequence generation; allocation concealment; blinding of participants; blinding of personnel/care providers; blinding of outcome assessor; incomplete outcome data; selective reporting; group similarity at baseline; co-interventions; intention-to-treat analysis; timing of outcome assessment; and any other bias not covered elsewhere. Each item was scored as “Yes” if it fulfilled the criteria, as “No” when there was a risk of bias and as “Unclear” if there was insufficient information. When it was unclear whether a study did or did not meet an item, or if no clear information regarding the item was stated, the author of the original study was contacted for clarification. A total score was

calculated by using the number of items scored as “Yes”. Differences in the reviewers’ assessment of risk of bias were discussed during a consensus meeting. A total score was computed, and high quality was defined as fulfilling six or more (>50%) of the internal validity criteria (range 0–12). The quality assessment scores for all studies are shown in Table 1.

### **Data extraction**

Data regarding each study were extracted and cross-checked by two reviewers. The following data were extracted from the studies: (1) characteristics of the studies: number of participants, sex, age, area of pain and inclusion/exclusion criteria (2) characteristics of the interventions: the type and content of interventions; (3) characteristics of the outcomes: pain and disability outcome measures, length of follow-up and (4) results summary of each study. Similarities in the outcome measures used, the subjects included and the interventions examined allowed for pooled analysis of most of the data.

The data extracted from all studies are shown in Table 2.

### **Data analysis**

Data analysis was performed by a statistician (HP). The treatment effects of physical interventions were compared to (1) behavioural and/or psychologically informed interventions and (2) combined interventions using meta-analyses. Since only one study<sup>107</sup> compared a behavioural and/or psychologically informed and combined intervention, no meta-analysis for this category was completed. The primary outcomes of interest were pain intensity and functional disability. Pain intensity was measured using a visual analogue scale

(VAS) or a numeric rating scale (NRS). The reported pain intensity scores were converted to a 10 point scale, where necessary, and a mean difference (MD) was computed. The analysis of functional disability required a standardised mean difference (SMD) to be computed as studies used a number of different measures to report disability including; Roland-Morris Disability Questionnaire (RMDQ), Oswestry Disability Index (ODI), Pain and Disability Index (PDI), Hannover Activities of Daily Living (ADL) instrument, Neck Pain and Disability Index, Low Back Outcome Scale and Neck Disability Index (NDI). Analyses were carried out at three assessment points, with data from studies included according to the time closest to these intervals: (1) Short-term follow-up (minimum of 12 weeks and <6 months), (2) Medium-term follow-up (minimum of 6 months and <12 months and (3) Long-term follow-up (minimum of 12 months).

A random-effects model was selected for all analyses a priori, as recommended by CBRG<sup>46</sup> and heterogeneity between treatment studies was reported using the  $I^2$  statistic. Substantial heterogeneity was determined using the cut-off;  $I^2 \geq 50\%$ . In studies where multiple contrasts were examined (e.g. physical intervention vs. behavioural and/or psychologically informed intervention 1 vs. behavioural and/or psychologically informed intervention 2), the sample size in the shared comparison was halved in order to avoid double-counting of participants in the analyses.

In cases where standard deviations were not reported at follow-up times, the baseline standard deviation was used in the analysis.<sup>46</sup> In studies where data were summarised using median and interquartile range (IQR) values, the mean was approximated using the median and the width of the IQR was used as an approximation of 1.35 times the standard deviation.<sup>46</sup> Pooled 95% confidence intervals were computed for MD and SMD and confidence intervals excluding zero were considered statistically significant. Clinical relevance was determined using the following effect size classifications: (1) Small: MD < 1

(i.e. less than 10% of the 10-mm VAS); SMD (Cohen's d) of 0.2; (2) Medium: MD < 2, SMD (Cohen's d) of 0.5; (3) Large: MD  $\geq$  2, SMD (Cohen's d) of 0.8.).<sup>21</sup>

The heterogeneity between studies was assessed visually from the forest plots, using formal Q-tests (chi-square test statistic and p-value) and the  $I^2$  statistic. Subgroup analyses were conducted by testing pooled differences in pain and disability between NP and LBP at each follow-up time. A sensitivity analysis was conducted to assess if limiting the analysis to low risk of bias studies changed the results. In this review, a negative effect size indicates that physical interventions are more beneficial than the comparison. All analyses were conducted in Review Manager 5.2.<sup>104</sup>

## Results

### Literature search

Study identification is summarised in Figure 1. The literature search of databases yielded 12,720 potentially relevant articles. 4,746 duplicates were removed and 7,974 titles and abstracts were scanned. 247 full-text studies were retrieved with 223 studies being excluded as they did not meet the eligibility criteria. Searching the reference lists of these articles did not yield any further articles. The major reasons for exclusion were of lack of an "active" control group and comparison of interventions from the same domain (physical, behavioural and/or psychologically informed or combined). 24 articles met the selection criteria.<sup>19, 24, 29, 35,</sup>

36, 40, 53, 55, 65, 67, 74, 78, 88, 90, 91, 93, 95, 98, 107, 119, 120

### **Quality assessment**

The quality assessment scores are shown in Table 1. 48 study authors were emailed about their studies (about treatment content and quality) and to clarify whether they were eligible to be included in this review. 26 authors replied. Studies were excluded if no reply was received from the study author. 21 studies included in this systematic review were deemed to have a low risk of bias ( $>6/12$ ) when scored using the CBRG bias assessment tool, with four studies<sup>19, 74, 78, 95</sup> scoring the highest (9/12). Three studies<sup>35, 90, 107</sup> were deemed to have a high risk of bias ( $<6/12$ ). Common methodological limitations identified across studies included lack of information on co-interventions, blinding and compliance to treatment.

### **Population**

The sample sizes of the included studies ranged from 30 to 393 participants. The average age of the participants in these studies ranged from 39 to 53.5 years. 18 studies investigated patients with CLBP, while six studies investigated participants with chronic neck pain (CNP).

### **Intervention characteristics**

The content and characteristics of the various physical, behavioural/psychologically informed and combined interventions can be seen in Table 2. Five studies compared physical and behavioural/psychologically informed interventions. 20 studies compared physical and combined interventions. Only one study compared a behavioural/psychologically informed and combined intervention.<sup>107</sup>

### **Clinical outcome measures**

All studies reported results for pain intensity. 23 of the 24 studies employed the VAS or NRS to measure pain intensity, while one study<sup>107</sup> utilised the McGill Pain Rating Index. Three studies did not report results for functional disability.<sup>29, 90, 107</sup> The ODI, NDI and RMDQ were the commonly adopted functional disability assessment scales, being used in 18 studies. One study employed the PDI.<sup>55</sup> Another study employed the Hannover ADL instrument.<sup>20</sup> Furthermore, two studies chose the Low Back Outcome Scale<sup>35, 36</sup> and another two utilised the Neck Pain and Disability Scale.<sup>78, 88</sup>

### **Meta-analysis**

22 of the 24 studies were included in the meta-analysis of pain and disability. Therefore, two studies<sup>35, 107</sup> were excluded from the analysis. The first study<sup>35</sup> was a five year follow-up and was excluded from the meta-analysis since the remaining studies all had a long-term follow-up of a maximum of 24 months. The second study<sup>107</sup> used an outcome measure (McGill Pain Rating Index) that was too heterogeneous to be pooled with the remaining studies in the physical versus behavioural/psychological and physical vs combined analyses. This was also the only study<sup>107</sup> to compare a behavioural and combined intervention meaning that pooling of data was not possible and consequently there is no comparison between behavioural and/or psychologically informed versus combined interventions in the meta-analysis. These two studies<sup>35, 107</sup> also had a high risk of bias (<6/12).



### **Subgroup and sensitivity analyses**

Subgroup analyses were conducted by testing pooled differences in pain and disability between NP and LBP studies at each follow-up time. No significant differences were found between subgroups in the effects on pain or disability ( $p>0.05$ ).

A sensitivity analysis was conducted by limiting to studies with a low risk of bias. 21 studies were included in the sensitivity analysis after those at high risk of bias<sup>35, 90, 107</sup> were excluded. No significant differences between interventions in the effects on pain and disability were found ( $p>0.05$ ).

### **Effects of Physical versus Behavioural/psychologically informed interventions on pain intensity**

No statistically significant difference was found for pain intensity between the physical and behavioural and/or psychologically informed groups at short term (two studies,  $n=272$ , MD= 0.03, 95% CI -0.52 to 0.57,  $I^2=0\%$ ) and at medium term (three studies,  $n=278$ , MD= -0.50, 95% CI -1.38 to 0.38,  $I^2=19\%$ ) follow-up (Figure 2).

Since only one study<sup>119</sup> measured pain in the long-term in the physical versus behavioural and or psychologically informed groups, there is no long-term plot in this section of meta-analysis. This study found no statistically significant difference for pain intensity between the physical and behavioural and/or psychologically informed groups.

### **Effects of Physical versus Behavioural/psychologically informed interventions on disability**

No statistically significant difference was found for disability between the physical and behavioural and/or psychologically informed groups at short term (two studies,  $n=272$ , MD= 0.02, 95% CI -0.23 to 0.27,  $I^2= 4\%$ ) and at medium term (three studies,  $n=278$ , SMD= -0.05, 95% CI -0.29 to 0.18,  $I^2=0\%$ ) follow-up (Figure 3).

Since only one study<sup>119</sup> measured disability in the long-term in the physical versus behavioural and/or psychologically informed groups, there is no long-term plot in this section of meta-analysis. This study found no statistically significant difference for disability between the physical and behavioural and/or psychologically informed groups.

### **Effect of Physical versus Combined interventions on pain intensity**

A statistically significant difference was found for pain between groups (favouring the combined group) at short term (five studies,  $n=529$ , MD= 0.52, 95% CI 0.16 to 0.88,  $I^2= 4\%$ ) and at long term (11 studies,  $n=1341$ , MD= 0.46, 95% CI 0.09 to 0.83,  $I^2=40\%$ ) follow-up (Figure 4).

No statistically significant difference was found for pain between physical and combined at medium term follow-up (12 studies,  $n=1535$ , MD= 0.14 95% CI -0.10 to 0.39,  $I^2=0\%$ ) (Figure 4).

**Effect of Physical versus Combined interventions on disability**

A statistically significant difference was found for disability between groups (favouring the combined group) at short term (five studies, n=529, SMD= 0.27 95% CI 0.01 to 0.54,  $I^2=56\%$ ) and at long term (10 studies, n=1189, SMD= 0.25 95% CI 0.07 to 0.43,  $I^2=54\%$ ) follow-up (Figure 5).

No statistically significant difference was found for disability between physical and combined at medium term follow-up (10 studies, n=1206, SMD= 0.12 95% CI -0.06 to 0.30,  $I^2=55\%$ ) (Figure 5).

**Effect of Behavioural/psychologically informed versus Combined interventions on pain intensity and disability**

Since only one study<sup>107</sup> compared a behavioural and/or psychologically informed and combined intervention, no meta-analysis for this category was completed. No statistically significant differences were found for pain and disability between behavioural and/or psychologically informed and combined groups.

**Discussion**

This systematic review and meta-analysis investigated the comparative effectiveness of physical, behavioural and/or psychologically informed and combined interventions for pain and disability in NSCSP populations. No statistically significant differences were found for pain and disability between physical and behavioural and/or psychologically informed groups

in the medium and long-term. No statistically significant differences were found for pain and disability in the single study<sup>107</sup> comparing behavioural and/or psychologically informed and combined interventions. While a small statistically significant difference was found for both pain and disability between the physical and combined group, favouring the combined group, this difference was small. This suggests that there are only small differences between physical, behavioural and/or psychologically informed and combined interventions for reducing pain and disability in NSCSP patients.

While it may appear surprising that these very different interventions demonstrate such similar effects for NSCSP, it is clear that simply combining them offers only a small additional benefit. Consequently, choosing the most cost-efficient, rehabilitation choice which is both acceptable to patients and feasible for a healthcare service to provide should be considered. Similarly, Kamper et al<sup>54</sup> found that combined multidisciplinary programmes are significantly more effective than physical therapies for CLBP, but given the small effect, the decision to choose a combined intervention should be balanced against the time and resources available.

One possible reason for the lack of differences is that both physical and behavioural and/or psychologically informed interventions may in fact have similar mechanisms of effect. This is based on trials showing that successful outcomes, even after a purely physical intervention, are often mediated by changes in cognitive and psychological factors (e.g fear, catastrophising, self-efficacy, beliefs).<sup>2, 69, 79, 96, 110</sup> Another possibility is that other important “non-specific factors” such as clinician support, empathy, ability to motivate and encourage and accommodate patients’ treatment preferences and expectations may be common to these seemingly different interventions.<sup>34</sup> This is supported by data demonstrating that a positive patient-therapist interaction is linked to reduced pain and disability.<sup>42</sup>

It has been proposed that most RCT's have not adequately dealt with the multi-dimensional nature of NSCSP.<sup>34, 76, 83, 100</sup> This is significant considering the growing evidence that NSCSP is associated with a complex interplay of biopsychosocial factors. These may include patho-anatomical factors (e.g. disc prolapse with radiculopathy, spondylolysis/spondylolisthesis, lateral recess/central stenosis),<sup>92</sup> physical factors (e.g. maladaptive postures and movement patterns, altered body perception, pain behaviours and deconditioning),<sup>60</sup> cognitive factors (e.g. unhelpful beliefs, catastrophising, hypervigilance, maladaptive coping strategies, poor self-efficacy),<sup>62</sup> psychological factors (e.g. fear, anxiety, depression),<sup>8, 11</sup> lifestyle factors (e.g. physical inactivity, sleep problems, chronic life stress),<sup>10, 58, 118</sup> neuro-physiological factors (e.g. peripheral and central nervous system sensitisation),<sup>25, 82</sup> social factors (e.g. socio-economic status, family, work and culture),<sup>4, 61</sup> and genetic factors.<sup>66</sup> Even the “combined” treatment approaches did not target this wide range of factors, for example commonly excluding factors such as sleep<sup>58, 108</sup> and life stress.<sup>62</sup>

Another potential reason for the similar effectiveness of these conservative interventions is that the interventions are insufficiently tailored to the needs of patients.<sup>51, 68, 83</sup> For example, one large RCT<sup>47</sup> demonstrated that people with LBP could be categorised into three different “risk” profiles, each with different natural histories for their LBP. Consequently, some groups may benefit from combined physical and psychological support more than others, and identification of these patients could be facilitated by using suitable screening measures.<sup>26, 47, 54, 63</sup> However, when the type (physical or combined) and amount of rehabilitation was matched to the perceived needs of each group, outcomes were improved. The effect sizes for this trial were small however, and in line with the effect sizes displayed in this review. Attempts to individualise rehabilitation in a biopsychosocial manner according to the needs of LBP patients, as opposed to targeting broad “risk” groups, resulted in significantly less pain and disability in another recent RCT.<sup>117</sup> However, since both of these

RCTs offered combined rehabilitation in both interventions arms, they were ineligible for this review. It is important however to acknowledge that individualising rehabilitation based on purely biomedical and physical factors alone does not appear likely to enhance outcomes.<sup>3, 15, 33, 44</sup> Therefore, while the findings of this review demonstrate that simply combining physical and behavioural and/or psychologically informed interventions does not increase effectiveness very much, there is a need for further studies investigating whether tailoring these rehabilitation options to the needs of patients can enhance effectiveness. The possibility that NSCSP will remain highly resistant to treatment in some patients, even when an individualised biopsychosocial approach is used, cannot be discounted. Additionally, the similar effects seen across interventions may also reflect the use of outcome measures which are influenced by the types of bias present in the included studies.

### **Future Research and Clinical implications**

Given the strong evidence that NSCSP is associated with a complex interplay of biopsychosocial factors, the challenge is to determine whether individualised care based on targeting these factors offers greater benefits over other current approaches.<sup>47, 51, 73, 83</sup> Future RCT's should also incorporate mediation analysis to investigate and better understand particular patient profiles who respond best to specific treatment approaches, and the mechanisms underlying different interventions,<sup>70, 96</sup> including consideration of the role of “non-specific” factors such as therapeutic alliance, and the use of qualitative approaches where necessary.

### Strength and limitations

This is the first comprehensive systematic review and meta-analysis to compare the effectiveness of physical, behavioural and/or psychologically informed and combined interventions in NSCSP. Most studies that were included were of high methodological quality. Kamper et al<sup>54</sup> published a systematic review during the completion of the current review, investigating physical versus combined interventions in CLBP. From this perspective, our physical versus combined comparison is a repeat (and therefore confirmation) of the Kamper comparison. The current review had also initially aimed to investigate behavioural and/or psychologically informed versus combined comparisons, but since only one study was found, a meta-analysis could not be completed on this comparison. Furthermore, our review expanded on the Kamper review by including NSCSP, not just CLBP and investigated physical versus behavioural and/or psychologically informed interventions, as well as physical versus combined interventions. However, there are significant issues in our review methodology which need to be acknowledged. Only RCTs published in English were included, therefore potentially relevant studies in other languages may have been excluded. In addition, searches were limited to published studies only, which introduce a risk of publication bias. Not all studies could be included in the meta-analysis. For example, there was no plot showing the effect of behavioural versus combined rehabilitation since there was only one study comparing these interventions.<sup>107</sup> This may indicate a preference for always including a physical component in interventions instead of a behavioural/psychological component, possibly displaying the dominance of the biomedical model in practice and that most treatments assume peripheral nociception is the primary driver of NSCSP. Furthermore, review procedures have evolved since the current authors submitted the original review protocol. The current authors used a summary score out of 12 and specific cut-off values to distinguish high from low quality studies. Using this system

means that a study that fulfils any six of the 12 criteria is deemed high quality. This approach has limitations however as meta-epidemiological evidence suggests that failure on any one of the 12 criteria might alone explain a small positive effect on a subjective self-reported outcome. Some study authors did not reply to emails regarding their study interventions and methodology. This may have resulted in errors of eligibility and risk of bias rating. Furthermore, while this approach was previously recommended by Cochrane, it is no longer advocated for risk of bias assessment. Also, in the current review all the primary outcome measures were subjective self-report scales (pain or disability) and the primary outcome data assessors were the patients themselves- hence high risk of bias for both of the above considerations for all studies. The current authors did not award a point for blinded assessment. This might be considered strict as the scoring is an arbitrary process, and it is simply not possible to get this point in studies of pain.

A further significant limitation of this review is the method used to group interventions; physical versus behavioural and/or psychologically informed versus combined. The authors chose these groupings based on their interpretation of the biopsychosocial model and their experience of different interventions. Therefore, the groupings are purely subjective, creating major difficulties for interpretation of the data. In reality, interventions cannot be easily differentiated and separated which introduces a lot of heterogeneity, making meaningful comparisons very difficult.

Only studies featuring an active control group were included which may have contributed to the small effect sizes. This was deemed appropriate however given the consistent evidence that physical, behavioural and/or psychologically informed and combined interventions are superior to minimal interventions, placebo or waiting list control groups.<sup>5, 105</sup> The meta-analysis pooled the results for NP and LBP together. It could be argued that the results may



have being different if plots were formed separately. However, the subgroup and sensitivity analyses performed showed no difference, further supporting the contention that LBP and NP both involve an interaction of multiple factors across the biopsychosocial spectrum.<sup>82, 83, 99</sup>

## **Conclusion**

No clinically significant differences were found for pain and disability between physical, behavioural and/or psychologically informed and combined interventions for NSCSP. As a result, choosing the most cost-efficient, feasible rehabilitation option may be reasonable. Further work may be needed to investigate whether tailoring rehabilitation to the needs of individual patients, which has been seen in recent RCTs for LBP, can enhance outcomes in NSCSP.

## References

1. Andrews NE, Strong J, Meredith PJ. Activity pacing, avoidance, endurance, and associations with patient functioning in chronic pain: A systematic review and meta-analysis. *Arch Phys Med Rehabil.* 93:2109-2121, 2012
2. Angst F, Gantenbein AR, Lehmann S, Gysi-Klaus F, Aeschlimann A, Michel BA, Hegemann F. Multidimensional associative factors for improvement in pain, function, and working capacity after rehabilitation of whiplash associated disorder: a prognostic, prospective outcome study. *BMC Musculoskelet Disord.* 15:130, 2014
3. Apeldoorn AT, Bosmans JE, Ostelo RW, de Vet HC, van Tulder MW. Cost-effectiveness of a classification-based system for sub-acute and chronic low back pain. *Eur Spine J.* 21:1290-1300, 2012
4. Ariëns GA, van Mechelen W, Bongers PM, Bouter LM, van der Wal G. Psychosocial risk factors for neck pain: a systematic review. *Am J Ind Med* 39:180-193, 2001
5. Artus M, van der Windt D, Jordan KP, Croft PR. The clinical course of low back pain: a meta-analysis comparing outcomes in randomised clinical trials (RCTs) and observational studies. *BMC Musculoskelet Disord.* 15:68, 2014
6. Artus M, van der Windt DA, Jordan KP, Hay EM. Low back pain symptoms show a similar pattern of improvement following a wide range of primary care treatments: a systematic review of randomized clinical trials. *Rheumatology.* 49:2346-2356, 2010
7. Assendelft W, Morton S, Yu E, Suttorp M, Shekelle P. Spinal manipulative therapy for low back pain. *Cochrane Database Syst Rev.* 1, 2004
8. Bener A, Verjee M, Dafeeah EE, Falah O, Al-Juhaishi T, Schlogl J, Sedeeq A, Khan S. Psychological factors: anxiety, depression, and somatization symptoms in low back pain patients. *J Pain Res.* 6:95-101, 2013

9. Bertozzi L, Gardenghi I, Turoni F, Villafañe JH, Capra F, Guccione AA, Pillastrini P. Effect of therapeutic exercise on pain and disability in the management of chronic nonspecific neck pain: systematic review and meta-analysis of randomized trials. *Phys Ther.* 93:1026-1036, 2013
10. Bjorck-van Dijken C, Fjellman-Wiklund A, Hildingsson C. Low back pain, lifestyle factors and physical activity: a population based-study. *J Rehabil Med.* 40:864-869, 2008
11. Blozik E, Laptinskaya D, Herrmann-Lingen C, Schaefer H, Kochen MM, Himmel W, Scherer M. Depression and anxiety as major determinants of neck pain: a cross-sectional study in general practice. *BMC Musculoskelet Disord.* 10:13, 2009
12. Bombardier C, Hayden J, Beaton DE. Minimal clinically important difference. Low back pain: outcome measures. *J Rheumatol.* 28:431-438, 2001
13. Bostick GP, Carroll LJ, Brown CA, Harley D, Gross DP. Predictive capacity of pain beliefs and catastrophizing in whiplash associated disorder. *Injury.* 44:1465-1471, 2013
14. Bray H, Moseley GL. Disrupted working body schema of the trunk in people with back pain. *BJSM.* 45:168-173, 2011
15. Brennan GP, Fritz JM, Hunter SJ, Thackeray A, Delitto A, Erhard RE. Identifying subgroups of patients with acute/subacute “nonspecific” low back pain: results of a randomized clinical trial. *Spine.* 31:623-631, 2006
16. Buitenhuis J, de Jong PJ. Fear avoidance and illness beliefs in post-traumatic neck pain. *Spine.* 36:238-243, 2011
17. Carroll LJ, Cassidy JD, Côté P. Depression as a risk factor for onset of an episode of troublesome neck and low back pain. *Pain.* 107:134-139, 2004

18. Carroll LJ, Ferrari R, Cassidy JD, Côté P. Coping and recovery in whiplash-associated disorders: early use of passive coping strategies is associated with slower recovery of neck pain and pain-related disability. *Clin J Pain*. 30:1-8, 2014
19. Christiansen S, Oettingen G, Dahme B, Klinger R. A short goal-pursuit intervention to improve physical capacity: A randomized clinical trial in chronic back pain patients. *Pain*. 149:444-452, 2010
20. Clar C, Tsertsvadze A, Court R, Hundt GL, Clarke A, Sutcliffe P. Clinical effectiveness of manual therapy for the management of musculoskeletal and non-musculoskeletal conditions: systematic review and update of UK evidence report. *Chiropr ManTherap*. 22:12, 2014
21. Cohen J: Statistical power analysis for the behavioral sciences, Routledge Academic, 2013.
22. Cramer H, Haller H, Lauche R, Dobos G. Mindfulness-based stress reduction for low back pain. A systematic review. *BMC Complement Altern Med*. 12:162, 2012
23. Cramer H, Lauche R, Haller H, Dobos G. A systematic review and meta-analysis of yoga for low back pain. *Clin J Pain*. 29:450-460, 2013
24. Critchley DJ, Ratcliffe J, Noonan S, Jones RH, Hurley MV. Effectiveness and cost-effectiveness of three types of physiotherapy used to reduce chronic low back pain disability: a pragmatic randomized trial with economic evaluation. *Spine*. 32:1474-1481, 2007
25. Curatolo M, Arendt-Nielsen L, Petersen-Felix S. Evidence, mechanisms, and clinical implications of central hypersensitivity in chronic pain after whiplash injury. *Clin J Pain*. 20:469-476, 2004
26. Dagfinrud H, Storheim K, Magnussen L, Ødegaard T, Hoftaniska I, Larsen L, Ringstad P, Hatlebrette F, Grotle M. The predictive validity of the Örebro

- Musculoskeletal Pain Questionnaire and the clinicians' prognostic assessment following manual therapy treatment of patients with LBP and neck pain. *Manual Ther.* 18:124-129, 2013
27. Dankaerts W, O'Sullivan P, Burnett A, Straker L. Differences in sitting postures are associated with nonspecific chronic low back pain disorders when patients are subclassified. *Spine.* 31:698-704, 2006
  28. Dankaerts W, O'Sullivan P, Burnett A, Straker L, Davey P, Gupta R. Discriminating healthy controls and two clinical subgroups of nonspecific chronic low back pain patients using trunk muscle activation and lumbosacral kinematics of postures and movements: a statistical classification model. *Spine.* 34:1610-1618, 2009
  29. Dellve L, Ahlstrom L, Jonsson A, Sandsjö L, Forsman M, Lindegård A, Ahlstrand C, Kadefors R, Hagberg M. Myofeedback training and intensive muscular strength training to decrease pain and improve work ability among female workers on long-term sick leave with neck pain: a randomized controlled trial. *Arch Environ Occup Health* 84:335-346, 2011
  30. Deyo RA, Mirza SK, Turner JA, Martin BI. Overtreating Chronic Back Pain: Time to Back Off? *J Am Board Fam Pract.* 22:62-68, 2009
  31. Engers A, Jellema P, Wensing M, Van der Windt D, Grol R, van Tulder MW. Individual patient education for low back pain. *Cochrane Database Syst Rev.* 1, 2008
  32. Falla D, Gizzi L, Tschapek M, Erlenwein J, Petzke F. Reduced task-induced variations in the distribution of activity across back muscle regions in individuals with low back pain. *Pain* 155:944-953, 2014
  33. Fersum KV, Dankaerts W, O'Sullivan PB, Maes J, Skouen JS, Bjordal JM, Kvåle A. Integration of sub-classification strategies in RCTs evaluating manual therapy

- treatment and exercise therapy for non-specific chronic low back pain (NSCLBP): a systematic review. *BJSM*. 44:1054-1062, 2009
34. Foster NE, Hill JC, Hay EM. Subgrouping patients with low back pain in primary care: are we getting any better at it? *Manual Ther*. 16:3-8, 2011
  35. Friedrich M, Gittler G, Arendasy M, Friedrich KM. Long-term effect of a combined exercise and motivational program on the level of disability of patients with chronic low back pain. *Spine*. 30:995-1000, 2005
  36. Friedrich M, Gittler G, Halberstadt Y, Cermak T, Heiller I. Combined exercise and motivation program: effect on the compliance and level of disability of patients with chronic low back pain: a randomized controlled trial. *Arch Phys Med Rehabil*. 79:475-487, 1998
  37. Furlan AD, Pennick V, Bombardier C, van Tulder M. 2009 updated method guidelines for systematic reviews in the Cochrane Back Review Group. *Spine*. 34:1929-1941, 2009
  38. Furlan AD, van Tulder MW, Cherkin D, Tsukayama H, Lao L, Koes BW, Berman BM. Acupuncture and dry-needling for low back pain. *Cochrane Database Syst Rev*. 1, 2005
  39. Griffin DW, Harmon D, Kennedy N. Do patients with chronic low back pain have an altered level and/or pattern of physical activity compared to healthy individuals? A systematic review of the literature. *Physiotherapy*. 98:13-23, 2012
  40. Gustavsson C, Denison E, Koch Lv. Self-management of persistent neck pain: a randomized controlled trial of a multi-component group intervention in primary health care. *Eur J Pain*. 14:630. e631-630. e611, 2010

41. Guzman J, Esmail R, Karjalainen KA, Malmivaara A, Irvin E, Bombardier C. Multidisciplinary bio-psycho-social rehabilitation for chronic low-back pain. *BMJ*. 322:1511-1516, 2006
42. Hall AM, Ferreira PH, Maher CG, Latimer J, Ferreira ML. The influence of the therapist-patient relationship on treatment outcome in physical rehabilitation: a systematic review. *Phys Ther*. 90:1099-1110, 2010
43. Hayden J, Van Tulder MW, Malmivaara A, Koes BW. Exercise therapy for treatment of non-specific low back pain. *Cochrane Database Syst Rev*. 3, 2005
44. Henry SM, Van Dillen LR, Ouellette-Morton RH, Hitt JR, Lomond KV, DeSarno MJ, Bunn JY. Outcomes are not different for patient-matched versus nonmatched treatment in subjects with chronic recurrent low back pain: a randomized clinical trial. *Spine*. 14:2799-2810, 2014
45. Henschke N, Ostelo R, van Tulder MW, Vlaeyen J, Morley S, Assendelft W, Main CJ. Behavioural treatment for chronic low-back pain. *Cochrane Database Syst Rev*. 7, 2010
46. Higgins JP, Green S: *Cochrane handbook for systematic reviews of interventions*, Wiley Online Library, 2008.
47. Hill JC, Whitehurst DG, Lewis M, Bryan S, Dunn KM, Foster NE, Konstantinou K, Main CJ, Mason E, Somerville S. Comparison of stratified primary care management for low back pain with current best practice (STarT Back): a randomised controlled trial. *Lancet*. 378:1560-1571, 2011
48. Hodges PW, Tucker K. Moving differently in pain: A new theory to explain the adaptation to pain. *Pain*. 152:S90-S98, 2011
49. Hoffman BM, Papas RK, Chatkoff DK, Kerns RD. Meta-analysis of psychological interventions for chronic low back pain. *Health Psychol*. 26:1-9, 2007

50. Hoy D, March L, Woolf A, Blyth F, Brooks P, Smith E, Vos T, Barendregt J, Blore J, Murray C, Burstein R, Buchbinder R. The global burden of neck pain: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis.* 73:1309-1315, 2014
51. Huijnen IP, Rusu AC, Scholich S, Meloto C, Diatchenko L. Subgrouping of Low Back Pain Patients for Targeting Treatments: Evidence from Genetic, Psychological and Activity-related Behavioral Approaches. *Clin J Pain.* 31:123-132, 2014
52. Hurwitz EL, Carragee EJ, van der Velde G, Carroll LJ, Nordin M, Guzman J, Peloso PM, Holm LW, Côté P, Hogg-Johnson S. Treatment of neck pain: noninvasive interventions: results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine.* 33:S123-152, 2008
53. Kääpä EH, Frantsi K, Sarna S, Malmivaara A. Multidisciplinary group rehabilitation versus individual physiotherapy for chronic nonspecific low back pain: a randomized trial. *Spine.* 31:371-376, 2006
54. Kamper Steven J, Apeldoorn Andreas T, Chiarotto A, Smeets Rob JEM, Ostelo Raymond WJG, Guzman J, van Tulder Maurits W: Multidisciplinary biopsychosocial rehabilitation for chronic low back pain. *Cochrane Database Syst Rev.* 2014
55. Kankaanpää M, Taimela S, Airaksinen O, Hänninen O. The Efficacy of Active Rehabilitation in Chronic Low Back Pain: Effect on Pain Intensity, Self-Experienced Disability, and Lumbar Fatigability. *Spine.* 24:1034-1042, 1999
56. Kasch H, Qerama E, Kongsted A, Bendix T, Jensen TS, Bach FW. Clinical assessment of prognostic factors for long-term pain and handicap after whiplash injury: a 1-year prospective study. *Eur J Neurol.* 15:1222-1230, 2008
57. Keller A, Hayden J, Bombardier C, Van Tulder M. Effect sizes of non-surgical treatments of non-specific low-back pain. *Eur Spine J.* 16:1776-1788, 2007



58. Kelly GA, Blake C, Power CK, O'Keeffe D, Fullen BM. The Association Between Chronic Low Back Pain and Sleep: A Systematic Review. *Clin J Pain.* 27:169-181 2011
59. Kumar S, Beaton K, Hughes T. The effectiveness of massage therapy for the treatment of nonspecific low back pain: a systematic review of systematic reviews. *Int J Gen Med.* 6:733-741, 2013
60. Laird RA, Gilbert J, Kent P, Keating JL. Comparing lumbo-pelvic kinematics in people with and without back pain: a systematic review and meta-analysis. *BMC Musculoskelet Disord.* 15:229, 2014
61. Lallukka T, Viikari-Juntura E, Raitakari O, Kähönen M, Lehtimäki T, Viikari J, Solovieva S. Childhood and adult socio-economic position and social mobility as determinants of low back pain outcomes. *Eur J Pain.* 18:128-138, 2014
62. Linton SJ. A review of psychological risk factors in back and neck pain. *Spine.* 25:1148-1156, 2000
63. Linton SJ, Nicholas M, MacDonald S. Development of a short form of the Örebro Musculoskeletal Pain Screening Questionnaire. *Spine.* 36:1891-1895, 2011
64. Ma VY, Chan L, Carruthers KJ. Incidence, prevalence, costs, and impact on disability of common conditions requiring rehabilitation in the United States: stroke, spinal cord injury, traumatic brain injury, multiple sclerosis, osteoarthritis, rheumatoid arthritis, limb loss, and back pain. *Arch Phys Med Rehabil.* 95:986-995 2014
65. Macedo LG, Maher CG, Latimer J, McAuley JH. Motor control exercise for persistent, nonspecific low back pain: a systematic review. *Phys Ther.* 89:9-25, 2009
66. MacGregor AJ, Andrew T, Sambrook PN, Spector TD. Structural, psychological, and genetic influences on low back and neck pain: a study of adult female twins. *Arthritis Care Res.* 51:160-167, 2004

67. Machado LA, Azevedo DC, Capanema MB, Neto TN, Cerceau DM. Client-Centered Therapy vs Exercise Therapy for Chronic Low Back Pain: A Pilot Randomized Controlled Trial in Brazil. *Pain Med.* 8:251-258, 2007
68. Mafi JN, McCarthy EP, Davis RB, Landon BE. Worsening trends in the management and treatment of back pain. *JAMA Int Med.* 173:1573-1581, 2013
69. Mannion AF, Junge A, Taimela S, Müntener M, Lorenzo K, Dvorak J. Active therapy for chronic low back pain: part 3. Factors influencing self-rated disability and its change following therapy. *Spine.* 26:920-929, 2001
70. Mansell G, Hill JC, Kamper SJ, Kent P, Main C, van der Windt DA. How can we design low back pain intervention studies to better explain the effects of treatment? *Spine.* 39:305-310, 2014
71. Marshall PW, Kennedy S, Brooks C, Lonsdale C. Pilates Exercise or Stationary Cycling for Chronic Nonspecific Low Back Pain: Does it Matter? A Randomized Controlled Trial With 6-Month Follow-up. *Spine.* 38:952-959, 2013
72. Martel M, Thibault P, Sullivan M. The persistence of pain behaviors in patients with chronic back pain is independent of pain and psychological factors. *Pain.* 151:330-336, 2010
73. McCarthy CJ, Arnall FA, Strimpakos N, Freemont A, Oldham JA. The biopsychosocial classification of non-specific low back pain: a systematic review. *PTR.* 9:17-30, 2004
74. Mehling WE, Hamel KA, Acree M, Byl N, Hecht FM. Randomized controlled trial of breath therapy for patients with chronic low-back pain. *Altern Ther Health Med* 11:44, 2005
75. Menke JM. Do manual therapies help low back pain? A comparative effectiveness meta-analysis. *Spine.* 39:463-472, 2014

76. Michaleff ZA, Maher CG, Lin C-WC, Rebeck T, Jull G, Latimer J, Connelly L, Sterling M. Comprehensive physiotherapy exercise programme or advice for chronic whiplash (PROMISE): a pragmatic randomised controlled trial. *Lancet*. 384:133-141, 2014
77. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med* 151:264-269, 2009
78. Monticone M, Baiardi P, Vanti C, Ferrari S, Nava T, Montironi C, Rocca B, Foti C, Teli M. Chronic neck pain and treatment of cognitive and behavioural factors: results of a randomised controlled clinical trial. *Eur Spine J*. 21:1558-1566, 2012
79. Monticone M, Ferrante S, Teli M, Rocca B, Foti C, Lovi A, Brayda Bruno M. Management of catastrophising and kinesiophobia improves rehabilitation after fusion for lumbar spondylolisthesis and stenosis. A randomised controlled trial. *Eur Spine J*. 23:87-95, 2014
80. Myhre K, Røe C, Marchand GH, Keller A, Bautz-Holter E, Leivseth G, Sandvik L, Lau B. Fear-avoidance beliefs associated with perceived psychological and social factors at work among patients with neck and back pain: a cross-sectional multicentre study. *BMC Musculoskelet Disord*. 14:329, 2013
81. Nederhand MJ, IJzerman MJ, Hermens HJ, Turk DC, Zilvold G. Predictive value of fear avoidance in developing chronic neck pain disability: consequences for clinical decision making. *Arch Phys Med Rehabil*. 85:496-501, 2004
82. Nijs J, Meeus M, Cagnie B, Roussel NA, Dolphens M, Van Oosterwijck J, Danneels L. A modern neuroscience approach to chronic spinal pain: combining pain neuroscience education with cognition-targeted motor control training. *Phys Ther*. 94:730-738, 2014

83. O'Sullivan P. It's time for change with the management of non-specific chronic low back pain. *BJSM*. 46:224-227, 2012
84. Oliveira VC, Ferreira PH, Maher CG, Pinto RZ, Refshauge KM, Ferreira ML. Effectiveness of self-management of low back pain: Systematic review with meta-analysis. *Arthritis Care Res*. 64:1739-1748, 2012
85. Peters ML, Vlaeyen JW, Kunnen AM. Is pain-related fear a predictor of somatosensory hypervigilance in chronic low back pain patients? *Behav Res Ther*. 40:85-103, 2002
86. Rainville J, Smeets RJ, Bendix T, Tveito TH, Poiraudreau S, Indahl AJ. Fear-avoidance beliefs and pain avoidance in low back pain—translating research into clinical practice. *Spine J*. 11:895-903, 2011
87. Rantonen J, Vehtari A, Karppinen J, Luoto S, Viikari-Juntura E, Hupli M, Malmivaara A, Taimela S. Face-to-face information combined with a booklet versus a booklet alone for treatment of mild low-back pain: a randomized controlled trial. *Scand J Work Environ Health* 40:156-166, 2014
88. Rendant D, Pach D, Lüdtke R, Reissbauer A, Mietzner A, Willich SN, Witt CM. Qigong versus exercise versus no therapy for patients with chronic neck pain: a randomized controlled trial. *Spine*. 36:419-427, 2011
89. Richards MC, Ford JJ, Slater SL, Hahne AJ, Surkitt LD, Davidson M, McMeeken JM. The effectiveness of physiotherapy functional restoration for post-acute low back pain: a systematic review. *Manual Ther*. 18:4-25, 2013
90. Roche-Leboucher G, Petit-Lemanac'h A, Bontoux L, Dubus-Bausière V, Parot-Shinkel E, Fanello S, Penneau-Fontbonne D, Fouquet N, Legrand E, Roquelaure Y. Multidisciplinary intensive functional restoration versus outpatient active

- physiotherapy in chronic low back pain: a randomized controlled trial. *Spine*. 36:2235-2242, 2011
91. Sahin N, Albayrak I, Durmus B, Ugurlu H. Effectiveness of back school for treatment of pain and functional disability in patients with chronic low back pain: a randomized controlled trial. *J Rehabil Med*. 43:224-229, 2011
92. Sheng-yun L, Letu S, Jian C, Mamuti M, Jun-hui L, Zhi S, Chong-yan W, Shunwu F, Zhao F. Comparison of Modic Changes in the Lumbar and Cervical Spine, in 3167 Patients with and without Spinal Pain. *PloS One*. 9:114993, 2014
93. Sherman KJ, Cherkin DC, Wellman RD, Cook AJ, Hawkes RJ, Delaney K, Deyo RA. A randomized trial comparing yoga, stretching, and a self-care book for chronic low back pain. *Arch Intern Med*. 171:2019-2026, 2011
94. Sjölander P, Michaelson P, Jaric S, Djupsjöbacka M. Sensorimotor disturbances in chronic neck pain—range of motion, peak velocity, smoothness of movement, and repositioning acuity. *Manual Ther*. 13:122-131, 2008
95. Smeets RJ, Vlaeyen JW, Hidding A, Kester AD, van der Heijden GJ, Knottnerus JA. Chronic low back pain: physical training, graded activity with problem solving training, or both? The one-year post-treatment results of a randomized controlled trial. *Pain*. 134:263-276, 2008
96. Smeets RJ, Vlaeyen JW, Kester AD, Knottnerus JA. Reduction of pain catastrophizing mediates the outcome of both physical and cognitive-behavioral treatment in chronic low back pain. *J Pain*. 7:261-271, 2006
97. Söderlund A, Lindberg P. Cognitive behavioural components in physiotherapy management of chronic whiplash associated disorders (WAD)-a randomised group study. *Physiother Theory Pract*. 17:229-238, 2001

98. Sorensen PH, Bendix T, Manniche C, Korsholm L, Lemvig D, Indahl A. An educational approach based on a non-injury model compared with individual symptom-based physical training in chronic LBP. A pragmatic, randomised trial with a one-year follow-up. *BMC Musculoskelet Disord.* 11:212, 2010
99. Sterling M, Jull G, Kenardy J. Physical and psychological factors maintain long-term predictive capacity post-whiplash injury. *Pain.* 122:102-108, 2006
100. Sterling M, Jull G, Vicenzino B, Kenardy J, Darnell R. Physical and psychological factors predict outcome following whiplash injury. *Pain.* 114:141-148, 2005
101. Sterling M, Kenardy J, Jull G, Vicenzino B. The development of psychological changes following whiplash injury. *Pain.* 106:481-489, 2003
102. Sveinsdottir V, Eriksen HR, Reme SE. Assessing the role of cognitive behavioral therapy in the management of chronic nonspecific back pain. *J Pain Res.* 5:371-380, 2012
103. Tan G, Rintala DH, Jensen MP, Fukui T, Smith D, Williams W. A randomized controlled trial of hypnosis compared with biofeedback for adults with chronic low back pain. *Eur J Pain.* 19:271-280, 2014
104. Team RDC. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing, 2014
105. Teasell RW, McClure JA, Walton D, Pretty J, Salter K, Meyer M, Sequeira K, Death B. A research synthesis of therapeutic interventions for whiplash-associated disorder (WAD): part 4—noninvasive interventions for chronic WAD. *PRM* 15:313, 2010
106. Thompson DP, Urmston M, Oldham JA, Woby SR. The association between cognitive factors, pain and disability in patients with idiopathic chronic neck pain. *Disabil Rehabil.* 32:1758-1767, 2010

107. Turner JA, Clancy S, McQuade KJ, Cardenas DD. Effectiveness of behavioral therapy for chronic low back pain: a component analysis. *J Consult Clin Psychol.* 58:573-579, 1990
108. Valenza MC, Valenza G, González-Jiménez E, De-la-Llave-Rincón AI, Arroyo-Morales M, Fernández-de-las-Peñas C. Alteration in sleep quality in patients with mechanical insidious neck pain and whiplash-associated neck pain. *Am J Phys Med Rehabil.* 91:584-591, 2012
109. van der Giessen R, Speksnijder C, Helders P. The effectiveness of graded activity in patients with non-specific low-back pain: a systematic review. *Disabil Rehabil.* 34:1070-1076, 2012
110. van Hooff ML, Spruit M, O'Dowd JK, van Lankveld W, Fairbank JC, van Limbeek J. Predictive factors for successful clinical outcome 1 year after an intensive combined physical and psychological programme for chronic low back pain. *Eur Spine J.* 23:102-112, 2014
111. van Hooff ML, van der Merwe JD, O'Dowd J, Pavlov PW, Spruit M, de Kleuver M, van Limbeek J. Daily functioning and self-management in patients with chronic low back pain after an intensive cognitive behavioral programme for pain management. *Eur Spine J.* 19:1517-1526, 2010
112. van Middelkoop M, Rubinstein SM, Kuijpers T, Verhagen AP, Ostelo R, Koes BW, van Tulder MW. A systematic review on the effectiveness of physical and rehabilitation interventions for chronic non-specific low back pain. *Eur Spine J.* 20:19-39, 2011
113. Van Tulder M, Furlan A, Bombardier C, Bouter L, Group EBotCCBR. Updated method guidelines for systematic reviews in the Cochrane Collaboration Back Review Group. *Spine.* 28:1290-1299, 2003

114. van Tulder MW, Ostelo R, Vlaeyen JW, Linton SJ, Morley SJ, Assendelft WJ. Behavioral treatment for chronic low back pain: a systematic review within the framework of the Cochrane Back Review Group. *Spine*. 25:2688-2699, 2000
115. Veehof MM, Oskam M-J, Schreurs KM, Bohlmeijer ET. Acceptance-based interventions for the treatment of chronic pain: a systematic review and meta-analysis. *Pain*. 152:533-542, 2011
116. Vereckei E, Susanszky E, Kopp M, Ratko I, Czimbalmos A, Nagy Z, Palkonyai E, Hodinka L, Temesvari I P, Kiss E. Psychosocial, educational, and somatic factors in chronic nonspecific low back pain. *Rheumatol Int*. 33:587-592, 2013
117. Vibe Fersum K, O'Sullivan P, Skouen J, Smith A, Kvåle A. Efficacy of classification-based cognitive functional therapy in patients with non-specific chronic low back pain: A randomized controlled trial. *Eur J Pain*. 17:916-928, 2013
118. Viikari-Juntura E, Martikainen R, Luukkonen R, Mutanen P, Takala E, Riihimäki H. Longitudinal study on work related and individual risk factors affecting radiating neck pain. *J Occup Environ Med*. 58:345-352, 2001
119. Viljanen M, Malmivaara A, Uitti J, Rinne M, Palmroos P, Laippala P. Effectiveness of dynamic muscle training, relaxation training, or ordinary activity for chronic neck pain: randomised controlled trial. *BMJ*. 327:475, 2003
120. Vonk F, Verhagen AP, Twisk JW, Köke AJ, Luiten MW, Koes BW. Effectiveness of a behaviour graded activity program versus conventional exercise for chronic neck pain patients. *Eur J Pain*. 13:533-541, 2009
121. Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Ezzati M, Shibuya K, Salomon JA, Abdalla S, Aboyans V. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 380:2163-2196, 2013



122. Wang X-Q, Zheng J-J, Yu Z-W, Bi X, Lou S-J, Liu J, Cai B, Hua Y-H, Wu M, Wei M-L. A meta-analysis of core stability exercise versus general exercise for chronic low back pain. *PloS One*. 7:e52082, 2012
123. Wertli MM, Eugster R, Held U, Steurer J, Kofmehl R, Weiser S. Catastrophizing-A Prognostic Factor for Outcome in Patients with Low Back Pain-A Systematic Review. *Spine*. 14:2639-2657, 2014
124. Wicksell RK, Ahlqvist J, Bring A, Melin L, Olsson GL. Can Exposure and Acceptance Strategies Improve Functioning and Life Satisfaction in People with Chronic Pain and Whiplash-Associated Disorders (WAD)? A Randomized Controlled Trial. *Cogn Behav Ther*. 37:169-182, 2008
125. Woby SR, Roach NK, Urmston M, Watson PJ. The relation between cognitive factors and levels of pain and disability in chronic low back pain patients presenting for physiotherapy. *Eur J Pain*. 11:869-877, 2007
126. Woby SR, Urmston M, Watson PJ. Self-efficacy mediates the relation between pain-related fear and outcome in chronic low back pain patients. *Eur J Pain*. 11:711-718, 2007
127. Yip CHT, Chiu TTW, Poon ATK. The relationship between head posture and severity and disability of patients with neck pain. *Manual Ther*. 13:148-154, 2008
128. Ylinen J, Salo P, Nykänen M, Kautiainen H, Häkkinen A. Decreased isometric neck strength in women with chronic neck pain and the repeatability of neck strength measurements. *Arch Phys Med Rehabil*. 85:1303-1308, 2004

## Figure Legends

Figure 1 Literature search flowchart

Supplementary Appendix A Literature search strategy

Supplementary Appendix B CBRG risk of bias assessment tool

Table 1 CBRG risk of bias scores for included studies

Table 2 Overview of characteristics of included studies

Figure 2 Effect of Physical vs Behavioural and/or psychologically informed interventions on pain

Figure 3 Effect of Physical vs Behavioural and/or psychologically informed interventions on disability

Figure 4 Effect of Physical vs Combined interventions on pain

Figure 5 Effect of Physical vs Combined interventions on disability

Table 1 CBRG risk of bias scores for included studies

Author	1	2	3	4	5	6	7	8	9	10	11	12	Total
Christensen et al. 2010	+	+	-	-	-	+	+	+	+	+	+	+	9
Critchley et al. 2007	+	+	-	-	-	-	+	+	+	-	+	+	7
Dellve et al. 2011	+	+	-	-	-	+	+	+	?	+	+	+	8
Ferreira et al. 2007	+	+	-	-	-	+	+	+	?	+	+	+	8
Friedrich et al. 2005	+	?	-	-	-	-	+	+	?	-	+	+	5
Friedrich et al. 1998	+	?	-	-	-	-	+	+	?	+	+	+	6
Gustavsson et al. 2006	+	+	-	-	-	?	+	+	?	?	+	+	6
Gustavsson et al. 2010	+	+	-	-	-	-	+	+	?	?	+	+	6
Gustavsson et al. 2011	+	+	-	-	-	-	+	+	?	?	+	+	6
Kankaanpaa et al. 1999	+	?	-	-	-	+	+	+	?	+	+	+	7
Kaapa et al. 2006	+	+	-	-	-	+	+	+	?	?	+	+	7
Macedo et al. 2012	+	+	-	-	-	+	+	+	?	+	+	+	8
Machado et al. 2007	+	+	-	-	-	+	+	+	?	+	+	+	8
Mehling et al. 2005	+	+	-	-	-	+	+	+	+	+	+	+	9
Monticone et al. 2012	+	+	-	-	-	+	+	+	+	+	+	+	9
Rendant et al. 2011	+	+	-	-	-	+	+	+	?	+	+	+	8
Roche-Leboucher et al. 2011	+	+	-	-	-	-	+	+	?	?	?	+	5
Sahin et al. 2011	+	+	-	-	-	+	+	+	+	+	?	+	8
Sherman et al. 2011	+	+	-	-	-	+	+	+	+	?	+	+	8
Smeets et al. 2008	+	+	-	-	-	+	+	+	+	+	+	+	9
Sorenson et al. 2010	+	+	-	-	-	+	+	+	-	-	+	+	7
Turner et al. 1990	+	?	-	-	?	-	+	+	?	+	?	+	5
Viljanen et al. 2003	+	+	-	-	-	+	+	+	+	?	+	+	8
Vonk et al. 2009	+	+	-	-	-	-	+	+	+	+	+	+	8

Table 2 Overview of characteristics of included studies

Study	Sample size	Gender	Mean age	Pain condition	Interventions	Pain intensity measure	Disability Measure	Length of follow-up	Inclusion and exclusion criteria	Results summary	Included in meta-analysis
<b>Christiansen et al., 2010</b>	60	38F/22M	47.7	CLBP	1.Exercise therapy and education plus goal setting, CBT and a goal pursuit strategy (Combined)  2. Exercise therapy and education (Physical)	NRS (0-10)	Hannover ADL instrument (0-100)	3mths	LBP >6mths	No significant difference in pain between groups  Significant difference observed in disability between groups, favouring group 1	✓
<b>Critchley et al., 2007</b>	212	136F/76M	44	CLBP	1.Individual physiotherapy (exercise, joint mobilization, massage) (Physical)  2.Spinal stabilisation classes (Physical)  3. Pain management	NRS (0-100)	RMDQ (0-24)	6mths 12mths 18mths	LBP>12wks	No significant difference in pain and disability between groups	✓

					classes (education, exercise, CBT) (Combined)						
<b>Dellve et al., 2011</b>	73	73F/0M		Chronic NP	1.Exercise (Muscular strength training) (Physical)  2. Myofeedback (Behavioural/or psychologically informed)	NRS (0-10)		3mths	NP>12mths	No significant difference in pain and disability between groups	✓
<b>Ferreira et al 2007</b>	240	165F/74M	53.5	CLBP	1.Spinal manipulation (Physical)  2.General exercise plus CBT (Combined)  3.Motor control exercises plus CBT (Combined)	VAS (0-10)	RMDQ (0-24)	6mths 12mths	LBP>3mths	No significant differences in pain and disability between groups	✓
<b>Friedrich et al 1998</b>	93	47F/46M	44	CLBP	1.Combined exercise and motivation program (Combined)  2.Exercise program (Physical)	NRS (0-100)	Low back outcome scale (0-75)	4mths 12mths	LBP>4mths	Significant difference observed in both pain and disability, favouring group 1	✓
<b>Friedrich et al 2005</b>	93	47F/46M	44	CLBP	1.Combined exercise and motivation program (Combined)	NRS (0-100)	Low back outcome scale (0-75)	5years	LBP>4mths	Significant difference observed both in	X

					2.Exercise program (Physical)					pain and disability between groups, favouring group 1, massive dropout	
<b>Gustavsson and von Koch 2006</b>	37	28F/1M	39.5	Chronic NP	1.Pain and stress management group intervention with applied relaxation (Combined)  2.Individual physiotherapy (electrotherapy, exercise, massage, acupuncture, heat) (Physical)	NRS (0-10)	NDI (0-50)	20wks	NP>3mths	No significant difference in pain and disability between groups	✓
<b>Gustavsson et al., 2010</b>	156	139F/17M	45.7	Chronic NP	1.A multi-component pain and stress self-management group intervention (Combined)  2.Individual physiotherapy (electrotherapy, exercise, massage, acupuncture, heat) (Physical)	NRS ( 0-10)	NDI (0-100)	20wks	NP>3mths	No significant difference in pain and disability between groups	✓
<b>Gustavsson</b>	156	139F/17M	45.7	Chronic	1.A multi-	NRS ( 0-	NDI (0-	1year	NP>3mths	No	✓

<b>et al., 2011</b>				NP	component pain and stress self-management group intervention (Combined)  2. Individual physiotherapy (electrotherapy, exercise, massage, acupuncture, heat) (Physical)	10)	100)	2years		significant difference in pain and disability between groups	
<b>Kaapa et al., 2006</b>	120	120F/0M	46.3	CLBP	1. Multidisciplinary group rehabilitation (exercise, CBT, relaxation, back school education) (Combined)  2. Individual physiotherapy (exercise, massage, spinal traction, mobilisation, ultrasound) (Physical)	NRS (0-10)	ODI (0-100)	6mths 12mths 2years	LBP>3mths	No significant difference in pain and disability between groups	✓
<b>Kankaanpaa et al., 1999</b>	59	22F/37M	39.6	CLBP	1. Exercise and behavioural support (Combined)  2. Individual physiotherapy (Physical)	VAS (0-100)	The Pain and Disability Index (0-70)	6mths 12mths	LBP>3mths	Significant difference observed both in pain and disability between groups, favouring	✓

										group 1	
<b>Macedo et al., 2012</b>	172	102F/70M	49	CLBP	1.Graded activity (Combined)  2.Motor control exercises (Physical)	NRS (0-10)	RMDQ (0-24)	6mths 12mths	LBP>3mths	No significant difference in pain and disability between groups	✓
<b>Machado et al. 2007</b>	33	23F/ 10M	43.5	CLBP	1.Exercise (walking, stretching, strengthening) (Physical)  2.Client-centered therapy (Behavioural and/or psychologically informed)	VAS (0-10)	RMDQ (0-24)	6mths	LBP>3mths	At short-term follow-up, significant difference observed in disability between groups, favouring group 1. At long-term, no significant difference in pain or disability between groups	✓
<b>Mehling et al., 2005</b>	36	26F/10M	49.2	CLBP	1.Breath therapy (Behavioural and/or psychologically informed)	VAS (0-10)	RMDQ (0-24)	6mths	LBP>3mths	No significant difference in pain and disability	✓



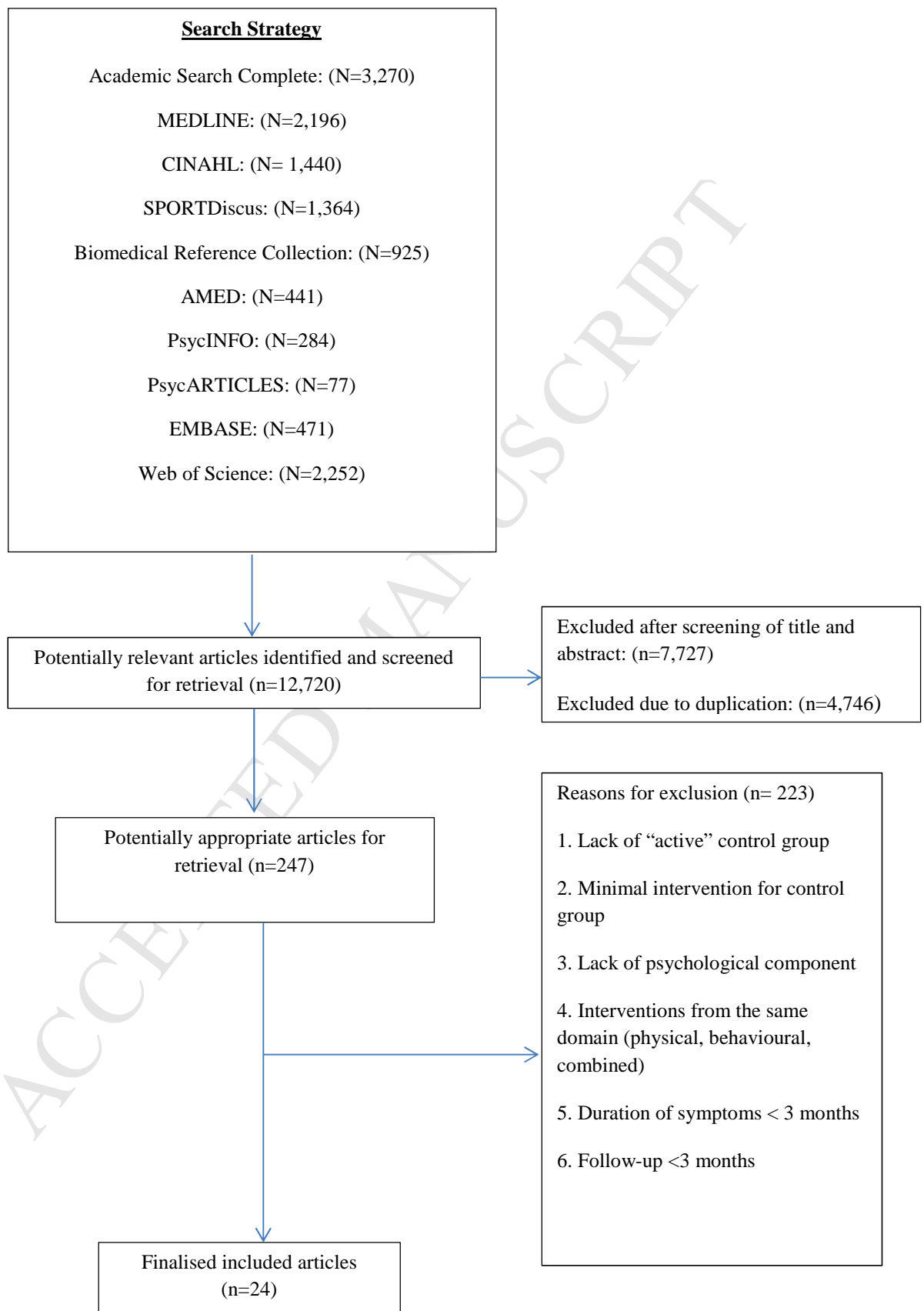
					2. Individual physiotherapy (exercise, education, soft tissue and joint mobilisation) (Physical)					between groups	
<b>Monticone et al., 2012</b>	80	60F/20M	49.5	CLBP	1. Neck exercises plus CBT (Combined) 2. Neck exercises (Physical)	NRS (0-10)	Neck pain and disability scale (0-100)	12mths	NP>3mths	No significant difference in pain and disability between groups	✓
<b>Rendant et al., 2011</b>	123	107F/15M	45.6	CLBP	1. Qigong (Combined) 2. Exercise therapy (Physical)	VAS (0-100)	Neck pain and disability scale (0-100)	3mths 6mths	NP>6mths	No significant difference in pain and disability between groups	✓
<b>Roche Leboucher et al., 2011</b>	132	46F/86M	39.8	CLBP	1. Functional restoration (exercise, occupational therapy, psychology) (Combined) 2. Individual physiotherapy (exercise, pain management) (Physical)	VAS (0-10)		12mths	LBP>3mths	No significant difference in pain and disability between groups	✓

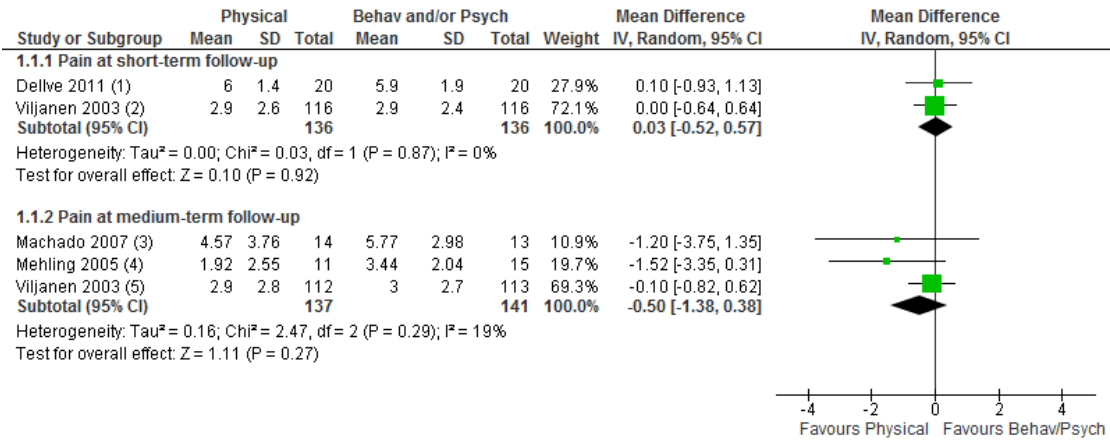
<b>Sahin et al., 2011</b>	146	112F/34M	49.3	CLBP	1.Back school, plus exercise plus TENS, US and heat (Combined)  2.Exercise plus TENS, US and heat (Physical)	VAS (0-10)	ODI (0-100)	3mths	LBP>12weeks	Significant difference observed in pain and disability between groups, favouring group 1	✓
<b>Sherman et al., 2011</b>	228	146F/82M	48.4	CLBP	1.Yoga (Combined)  2.Stretching (Physical)	NRS (0-10)	RMDQ (0-23)	12wks 26wks	LBP>3mths	No significant difference in pain and disability between groups	✓
<b>Smeets et al., 2008</b>	223	105F/118M	41.6	CLBP	1.Exercise (Physical)  2.Graded activity plus problem solving (Combined)  3.Exercise plus graded activity and problem solving (Combined)	VAS (0-100)	RMDQ (0-24)	6mths 12mths	LBP>3mths	No significant difference in pain and disability between groups	✓
<b>Sorensen et al., 2010</b>	207	108F/ 99M	39	CLBP	1.Exercise and Educational programme (Combined)	NRS (0-10)	RMDQ (0-23)	6mths 12mths	LBP>4mths	No significant difference in pain and disability	✓

					2.Individual exercise therapy (Physical)					between groups	
<b>Turner et al., 1990</b>	96	46F/50M	44	CLBP	1.Group behavioural therapy plus aerobic exercise (Combined)  2.Behavioural therapy only (Behavioural and/or psychologically informed)  3.Aerobic exercise only (Physical)	McGill pain rating index (0-78)		6mths 12mths	LBP>6mths	No significant difference in pain and disability between groups	X
<b>Viljanen et al., 2003</b>	393	393F/0M	45	Chronic NP	1.Dynamic muscle training (Physical)  2.Relaxation (Behavioural and/or psychologically informed)  3.Ordinary activity (Physical)	NRS (0-10)	NDI (0-80)	3mths 6mths	NP>12wks	No significant difference in pain and disability between groups	✓
<b>Vonk et al., 2009</b>	30	9F/21M	45.7	Chronic NP	1.Behaviour graded activity (Combined)	NRS (0-10)	NDI (0-100)	26wks 12mths	NP>3mths	No significant difference	✓

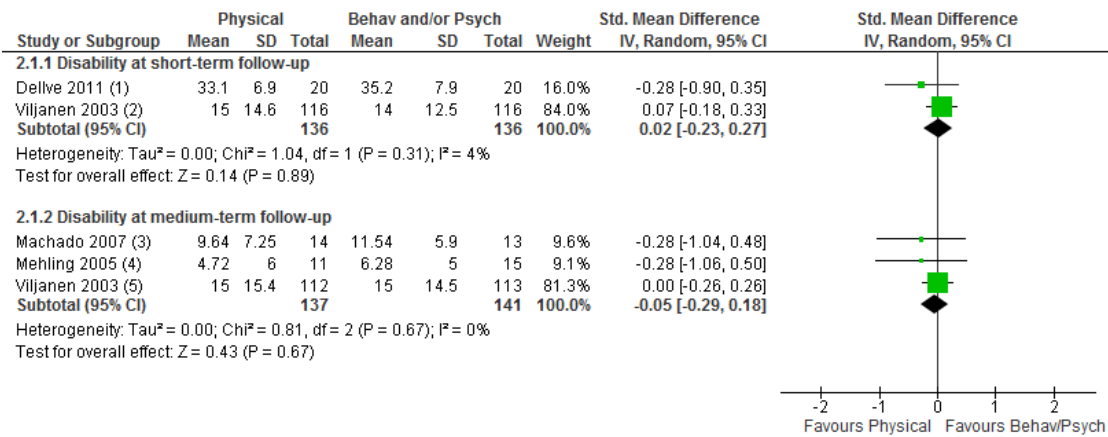
					2. Individual physiotherapy (exercise, massage, mobilizations) (Physical)					in pain and disability between groups	
--	--	--	--	--	---	--	--	--	--	---------------------------------------	--

mths: months; CBT: cognitive behavioural therapy; LBP: low back pain; APT: active physical training; NP: neck pain; MET: motivational enhancement treatment

**Figure 1 Literature Search Flowchart**



- (1) Exercise vs. Myofeedback; change scores presented in text; SD used from baseline; neck  
(2) Exercise vs. relaxation; neck  
(3) Exercise vs. client-centred therapy; data from author; low back  
(4) Individual physiotherapy vs. breath therapy; change scores presented in text; SD from baseline; low back  
(5) Exercise vs. relaxation; neck



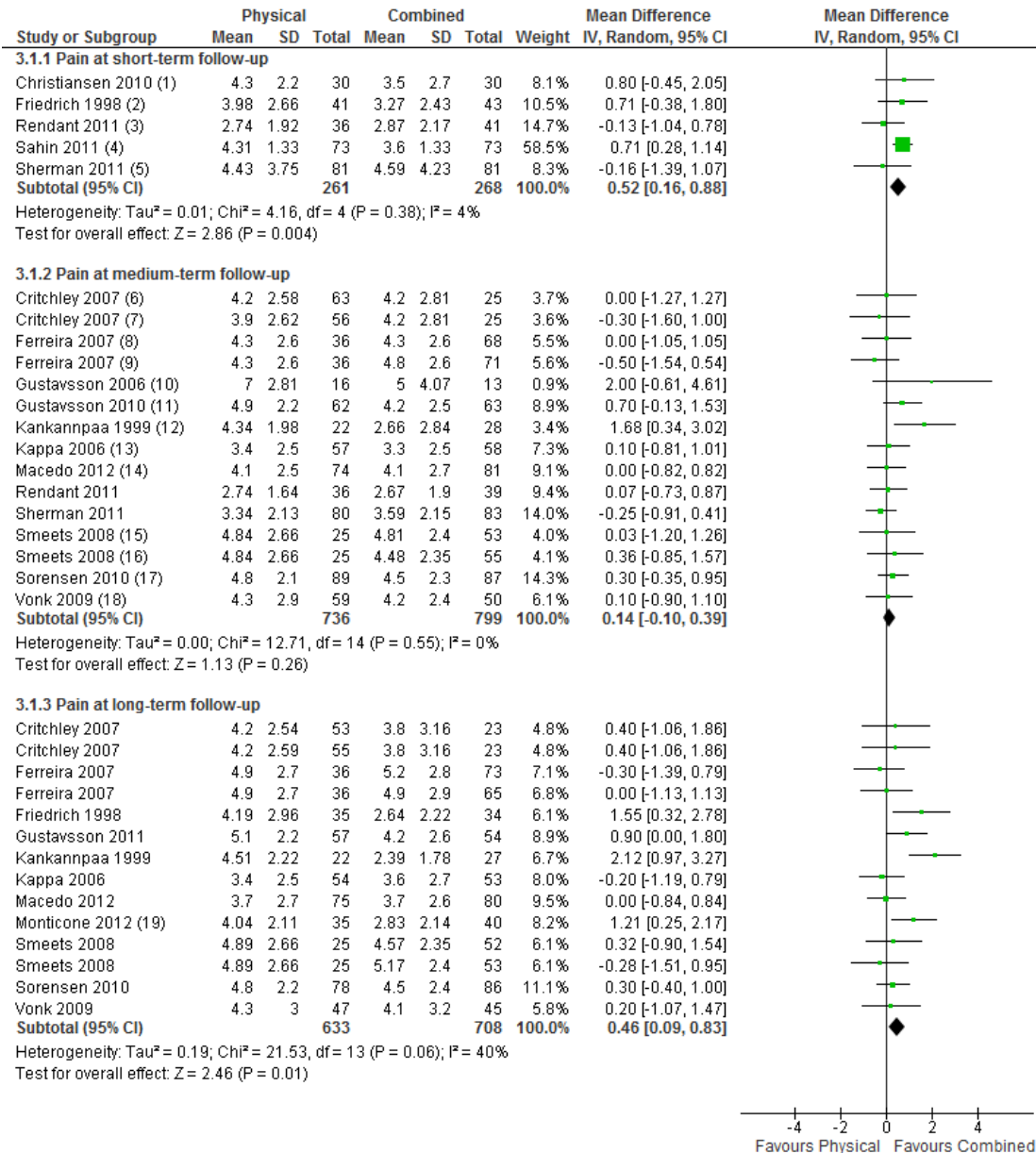
(1) Exercise vs. Myofeedback; SD used from baseline; Work Ability Index (scores reversed); neck

(2) Exercise vs. relaxation; NDI; neck

(3) Exercise vs. client-centred therapy; data from author; RMDQ; low back

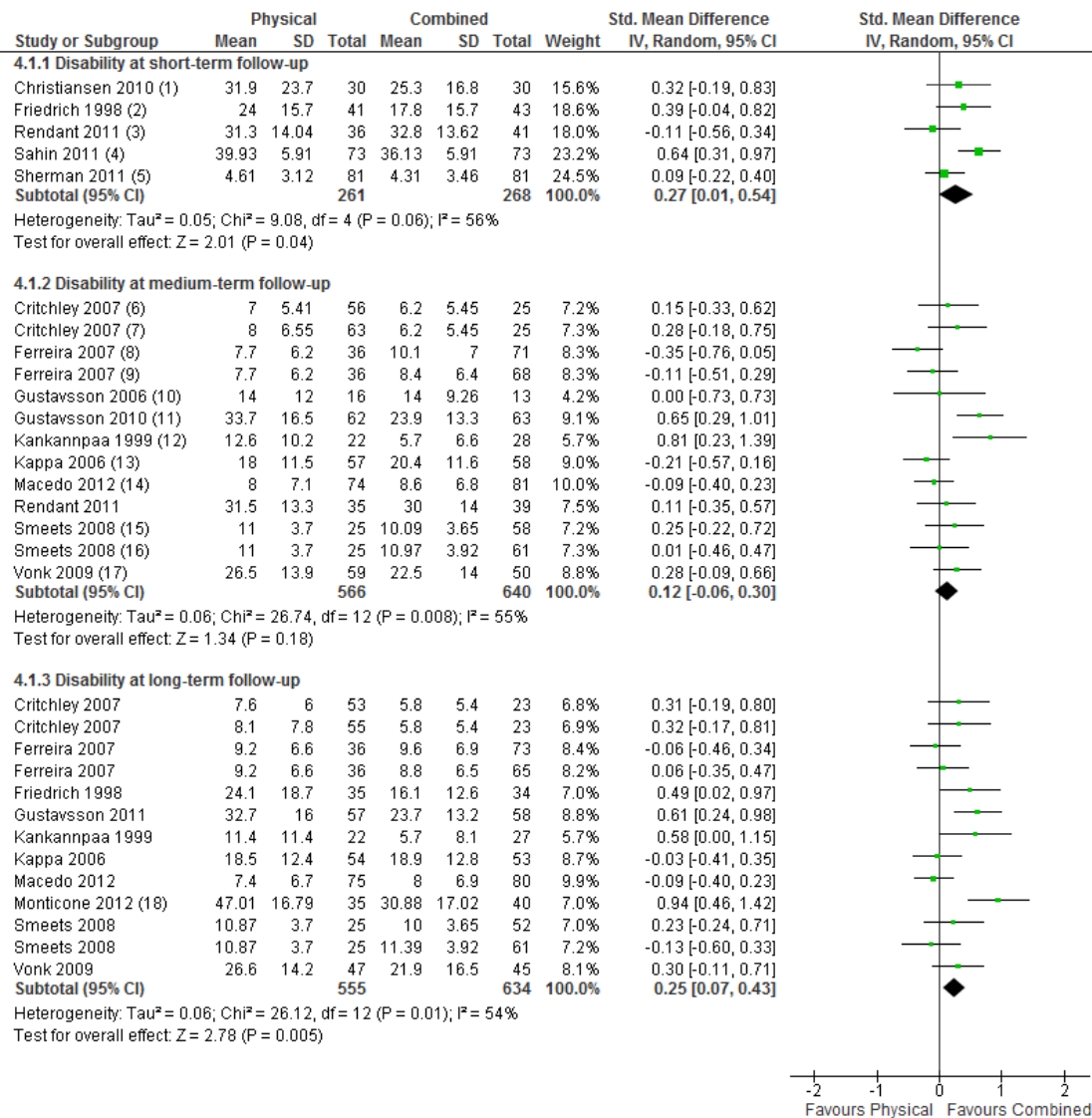
(4) Individual physiotherapy vs. breath therapy; change scores presented in text; SD from baseline; RMDQ; low back

(5) Exercise vs. relaxation; NDI; neck



- (1) Exercise vs. exercise + goal setting; low back
- (2) Exercise vs. exercise + motivation; low back
- (3) Exercise vs. qigong; neck
- (4) Individual physiotherapy vs. individual physiotherapy + back school; low back
- (5) Exercise vs. yoga; adjusted scores from regression; low back
- (6) Individual physiotherapy vs. physiotherapy pain management; number of pain management subjects was halved; low back
- (7) Spinal stabilisation vs. physiotherapy pain management; number of pain management subjects was halved; low back
- (8) SMT vs. motor control exercises + CBT; number of subjects in SMT was halved; neck
- (9) SMT vs. general exercises + CBT; number of subjects in SMT was halved; neck
- (10) Individual physiotherapy vs. pain management + stress management; mean and SD estimated from median and IQR; neck
- (11) Individual physiotherapy vs. pain management + stress management; neck
- (12) Individual physiotherapy vs. exercise + behavioural support; low back
- (13) Individual physiotherapy vs. exercise + relaxation + CBT + education; low back
- (14) Motor control exercises vs. graded activity; low back
- (15) Exercise vs. exercise + graded activity + problem solving; number of subjects in exercise was halved; SD from baseline; low back
- (16) Exercise vs. graded activity + problem solving; number of subjects in exercise was halved; SD from baseline; low back
- (17) Exercise vs. education; low back
- (18) Exercise vs. graded activity; neck
- (19) Neck exercises vs. neck exercises + CBT; neck





- (1) Exercise vs. exercise + goal setting; Hannover ADL Instrument (scores reversed); low back
- (2) Exercise vs. exercise + motivation; low back outcome scale (scores reversed); low back
- (3) Exercise vs. qigong; pain and neck disability scale; neck
- (4) Individual physiotherapy vs. individual physiotherapy + back school; ODI; low back
- (5) Exercise vs. yoga; adjusted scores from regression; RMDQ; low back
- (6) Spinal stabilisation vs. physiotherapy pain management; number of pain management subjects was halved; RMDQ; low back
- (7) Individual physiotherapy vs. physiotherapy pain management; number of pain management subjects was halved; RMDQ; low back
- (8) SMT vs. general exercises + CBT; number of subjects in SMT was halved; RMDQ; neck
- (9) SMT vs. motor control exercises + CBT; number of subjects in SMT was halved; RMDQ; neck
- (10) Individual physiotherapy vs. pain management + stress management; mean and SD estimated from median and IQR; NDI; neck
- (11) Individual physiotherapy vs. pain management + stress management; NDI; neck
- (12) Individual physiotherapy vs. exercise + behavioural support; PDI; low back
- (13) Individual physiotherapy vs. exercise + relaxation + CBT + education; ODI; low back
- (14) Motor control exercises vs. graded activity; RMDQ; low back
- (15) Exercise vs. graded activity + problem solving; number of subjects in exercise was halved; SD from baseline; RMDQ; low back
- (16) Exercise vs. exercise + graded activity + problem solving; number of subjects in exercise was halved; SD from baseline; RMDQ; low back
- (17) Exercise vs. graded activity; NDI; neck
- (18) Neck exercises vs. neck exercises + CBT; neck pain and disability scale; neck

**Highlights**

- Conservative rehabilitation for NSCSP includes physical, behavioural and/or psychologically informed or combined interventions.
- We performed a systematic review and meta-analysis to compare the effectiveness of physical, behavioural and/or psychologically informed, and combined interventions on pain and disability in patients with NSCSP.
- No clinically significant differences were found for pain and disability between physical, behavioural and/or psychologically informed and combined interventions.